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Original Article

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Association of Mediterranean and DASH Diets Adherence with Dyslipidemia: A Cross-Sectional Study

Sanaz Mehrabani[1], Shirin Gerami[2], Mehran Nouri[3,4,5], Milad Rajabzadeh-Dehkordi[5], Moein Askarpour[6], Maryam Najafi[5], Niloofar Omidbeigi[1] and Shiva Faghih[2,5]*

1. Department of Clinical Nutrition, School of Nutrition and Food Science, Food Security Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

2. Nutrition Research Center, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

3. Health Policy Research Center, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran

4. Students' Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran

5. Department of Community Nutrition, School of Nutrition and Food Science, Shiraz University of Medical Sciences, Shiraz, Iran

6.Student Research Committee, Department of Clinical Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

Background: Some dietary patterns like Dietary Approaches to Stopping Hypertension (DASH) and/or Mediterranean Diet (MED) are often recommended to prevent Cardio Vascular Diseases (CVDs) based on their effects on lipid profile. Thus, we aimed to investigate the relationship between the DASH diet score and Mediterranean diet score with lipid profile in healthy individuals aged 20-50 years in Shiraz, Iran.

Methods: In this cross-sectional study, 236 participants were selected from Shiraz (Iran) medical centers through random cluster sampling. Information about food intake was collected using a 168-item Food Frequency Questionnaire (FFQ), then DASH score and MED diet score were calculated. Logistic regression was used to evaluate the relation between DASH and MED score adherence and lipid profile.

Results: Individuals in the highest tertile of MED and DASH pattern adherence had significantly lower Low-Density Lipoprotein (LDL) compared with those in the first tertile ($p<0.05$). In both crude and adjusted model, higher adherence to the MED pattern was associated with reduced odds of Total Cholesterol (TC) (OR: 0.30; 95% CI: 0.13–0.66 and OR: 0.27; 95% CI: 0.12–0.61) and LDL (OR: 0.36; 95% CI: 0.17–0.77 and OR: 0.32; 95% CI: 0.15–0.70). Moreover, higher adherence to the DASH pattern was associated with reduced OR of LDL in crude (OR: 0.43; 95% CI: 0.19–0.94) and TC in adjusted model (OR: 0.44; 95% CI: 0.20–0.96).

Conclusion: The study illustrated a negative association between the MED diet and serum levels of TC and LDL. Also, a higher DASH score was associated with lower TC. Future studies are necessary to confirm these findings.

Keywords: DASH, Mediterranean diet, Lipid profile

*** Corresponding author**

Shiva Faghih, Ph.D
Nutrition Research Center, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
Tel: +98 71 3725 1007
Email: shivafaghih@gmail.com

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Introduction

Cardiovascular Diseases (CVDs) are the leading cause of morbidity worldwide. According to world health organization (1) report, out of the 17 million deaths under the age of 70 from non-communicable diseases in 2019, 38% were due to CVDs (1). And the prevalence of hypertriglyceridemia, hypercholesterolemia and low levels of High Density Lipoprotein (HDL) reported 46.0, 41.6 and 35.5% in Iranian population, respectively (2). Demographic factors, lifestyle, unhealthy diet, dyslipidemia and metabolic syndrome are involved in the development of CVDs (3). The prevalence of dyslipidemia varies geographically, but it is generally estimated that more than half of the adult population worldwide has dyslipidemia (4).

Recently, much attention has been given to the association between dietary patterns and CVDs risk factors, which is a more comprehensive approach compared to the study of nutrients or individual food groups. Several studies have examined the beneficial effects of dietary patterns in reducing insulin resistance, controlling fasting blood glucose and lipid profile (5-7). Among different priori dietary patterns, Dietary Approaches to Stopping Hypertension (DASH) and/or Mediterranean Diet (MED) are often recommended to prevent CVDs and associated health consequences (6,7). The beneficial effects of DASH diet on lipid profile can be due to its low fat content so that it is low in total fat, saturated fat and cholesterol, and high in potassium, calcium and magnesium (8). Moreover, the significant fiber content of DASH and MED diet can increase the fecal excretion of bile acids, reduce the cholesterol pool in the liver, modify the activity of enzymes involved in calcium homeostasis and regulate the expression of liver low-density lipoprotein (LDL) receptors and increase plasma LDL elimination (9).

According to previous studies, DASH diet is associated with decreased serum levels of TC (Total Cholesterol), TG (Triglyceride), LDL and LDL/HDL ratio (10). In addition, high adherence to the MED diet may be directly associated with increased HDL levels and a reduced risk of high TC (10,11). Some studies, however, have found no association between the DASH/MED diet and lipid profile (12,13).

Considering the importance of lipid profile in the development of cardiovascular disease and its relationship with dietary patterns and the lack of studies and conflicting results in this field, in this study, we aimed to evaluate the DASH diet score and Mediterranean diet score among adult population in Shiraz and find their associations with lipid profile.

Materials and Methods

Study population

This cross-sectional study was performed on 236 participants from healthcare centers of Shiraz-Iran [The detailed of this study have been previously published (14,15)]. Men and women with the limit age of 20-50 years were selected through cluster random sampling. Participants had not previously followed any particular diet and did not have history of any chronic diseases. After describing the purpose and method of the study, all the participants signed the written informed consents.

Ethics: Shiraz University of Medical Sciences has approved the protocol of this study (IR.SUMS.REC.1394.S146).

Dietary assessment

The habitual dietary intakes of participants were collected by a 168-item Food Frequency Questionnaire (FFQ) through face-to-face interviews. The validity and reliability of this questionnaire have been evaluated among Iranian adults (16). Based on household scales, the food intakes of participants in the completed FFQs were changed to grams. For calculating the average of energy and nutrients intakes, NUTRITIONIST IV for Iranian was used (version 7.0; N-Squared Computing, Salem, OR, USA).

Diet quality scores

DASH score was calculated using 8 components and participants were placed in quintiles based on their intake ranking. The components including high intake of vegetables, fruits, legumes and nuts, low-fat dairies, and whole grain (1 point was devoted to quintile 1 and 5 points were devoted to quintile 5) also low intake of sodium, red meats and sweetened beverages (5 points were assigned to quintile 1 and 1 point was assigned to quintile 5). Finally, total points of 8 components was 8 to 40, which was considered

Table 1. Baseline characteristics of the participants by tertiles of MED and DASH pattern adherence

Variables	MED				DASH			
	T_1 (n=85)	T_2 (n=70)	T_3 (n=81)	p	T_1 (n=80)	T_2 (n=75)	T_3 (n=81)	p
Age (year)	45.25±10.96	45.22±11.95	47.37±12.36	0.420	45.22±11.83	46.27±11.61	46.67±11.87	0.719
Weight (*kg*)	75.63±14.40	73.30±13.65	75.01±14.80	0.594	75.40±13.18	74.38±15.80	74.20±14.17	0.847
Height (*cm*)	162.14±8.51	162.22±9.22	162.98±11.15	0.832	164.46±9.18	161.91±9.69	160.18±9.85	0.020
BMI (kg/m^2)	28.74±4.80	27.85±4.71	28.14±4.56	0.485	27.90±4.53	28.32±5.23	28.77±4.22	0.515
Waist (*cm*)	94.69±11.95	93.44±10.91	94.36±11.16	0.788	93.78±11.06	93.94±12.42	95.13±10.55	0.740
WHR	0.89±0.06	0.90±0.08	0.91±0.07	0.370	0.90±0.07	0.89±0.07	0.91±0.09	0.473
TG (*mg/dl*)	125.50±62.35	125.75±69.93	114.35±61.80	0.477	130.80±59.41	120.13±64.61	109.79±69.69	0.123
TC (*mg/dl*)	187.25±48.83	179.21±38.56	172.55±39.47	0.088	187.54±45.30	174.59±41.71	175.04±40.48	0.085
LDL (*mg/dl*)	114.41±38.68	112.47±33.15	101.33±33.74	0.028	115.64±35.66	108.03±34.36	102.05±28.76	0.039
HDL (*mg/dl*)	38.27±9.19	37.31±10.15	38.45±13.52	0.821	38.18±9.95	36.69±11.20	39.26±12.38	0.379
Physical activity (MET/day)	16..49±33.14	24.77±38.16	22.71±48.50	0.409	21.97±46.60	24.03±45.13	16.53±20.68	0.528
Sex [n (%)]								
Male	28 (28.9)	30 (30.9)	39 (40.2)	0.129	43 (44.3)	32 (33.0)	22 (22.7)	0.230
Female	57 (41.0)	40 (28.8)	42 (30.2)		50 (36.0)	44 (31.7)	45 (32.4)	
Smoking history [n (%)]								
Yes	13 (46.4)	9 (32.1)	6 (21.4)	0.278	15 (53.6)	7 (25.0)	6 (21.4)	0.263
No	72 (34.6)	61 (29.3)	75 (36.1)		78 (37.5)	69 (33.2)	61 (29.3)	
Alcohol history [n (%)]								
Yes	2 (50.0)	1 (25.0)	1 (25.0)	0.838	2 (50.0)	2 (50.0)	0 (0.0)	0.434
No	83 (35.8)	69 (29.7)	80 (34.5)		91 (39.2)	74 (31.9)	67 (28.9)	

MED, Mediterranean diet score; DASH, dietary approaches to stop hypertension trial (DASH) diet score; BMI, body mass index; WHR, waist to hip ratio; TG, triglyceride; TC, total cholesterol; LDL, low density lipoprotein; HDL, low density lipoprotein.

Values are mean ± SD for continuous and percentage for categorical variables.

Using one-way ANOVA for continuous and Chi-square test for categorical variables.

Significant associations are in bold.

as DASH score (17).

For MED diet score, food intake of participants was categorized into 10 components including whole grains, potatoes, vegetables, fruits, legumes, fish, poultry, red and processed meats, high fat dairy products, and olive oil (we allocated separate ratings, from 0 to 5 or the inverse). Alcohol consumption was excluded for religious reasons sine it is not common in the Iranian diet. Total score of these 10 items was 0 to 50, which was used as MED score (18).

Biochemical assessments

A blood sample was collected from each participant after 12 hours fasting. Lipid profile including TC, TG, LDL and HDL were measured by commercially-existing enzymatic reagents (Pars Azmoon, Tehran, Iran).

Socio-demographic and anthropometric assessments

Age, sex, alcohol intake and smoking habits (yes or no), were gathered using a demographic questionnaire. We used the International Physical Activity Questionnaires (IPAQ) for determining physical activity level (19). Anthropometric indices (weight, height and waist circumference) were measured by a trained nutritionist. The individual's weight was measured by a digital scale (SECA 813; Seca, Hamburg, Germany) with an accuracy of 100 *g* in light clothing. Height was recorded using a tape with 0.5 *cm* precision (their feet together, and their eyes in a parallax situation) and the measurement of waist circumference was performed between the lowest rib and the iliac crest with a non-stretchable tape. BMI was calculated as: Weight (*kg*) / Height (m^2).

Table 2. Dietary nutrients and food intakes of the participants across tertiles of MED and DASH pattern adherence

Variables	MED				DASH			
	T_1 (n=85)	T_2 (n=70)	T_3 (n=81)	p-value	T_1 (n=80)	T_2 (n=75)	T_3 (n=81)	p-value
Nutrient items								
Energy (*kcal*/d)	2621.18±125.04	2729.45±116.73	2969.49±110.04	0.095	2771.03±116.42	2818.31±123.97	2723.78±113.78	0.867
Carbohydrate (*g*/d)	415.81±18.83	423.13±19.25	467.23±18.25	0.054	429.89±17.99	441.19±19.38	424.60±19.74	0.832
Protein (*g*/d)	82.80±4.32	87.84±3.94	99.43±3.99	0.013	88.07±4.26	91.78±3.88	90.66±4.29	0.802
Fat (*g*/d)	79.31±4.73	82.38±4.51	86.53±3.84	0.491	82.72±4.31	83.94±4.87	81.27±3.71	0.920
Cholesterol (*mg*/d)	222.36±16.41	198.20±9.81	241.03±13.64	0.109	228.86±15.35	224.51±14.67	208.24±9.53	0.573
Vitamin B_6 (*mg*/d)	1.95±0.09	2.16±0.10	2.38±0.08	0.005	2.03±0.09	2.21±0.08	2.28±0.11	0.158
Vitamin B_9 (*µg*/d)	690.82±29.22	712.36±25.99	777.34±30.19	0.082	714.04±25.89	736.71±29.56	733.64±33.13	0.825
Vitamin C (*mg*/d)	195.08±18.87	201.90±11.39	205.74±11.57	0.870	180.03±16.89	219.11±12.22	208.74±12.42	0.13
Calcium (*mg*/d)	1039.89±44.39	1164.16±58.79	1229.31±49.02	0.022	1049.13±42.11	1145.76±49.62	1265.80±61.71	0.011
Magnesium (*mg*/d)	400.99±19.56	477.00±27.30	540.20±25.22	< 0.001	420.01±22.11	493.56±23.08	517.30±28.60	0.011
Food items								
Whole grains (*g*/d)	212.69±12.75	221.62±17.74	213.90±17.46	0.917	228.98±15.17	205.59±15.16	208.93±17.51	0.506
Refined grains (*g*/d)	495.03±20.37	444.91±22.94	419.95±20.26	0.033	502.05±20.81	459.64±18.95	382.30±21.78	< 0.001
Vegetables (*g*/d)	389.22±19.66	426.28 ±23.87	459.47±26.39	0.095	322.84±15.38	441.71±21.09	545.47±28.94	< 0.001
Fruits (*g*/d)	529.61±39.66	513.03±28.86	471.69±31.44	0.458	459.38±36.35	550.70±32.55	515.84±30.45	0.144
Legumes (*g*/d)	46.96±4.28	64.33±4.71	82.69±7.36	<0.001	48.01±3.95	62.13±5.28	89.63±7.98	< 0.001
Nuts (*g*/d)	17.92±1.79	20.85±4.48	17.21±3.21	0.712	16.34±2.70	23.35±4.38	16.16±1.69	0.198
Dairy (*g*/d)	268.70±16.83	326.25.48	306.93±18.63	0.120	238.87±13.17	299.51±17.32	381.83±28.34	< 0.001
Meats (*g*/d)	67.58±8.41	53.45±4.04	43.77±4.32	0.021	73.22±7.95	47.91±3.66	38.51±3.66	< 0.001
Sweet desserts (*g*/d)	45.03±2.98	40.76±5.16	49.69±4.57	0.345	50.65±4.44	40.09±3.04	44.01±4.85	0.180

MED, Mediterranean diet score; DASH, dietary approaches to stop hypertension trial (DASH) diet score.
Values are mean ± SD.
Using one-way ANOVA.
Significant associations are in bold.

Statistical analysis

Dyslipidemia has been defined as the existence of one or more of these disorders: TC more than 200 *mg/dl*, TG more than 150 *mg/dl*, LDL more than 130 *mg/dl*, HDL less than 40 *mg/dl* for males and less than 50 *mg/dl* for females (20). DASH and MED scores were calculated based on energy adjusted method. Then, they were divided into tertiles, and changed to tertile. Participants in the last tertile showed more adherence of MED and DASH compared to the first tertile. We used a Kolmogorov-Smirnov test to examine the normality of data. The analysis of variance (ANOVA) was used to assess the association between quantitative variables, and Chi-square test was utilized to assess the association between qualitative variables. We used crude and adjusted model logistic regression to evaluate the relation between DASH and MED score adherence. In adjusted model, the effects of energy, age, BMI, sex, physical activity, smoking and alcohol history were controlled. Statistical analyses were performed by SPSS (version 23.0), SPSS Inc, Chicago IL (IBM Corp, Armonk, New York, USA). p values less than 0.05 were considered statistically significant.

Results

Baseline characteristics and lipid profiles of the study participants are presented in table 1. Individuals in the highest tertile of MED and DASH pattern adherence had significantly lower LDL compared with those in the first tertile (P<0.05).

Individuals in the last tertile of MED pattern adherence

Table 3. Crude and multivariable-adjusted odds ratios of lipid profile across tertile of MED and DASH pattern adherence

Variables	MED						DASH					
	T_1	T_2	p	T_3	p	P_{trend}	T_1	T_2	P	T_3	p	P_{trend}
TG (*mg/dl*)												
Crude Model	Ref.	1.59 (0.77,3.26)	0.204	1.13 (0.55,2.33)	0.723	0.718	Ref.	1.49 (0.76,2.92)	0.243	0.73 (0.34,1.57)	0.427	0.550
Adjusted Model	Ref.	1.60 (0.76-3.36)	0.211	0.99 (0.47-2.11)	0.997	0.998	Ref.	1.45 (0.73-2.90)	0.282	0.79 (0.35-1.75)	0.567	0.707
TC (*mg/dl*)												
Crude Model	Ref.	0.71 (0.36,1.43)	0.35	0.30 (0.13,0.66)	0.003	0.003	Ref.	0.56 (0.27,1.13)	0.106	0.50 (0.24,1.06)	0.073	0.055
Adjusted Model	Ref.	0.69 (0.33-1.43)	0.321	0.27 (0.11-0.61)	0.002	0.002	Ref.	0.52 (0.25-1.08)	0.081	0.46 (0.20-0.98)	0.047	0.039
LDL (*mg/ dl*)												
Crude Model	Ref.	0.71 (0.36,1.43)	0.351	0.36 (0.17,0.77)	0.009	0.009	Ref.	0.84 (0.43,1.64)	0.615	0.43 (0.19,0.94)	0.036	0.041
Adjusted Model	Ref.	0.66 (0.32-1.35)	0.261	0.32 (0.14-0.69)	0.004	0.004	Ref.	0.82 (0.41-1.63)	0.582	0.48 (0.21-1.07)	0.074	0.081
HDL (*mg/dl*)												
Crude Model	Ref.	0.97 (0.45,2.06)	0.940	0.54 (027,1.08)	0.083	0.079	Ref.	0.86 (0.43,1.74)	0.691	0.67 (0.33,1.37)	0.280	0.285
Adjusted Model	Ref.	0.96 (0.43-2.13)	0.925	0.47 (0.22-1.01)	0.052	0.053	Ref.	0.82 (0.39-1.72)	0.611	0.64 (0.30-1.35)	0.246	0.248

MED, Mediterranean diet score; DASH, dietary approaches to stop hypertension trial (DASH) diet score, TG, triglyceride; TC, total cholesterol; LDL, low density lipoprotein; HDL, low density lipoprotein.

Adjusted for age, energy intake, BMI, sex, physical activity, smoking and alcohol history.

These values are odd ratio (95% CIs).

Obtained by logistic regression.

Significant associations are in bold.

had significantly higher intakes of protein (p=0.01), Vit B_6 (p=0.005), calcium (p=0.02), magnesium (p<0.001), legumes (p<0.001), and lower intakes of refined grains (p=0.03) and meats (p=0.02). Also, in terms of the DASH pattern adherence, individuals within the highest tertile tended to consume more calcium (p=0.01), magnesium (p=0.01), vegetables (p<0.001), legumes (p<0.001) and dairy (p<0.001), and less refined grains and meats (all P < 0.001) compared to those in the first tertile (Table 2).

As shown in table 3, higher adherence to the MED pattern was associated with reduced odds of high TC and LDL in both crude (OR: 0.30; 95% CI: 0.13–0.66; P-trend =0.003 and OR: 0.36; 95% CI: 0.17–0.77; P-trend =0.009) and adjusted model (OR:0.27; 95% CI: 0.11–0.61; p=0.002 and OR:0.32; 95% CI: 0.14–0.69; p=0.004). Higher adherence to the DASH pattern was associated with reduced odds of LDL in crude (OR:0.48; 95% CI: 0.19–0.94; p=0.03) and TC in the adjusted model (OR:0.46; 95% CI:0.20–0.98; p=0.04).

Discussion

In this study, we examined the association between MED diet and DASH score with lipid profile. Our findings demonstrated better TC and LDL levels with MED diet, while it was not associated with TG and HDL-C concentration. Also, higher adherence to DASH dietary pattern was associated with lower TC level, but not with TG, HDL and LDL concentration after adjusting for potential confounders.

The evidence regarding the link between MED and DASH diet adherence and lipid profile is inconclusive. So far, results of some studies are in line with our findings, while some of them revealed inconsistent results. For instance, in agreement with the results of our study, some observational studies represented that higher adherence to MED dietary pattern was associated with lower TC or LDL concentration (21-23), whereas some of the studies found no association between MED dietary pattern adherence and improvement in TC or LDL (24). On the other hand, some studies revealed that higher score of MED dietary pattern was associated with lower level of TG or HDL which is in contrast with our findings (25,26). Besides, results of our study showed the negative association between DASH diet adherence and TC level, while other blood lipids were not associated with DASH score. In agreement with our study, a recent meta-analysis of clinical trials on participants with chronic diseases, indicated that DASH diet could improve serum TC and LDL, but had no significant effects on TG and HDL level. The inverse association between DASH diet and TC was also found in some other observational studies (27,28). However, some studies found no association between DASH dietary pattern and improvement in lipid profile (29,30). Discrepancies observed across previous studies might be explained by differences in different sample sizes and populations also adjustment of analysis for different confounders. Moreover, the availability of foods, techniques of food procurement and eating habits may differ between the Mediterranean and non-Mediterranean regions like Iran. A given population's intake of total fish may not accurately reflect their consumption of omega-3 LC-PUFAs since the proportion of oily and non-oily fish intake may vary by country. Also, omega-3 content of oily fish that can play role in regulating TG level is influenced by many factors, including the food that they consumed (31).

According to the meta-analysis of randomized controlled trials, whole grain intake leads to improvement in TC, LDL and TG level compared with control. On the other hand, nuts and fruit intake were not different significantly across the tertile of DASH and MED diet score according to results of our study. Nuts' intake is inversely associated with coronary heart disease and may have a beneficial effect on lipid profile. Besides, higher intake of fruit intake leads to decreased risk of dyslipidemia according to the studies (32,33).

Also, the Mediterranean diet contains high amounts of legumes, nuts, olive oil, fish, fruits and vegetables, and other components that may play a role in preventing CVDs and hyperlipidemia. Olive oil as the main source of fat in the MED diet is a rich source of MUFAs and polyphenols. MUFAs-reached diets can induce a beneficial effect on lipid profile by decreasing TC and LDL levels and increasing HDL concentration (34). Moreover, the polyphenols' content of olive oil can increase HDL level and promote its function (31,35). Long-chain ω-3 fatty acids are another important component of MED diet (36). The effect of fish intake as a source of omega-3 PUFA on improving TG, TC, and LDL has been reported in some studies (37-39). Nuts, the other important component of MED diet has a role in modulating lipid profile. A recent meta-analysis revealed that intake of pistachio could decrease TC concentration and cashew intake can increase HDL level (40). Nuts are good source of arginine and fibers (41). Arginine improves lipid profile by increasing lipolysis, and NO synthesis, as well as decreasing mRNA expression of hepatic 3-hydroxyl-3-methylglutaryl-CoA reductase (41).

Favorable effects of the Mediterranean and DASH diet on lipid profiles might be due to their components. In the DASH diet, cholesterol and saturated fat intake are limited, which could lead to a decrease in LDL and total cholesterol concentrations (42). Also, DASH and Mediterranean dietary patterns contain high amount of fibers. The cholesterol-lowering effect of dietary fibers intake was demonstrated in some randomized and observational studies (43). Dietary fibers manipulate cholesterol homeostasis by reducing cholesterol pools in the liver, improving hepatic LDL receptor expression, and increasing plasma LDL receptor activity (9). Besides, DASH diet contains a large number of micronutrients like calcium, which plays a role in modulating lipid profile. The results of our study also showed that participants in the last tertile of DASH dietary pattern adherence consumed more amount of calcium. A recent animal study reported a better serum lipid profile in rats fed higher levels of calcium and a decreased reabsorption of bile acids, neutral sterols, and saturated and trans fatty acids (44). Calcium can prevent fat absorption by forming calcium-fatty soaps, regulating lipolysis and lipogenesis, and increasing thermogenesis (45).

Our findings should be interpreted in light of some limitations. First, due to the nature of cross-sectional study, causal correlations between MED and DASH dietary adherence and lipid profiles could not be established. Second, the study was carried out in Shiraz city, thus generalization of our results to all Iranian adults should be done with caution. Finally, although adjustment was performed for some confounders, there might be other confounders not assessed in this study.

Conclusion

This cross-sectional study revealed a negative association between the MED and serum levels of TC and LDL. Moreover, a higher DASH score was associated with lower TC. Further prospective studies with a larger sample size are needed to confirm our findings.

Consent for publication

Not applicable.

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Conflict of Interest

All the authors declare that they have no conflict of interest.

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