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Original Article

Dietary patterns in relation to lipid profiles among Iranian adults

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Abstract

Introduction: Lipid metabolism is one of the main concerns of cardiovascular disease and atherosclerosis. Little is known about the association between dietary patterns and dyslipidemia. Therefore, the present study aimed to determine such association among Iranian adults.
Methods: This cross-sectional study was conducted on 1433 Iranian adults in Isfahan Healthy Heart Program (IHHP). Usual dietary intakes were assessed with the use of a 48 items food frequency questionnaire (FFQ). Factor analysis was used to identify dietary patterns. Three major dietary patterns were identified: western, semi healthy and healthy fat patterns.
Results: After adjustment, subjects in the upper quartiles of western dietary pattern were more likely to have high total cholesterol concentrations than those in the first quartile (odds ratio [OR]: 2.07; 95% CI: 1.25-3.42). Individuals with greater adherence to western dietary pattern had greater odds of having high low-density lipoprotein-cholesterol (LDL-C) levels compared with those in the lowest quartiles (2.53; 1.45-4.40).
Conclusion: Semi healthy dietary pattern was not associated with cardiovascular disease (CVD) risk factors. Same trend was observed for healthy fat dietary pattern. Significant association was found between western dietary pattern and dyslipidemia among Iranian adults.

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Introduction

Cardiovascular disease (CVD) is the leading cause of death, worldwide. These kinds of diseases are responsible for approximately 80% of death in developing countries.[1] Cardiovascular death rates have considerably decreased in western nations during the two last decades; however a dramatic increasing trend has been reported in developing countries like Iran, where CVD has been estimated to be responsible for up to 38% of total mortality rates.[2,3] Dyslipidemia is prevalent among more than two-third of Iranians.[4] The prevalence of low HDL-C and hypertriglyceridemia is increasing among Iranians compared to western countries. According to the reports, 37% of Americans are affected by low high-density lipoprotein-cholesterol (HDL-C) concentration,[5] while it is about 69% among Iranians.[6] Thus, elucidating the causes of this discrepancy is of great importance.

Several contributing factors including low physical activity, smoking and unhealthy diet have been linked to dyslipidemia and subsequently cardiovascular diseases, worldwide.[7] Based on the reports in Iran, trans and saturated fats, red and processed meats and refined grains as well as fast foods have been adversely associated with cardiovascular risk factors among Iranians.[8-11] However, favorable relation between fruits, vegetables, legumes, whole grains and cardiovascular disease has been reported in Iran.[10,12,13] Although relationship between several dietary components and CVD has widely been assessed,[9-13] total interactions of dietary compounds cannot be captured by distinct assessments of foods and nutrients. Therefore,

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recent evidence focused on dietary patterns for assessing the diet-diseases relationship. Although many investigations have evaluated the association between dietary patterns and cardiovascular risk factors among American[14,15] and European population,[16-18] relatively limited study have assessed this relationship in Asian countries, particularly in middle-east region.[19,20] In the best of our knowledge, several dietary patterns including healthy, western and traditional Iranian dietary patterns have been previously identified in Iran and adverse association of western and unhealthy patterns with cardiovascular risk factors including obesity, inflammation, insulin resistance and metabolic syndrome has been shown.[7,21,22] However, it should be taken into account that these investigations confined to small sample of females and conclusive information from large population-based sample is not available. For example, one report[20] previously assessed the association between dietary patterns and dyslipidemia among female teachers, who were highly educated with relatively better socioeconomic status. However due to the small and non-representative sample, its findings cannot be generalized to whole Iranian population. Given the high prevalence of dyslipidemia among Iranians as well as lack of enough evidence regarding the association of dietary patterns and dyslipidemia, further attention should be paid on this aspect of diet-disease relations. Therefore, the present study was conducted on a large community-based sample of Iranian adults to identify the relationship between dietary patterns using factor analysis and dyslipidemia.

Materials and Methods

The present study was conducted within the framework of Isfahan Healthy Heart Program (IHHP), which is a comprehensive community-based intervention study that was performed on a representative sample of Iranian adults aged nineteen years and above, done for the purpose of precluding and controlling CVD, their risk factors and their subsequent morbidity and mortality, by declining their determinants and life-style improvement. The study design, sampling method and properties of participants have been described elsewhere.[23,24] Briefly, the project was carried out between 1999 to 2006 in three central cities of Iran with similar socioeconomic, demographic and health profile, two counties as interventional communities including Isfahan and Najafabad and one as reference community including Arak. In the IHHP, 12 600 subjects aged ≥19 years were selected using multistage cluster random sampling method based on residence area (urban vs rural), age and sex. At first, census blocks of each county which were provided by the Ministry of Health were selected randomly. This selection was based on the probability of selection proportional to the expected number of households. A single age-eligible adult was randomly selected among each households. As described in our earlier study, Isfahan, Arak and Najafabad were divided into 93, 60 and 47 clusters with 1000 households in each cluster. Twenty five clusters of Isfahan, 23 of Arak and 15 ones from Najafabad were randomly selected. Five to 10% of households in these clusters were selected for enumeration. Then, for each household, a none-pregnant Iranian female aged 19 years old was randomly selected. After sample size calculation for each gender (n=1207), they were divided into various age groups including 19-24, 25-34, 35-44, 45-54, 55-64 and = 65 years. After doubling and considering missing rates the total number was 6300 for each intervention and reference area group.[23] Present study is a sub-population one from the main study. An interview-based questionnaire was administered to collect information regarding demographic features, socioeconomic, educational and marital status, physical activity, smoking, medical history and family history of chronic disease as well as nutritional intakes which was assessed by a validated food frequency questionnaire (FFQ). Furthermore single 24-hour recall questionnaire was administered in 2000 randomly selected participants of the IHHP according to the age and sex distribution. In the current study participants that had history of chronic disease like CVD, diabetes or stroke that might lead to changes in diet were excluded (n=231). We also exclude subjects with total energy intake outside the range of 800-4200 kcal/d[25] (n=142). Therefore, present analysis was conducted on 1433 subjects. All participants signed a written informed consent at the entry of the study.

Dietary intakes assessment

Dietary intakes were assessed using a validated FFQ, through face-to-face interview.[26] The FFQ contained a list of 48 food items commonly consumed in Iran. It was designed based on the Countrywide Integrated Non-communicable Disease Intervention (CINDI) program questionnaire.[27] The FFQ of CINDI was translated to Persian through the forward and back-translation procedure. One nutritionist performed forward translation and another one done the back translation. Then three professional nutritionists proved it.[28] Frequency consumption of food items during the previous year in terms of daily, weekly or monthly was asked from each participant.[28] Then reported frequency of each food item was converted to a daily intake. We categorized foods into 18 groups for use in the dietary pattern analysis (Table 1). Defining the food groups was based on the nutrient similarity of foods. To evaluate the energy and nutrient intake of the subjects a 24-hour recall was administered in the sub-sample. The data were calculated by the Iranian Food Consumption Program (IFCP) designed by ICRC.

Biomarkers Assessment[6]

Lipid profile of participants was measured by collecting fasting blood samples. Serum triglyceride (TG) concentrations were measured with the use of TG kits by enzymatic colorimetric tests with glycerol phosphate

Table 1. Food grouping used in factor analysis

Food groups	Food items
Fast food	Pizza, sausages, hamburger
Butter	Butter, cream
Sweets and desserts	Chocolates, cookies, cakes, confections, jam, biscuits
Soft drink	Soft drink, Industrial fruit juice
Canned food	Canned food
Dairy	Milk (high fat milk), yoghurt, cheese
Red meats	Beef, lamb, beef liver, beef kidney, beef heart, egg
Poultry	Chicken
Fish	Fish
Legumes	Legumes, beans, peas, lima beans, lentil, soy
Vegetables	Green leafy vegetables, tomato, carrots, lettuce, garlic, potato, cooked vegetable, dried vegetables
Fruit	Pears, apricots, cherries, apples, raisins or grapes, bananas, cantaloupe, watermelon, oranges, grapefruit, kiwi, strawberries, peaches, nectarine, tangerine, mulberry, plums, persimmons, pomegranates, lemons, pineapples, fresh figs, dates, dried figs, dried dates, other dried fruit
Bread	Bread
Rice	Rice
Nuts	Peanuts, almonds, pistachios, hazelnuts, roasted seeds, walnuts
Animal fat	Animal fat, hydrogenated fat, skin of poultry, tallow
Vegetable oil	Vegetable oil, olive oil
Pickles	Pickles, salted vegetables

oxidase. HDL cholesterol was measured after precipitation of the apolipoprotein B–containing lipoproteins with phosphotungstic acid. Low-density lipoprotein-cholesterol (LDL-C) was estimated using Friedwald equation when TG was less than 400 mg/dL.

Physical activity assessment

The physical activity habits were assessed by using the Baecke questionnaire[29] based on the metabolic equivalent minutes per week (MET-min/wk). To estimate total MET-min/wk for each person, the MET-min/wk for each exercise was calculated (days per week * minutes of * MET equivalent of exercise) then all MET-min/wk values were summed up.

Statistical analysis

Factor analysis (principle component) was applied to determine main dietary patterns, on the basis of 18 food groups derived by compacting food items in FFQ. Factors were retained using the Scree test, if their eigenvalues were >1.[30] The factors were rotated by an orthogonal transform. The obtained factors were labeled based on our interpretation of the data. We calculated the factor score for each dietary pattern by summing the intakes of food groups weighted by their factor loadings and each participant gained a factor score for each pattern. The normal distribution of variables was tested using Kolmogorov-Smirnov test and histogram curve.

Participants were classified based on quartile cut-points of dietary patterns. To compare general characteristics of study participants, we used one-way analysis of variance (ANOVA) or Kruskal-Wallis test (when assumptions including normality or homogeneity of variance were not hold). To examine significant difference in the distribution of subjects in different categories, chi-square test was done. To identify the association between dietary patterns and cardiovascular risk factors, we used logistic regression in different models. First we controlled for total energy intake (kcal/d) (continuous), age (continuous), gender (male/female, categorical), marital (married/single, categorical), physical activity (MET-min/wk, continuous) and education (0-5 years/6-12 years/>12 years, categorical) status. Then we additionally adjusted for ever smoking (categorical) and family history of stroke (categorical). Finally we controlled for body mass index (BMI) (continuous). In all analysis, the first quartile of dietary pattern scores was considered as reference. To determine *P* value for trend across quartile of dietary patterns, we assigned the median extent of dietary patterns to individual's variable as continuous variable in logistic regression for elevated vs. normal cardiovascular risk factors. "When we obtained energy-adjusted dietary patterns' scores and repeated the analysis for associations based on this approach, the findings did not change". Statistical analyses were done using the Statistical Package for Social Sciences (SPSS Inc, version 15.0). *P* values < 0.05 were considered statistically significant.

Results

Nutrient profiles for 3 major dietary patterns which are extracted by the use of principle component analysis are presented in Table 2. Factor 1, the western dietary pattern was associated with greater intakes of fast foods, butter and cream, sweet, soft drink and industrial fruit juice,

Table 2. Factor loading matrix for major dietary patterns

Food groups	Dietary patterns		
	Western	Semi healthy	Healthy fat
Fast food	0.64	-0.01	0.08
Butter	0.60	0.13	0.01
Sweet	0.59	0.02	0.10
Soft drink	0.55	0.07	0.12
Canned food	0.48	0.03	0.04
Nuts	0.47	0.27	-0.02
Dairy	0.42	0.10	-0.08
Red meat	0.30	0.30	-0.21
Poultry	0.18	0.32	0.39
Fish	0.31	0.19	0.43
Legumes	0.14	0.41	-0.25
Vegetable	0.01	0.77	-0.01
Fruit	0.06	0.65	0.21
Bread	-0.09	0.06	-0.51
Rice	0.08	0.52	0.14
Vegetable oil	0.003	0.08	0.67
Animal fat	0.17	0.33	-0.60
Pickle	0.11	0.56	-0.14

canned food, seed and pistachio, high fat milk, fish and red meat. The components of the semi healthy dietary pattern were vegetable, fresh fruits, pickles, rice, legume and soy, poultry and animal fat and red meat. Factor 3, the healthy fat dietary pattern was related to higher consumption of vegetable and olive oil, fish, poultry and lower intakes of animal fat and bread.

Characteristics of all participants across quartiles of dietary patterns are shown in Table 3. Subjects in the top quartile of western dietary pattern were significantly more likely to be younger, male and ever smoker compared to subjects in the lowest quartile. Furthermore, these participants were more physically active and had lower BMI than those in the lowest quartile of western dietary pattern. Individuals in the upper quartile of healthy fat dietary pattern were more likely to have a positive family history of stroke compared with subjects in the lowest quartile. Distribution of general characteristics across quartiles of semi healthy dietary pattern was not significantly different. Greater intakes of total energy, fat and cholesterol as well as higher intakes of dietary fiber were observed among participants in the top quartile of western dietary pattern and semi healthy dietary pattern. Higher western and semi healthy dietary pattern scores were associated with lower intakes of carbohydrates. Individuals in the upper quartiles of healthy fat dietary pattern consumed less energy and more protein in comparison with those in the lowest quartile.

Multivariable-adjusted odds ratios for cardiovascular risk factors across different quartiles of dietary patterns are provided in Table 4. In crude model, the western dietary pattern was not associated with high total cholesterol, however when potential confounders including age, gender, marital and education status, total energy intake and physical activity were taken into account, subjects in the upper quartiles of western dietary pattern were 95% more likely to have high total cholesterol concentrations than those in the first quartile (odds ratio [OR]: 1.95; 95% CI: 1.21-3.13). This association remained also significant after further adjustment for smoking, family history of stroke and BMI (2.07; 1.25-3.42). After controlling for potential confounders, individuals in the top quartiles of western dietary pattern had greater odds of having high LDL-C levels compared with those in the lowest quartiles (2.68; 1.58-4.54). When other potential confounders including smoking, family history of stroke and BMI were taken into account, subjects in the upper quartiles of western dietary pattern were more likely to have high LDL-C concentrations than those in the first quartile (2.53; 1.45-4.40). After adjustment for potential confounders, the western dietary pattern was not associated with higher TG and HDL-C levels. We found no significant association between higher semi healthy dietary pattern scores and cardiovascular risk factors. The same finding was also reached for the healthy fat dietary pattern.

Discussion

We found three major dietary patterns in a population-based sample of Iranian adults: the semi healthy dietary pattern, the western dietary pattern and the healthy fat dietary pattern. The western dietary pattern was associated with elevated levels of LDL-C and total cholesterol. No significant association was observed between the semi-healthy dietary pattern or healthy fat dietary pattern and CVD risk factors. Although the contributions of dietary patterns to the risk of myocardial infarction, metabolic syndrome, inflammation and endothelial dysfunction and diabetes have been frequently shown in western societies,[31-35] to our knowledge this is among the first investigations reporting the association between empirically-derived dietary patterns and dyslipidemia among a large representative sample of adults in the Middle East regions. Some food intake pattern including healthy, western and traditional Iranian dietary patterns have been previously identified in Iran and adverse association of western and unhealthy pattern with attention deficit hyperactivity disorder,[36] obesity,[21] inflammation,[7] breast and esophageal cancer[37,38] has been shown. However, it should be taken into account that these investigations confined to small sample of female and children and no information among a large population-based sample is available. Therefore detecting a western dietary pattern in a developing country like Iran needs to be more studied and explained. This might open the nutrition transition importance in Iran and might clear the rout of several chronic diseases.

In the current study, western dietary pattern was adversely associated with lipid profiles. These findings are consistent with other studies which showed significant direct association between western dietary pattern and cardiovascular risk factors.[20,39,40] Using factor analysis in the Strong Heart Study which conducted among

Table 3. Characteristics and dietary intakes of study participants by quartile categories of dietary pattern scores

	Western dietary pattern					Semi healthy dietary pattern					Healthy fat dietary pattern				
	1	2	3	4	P	1	2	3	4	P	1	2	3	4	P
N	350	352	353	352		353	353	347	355		355	352	353	348	-
Age (y)	43±15[a]	37±13[b,c]	33.5±12[c]	30.8±11.7	0.001[1]	37±14	36±14	36±13	36±14	0.57[1]	35±13	39±14	36±13	37±14	0.12[1]
Female	29	27	23	21	0.001	23.9	24	24.5	28	0.07	26.5	24	24	25	0.50
BMI (Kg/m^2)	27±4[b,c]	26±4.9[c]	25±5	24.9±4.8	0.001[1]	25.5±5	25±5	26±5	26±5	0.39[2]	25±5	25±5	26±5	26±5	0.09[2]
Physical activity	790±463[b,c]	843±483	905.5±510	901.3±499	0.006[1]	885±535	835±479	891±487	827±459	0.25[1]	828±495	879±500	887±487	845±487	0.17[1]
Ever smoker %	22	20	26	32.6	0.02	25	30	27	19	0.08	25	27	25	23	0.87
Family history of stroke % 1	34	22	28	15	0.06	25	31	19	26	0.43	12	22	28	38	0.006
Dietary intakes															
Total energy, kcal/d	1832.5±670[b,c]	1907±721[b,c]	2073±735	2198.3±718.2	0.001[1]	1839.9±674[b,c]	1965.3±713	2087±726	2119±753.5	0.001[1]	2151±730[a]	1990±728	1936±721	1933±701	0.001[1]
Protein, % total energy	13±3	13±3	13±3	13±3	0.16[1]	13±3	13±3	13±3	13±3	0.62[1]	12.5±3[a]	13±3	13.5±3	14±3	0.001[2]
Carbohydrate, % total energy	62±11[b,c]	61±11[c,d]	59±12	59±10	0.001[2]	63±11[a]	60.5±11.5	59.5±10.5	58±10	0.001[2]	61±10	60±11	61±11	59±11	0.07[2]
Fat, % total energy	27±9.5[b,c]	28±9[c,d]	30±10	30.1±8.8	0.001[1]	26.5±9[b,c]	28±9[c]	29±9	30.5±9	0.001[2]	29±9	28±9	28±9.5	29±10	0.25[2]
Cholesterol, mg/d	251±206[b,c]	272±202[b,c]	318.5±209.5	320.7±201.2	0.001[1]	252±194[b,c]	281.6±202[c]	300±204	329±219	0.001[1]	307±189[d]	280.5±210	291±202	285±225	0.35[1]
Dietary fiber, g/d	16±11[c]	15±9[c]	17±8	17.8±7.5	0.009[1]	15.5±7[b,c]	17±11	17±8	18±8	0.005[1]	17±7	17±8	16±8	17±11	0.31[1]

[1] indicates: *P* value obtains from Kruskal Wallis test.
[2] indicates: *P* value obtains from ANOVA.
Values are presented as mean ±SD or percentage. Letters indicate difference within a pattern: a vs. other quartiles *P*<0.05, b vs quartile 3 *P*<0.05, c vs quartile 4 *P*<0.05, d vs quartile 2 *P*<0.05. Analysis of variance for quantitative variables and chi-square test for qualitative variable.

Table 4. Multivariate adjusted odds ratios (95% confidence intervals) of cardiovascular risk factors across quartile categories of dietary pattern scores among IHHP participants[1]

	Western Pattern					Semi healthy Pattern					Healthy fat pattern				
	1	2	3	4	*P* trend	1	2	3	4	*P* trend	1	2	3	4	*P* trend
Total Cholestrol ≥240 mg/dL															
Crude	1.00	1.23 (0.82-1.84)	0.60 (0.38-0.95)	0.97 (0.64-1.48)	0.4	1.00	1.33 (0.88-1.99)	0.93 (0.60-1.43)	0.81 (0.52-1.27)	0.22	1.00	0.90 (0.59-1.38)	0.70 (0.45-1.09)	1.12 (0.74-1.68)	0.67
Model 1[2]	1.00	1.73 (1.12-2.65)	1.03 (0.63-1.69)	1.95 (1.21-3.13)	0.045	1.00	1.50 (0.98-2.30)	1.07 (0.68-1.68)	0.91 (0.57-1.43)	0.39	1.00	0.80 (0.51-1.24)	0.64 (0.40-1.02)	1.06 (0.68-1.64)	0.93
Model 2[3]	1.00	1.72 (1.11-2.68)	1.04 (0.63-1.73)	2.02 (1.24-3.28)	0.033	1.00	1.54 (0.99-2.39)	1.05 (0.66-1.68)	0.97 (0.61-1.55)	0.54	1.00	0.83 (0.53-1.30)	0.62 (0.38-1.01)	0.98 (0.62-1.55)	0.80
Model 3[4]	1.00	1.72 (1.10-2.70)	1.07 (0.64-1.79)	2.07 (1.25-3.42)	0.036	1.00	1.53 (0.97-2.39)	1.03 (0.64-1.65)	0.84 (0.52-1.36)	0.24	1.00	0.80 (0.51-1.27)	0.56 (0.34-0.91)	0.88 (0.55-1.40)	0.40
LDL ≥160 mg/dL															
Crude	1.00	1.22 (0.76-1.97)	0.84 (0.50-1.40)	1.28 (0.80-2.05)	0.44	1.00	0.85 (0.54-1.35)	0.76 (0.48-1.22)	0.71 (0.44-1.15)	0.22	1.00	0.69 (0.42-1.12)	0.68 (0.42-1.10)	0.99 (0.63-1.55)	0.91
Model 1[2]	1.00	1.65 (1.007-2.72)	1.44 (0.83-2.48)	2.68 (1.58-4.54)	0.001	1.00	1.01 (0.63-1.63)	0.93 (0.57-1.51)	0.82 (0.50-1.34)	0.43	1.00	0.62 (0.37-1.02)	0.64 (0.39-1.06)	1.004 (0.62-1.62)	0.87
Model 2[3]	1.00	1.49 (0.90-2.49)	1.41 (0.80-2.46)	2.51 (1.46-4.31)	0.001	1.00	1.05 (0.64-1.72)	0.96 (0.58-1.58)	0.86 (0.52-1.42)	0.56	1.00	0.65 (0.39-1.09)	0.62 (0.36-1.04)	0.98 (0.60-1.61)	0.96
Model 3[4]	1.00	1.51 (0.90-2.53)	1.44 (0.82-2.52)	2.53 (1.45-4.40)	0.002	1.00	1.05 (0.64-1.73)	0.92 (0.56-1.54)	0.78 (0.46-1.31)	0.34	1.00	0.65 (0.39-1.09)	0.57 (0.33-0.97)	0.92 (0.55-1.52)	0.77
Trigliceride ≥200 mg/dL															
Crude	1.00	0.90 (0.64-1.28)	0.86 (0.61-1.22)	0.69 (0.48-0.99)	0.041	1.00	1.09 (0.77-1.55)	1.13 (0.80-1.61)	0.93 (0.65-1.34)	0.77	1.00	0.98 (068-1.40)	0.92 (0.64-1.33)	1.35 (0.96-1.92)	0.08
Model 1[2]	1.00	1.13 (0.79-1.63)	1.18 (0.81-1.72)	0.99 (0.66-1.48)	0.78	1.00	1.16 (0.80-1.68)	1.23 (0.85-1.78)	1.02 (0.70-1.49)	0.89	1.00	0.87 (0.60-1.27)	0.86 (0.59-1.26)	1.24 (0.86-1.80)	0.25
Model 2[3]	1.00	1.11 (0.77-1.61)	1.14 (0.78-1.68)	1.002 (0.66-1.51)	0.82	1.00	1.19 (0.82-1.73)	1.24 (0.85-1.81)	1.03 (0.70-1.52)	0.92	1.00	0.94 (0.64-1.39)	0.95 (0.64-1.40)	1.27 (0.87-1.87)	0.23
Model 3[4]	1.00	1.15 (0.78-1.69)	1.19 (0.80-1.77)	0.99 (0.60-1.34)	0.75	1.00	1.16 (0.79-1.71)	1.18 (0.80-1.74)	0.90 (0.60-1.34)	0.53	1.00	0.90 (0.60-1.34)	0.92 (0.61-1.37)	1.16 (0.78-1.73)	0.48
HDL female <50 male <40															
Crude	1.00	0.96 (0.71-1.30)	1.13 (0.83-1.52)	0.82 (0.61-1.11)	0.26	1.00	0.90 (0.66-1.21)	0.98 (0.73-1.33)	0.89 (0.66-1.21)	0.69	1.00	0.69 (0.51-0.93)	0.81 (0.60-1.09)	0.83 (0.61-1.12)	0.40
Model 1[2]	1.00	0.97 (0.70-1.33)	1.26 (0.90-1.76)	0.91 (0.64-1.28)	0.67	1.00	0.89 (0.65-1.22)	0.96 (0.69-1.31)	0.77 (0.56-1.06)	0.17	1.00	0.74 (0.53-1.01)	0.89 (0.65-1.23)	0.95 (0.68-1.32)	0.99
Model 2[3]	1.00	0.96 (0.69-1.33)	1.26 (0.90-1.76)	0.88 (0.62-1.24)	0.55	1.00	0.85 (0.61-1.17)	0.93 (0.67-1.28)	0.75 (0.54-1.05)	0.15	1.00	0.76 (0.55-1.06)	0.91 (0.66-1.26)	0.95 (0.68-1.33)	0.95
Model 3[4]	1.00	0.96 (0.69-1.33)	1.27 (0.90-1.78)	0.88 (0.62-1.26)	0.58	1.00	0.85 (0.61-1.18)	0.94 (0.68-1.30)	0.78 (0.56-1.09)	0.23	1.00	0.76 (0.55-1.05)	0.89 (0.64-1.23)	0.96 (0.68-1.34)	0.97

[1] Values are OR (95% CI)
[2] Model1: adjusted by sex, age, marital, education, energy, Z-Score total daily physical activity.
[3] Model2: further adjusted by ever smoke and family history of stroke.
[4] Model 3: further adjustment by BMI.

American Indian adults lived in the United States,[40] found that participants in the highest quartiles of western dietary pattern had greater levels of LDL-C, insulin resistance and lower degrees of HDL-C. Furthermore, animal-food pattern that characterized with greater intakes of meat, fish and dairy products was significantly associated with obesity and hypercholesterolemia among Korean men.[20] It has also been shown that increased fast food intake was related to future development of adverse effects on health outcomes including weight, waist circumferences, insulin sensitivity and lipid profiles.[41] Such evidence has been found in a population-based investigation among Iranian adults.[42]

Fast foods, soft drinks and animal meats were dominant in the western dietary pattern in the current study. In the United States, fast food intake accounts for 2% of energy intake in 1970, currently the corresponding figure is about 33-37%.[41,43] Nutrition transition caused to dramatically increased consumption of fast food and soft drinks in Iran similar to other developed countries. Although fast foods are quick and relatively cheap in comparison to other food, they contain high energy density, high fats, and large amounts of refined grain, high glycemic load and low fiber content.[44,45]

Recently, Rouhani et al,[46] indicated that Isfahanian adolescents consumed fast foods in a high rate and fast food consumption was related to poor diet quality, higher energy intake and greater prevalence of overweight and obesity which could be mostly mediated through massive portion size and high energy density of these kind of foods. Obesity is the chief core of many chronic diseases and may subsequently leads to increase cardiovascular risk factors including hyperlipidemia. In addition to high energy density, fast foods are rich sources of saturated and trans fats. Recently, it has been shown that trans fats accounts for 24% and 31% of total fats in most prevalent sausages and hamburgers, respectively in Iran.[44] The detrimental influence of saturated and trans fats on lipid profiles, metabolic syndrome, systemic inflammation and endothelial dysfunction has been established.[47] In addition to high amounts of their harmful fats, fast foods usually are prepared with the use of frying and partially hydrogenated vegetable oils (PHVO) in Iran. Prior studies indicated that greater use of PHVO was associated with increased risk of having dyslipidemia and systemic inflammation.[8,11]

It should be noted that high refined carbohydrate and glycemic load of fast foods was another harmful aspect of these kinds of foods. Furthermore, fast foods consumption is generally accompanied with soft drinks intake which further increase glycemic index and glycemic load of diet.[48] Many studies reported a significant direct link between high glycemic index and glycemic load diet and cardiovascular risk factors such as high TGs and low HDL-C.[49,50]

Given the dramatic shift to consume western dietary pattern heavily loaded in fast foods, soft drinks and red meats in developing countries like Iran and its direct association with increments of cardiovascular risk factors as observed in the current study, further attention should be paid to increase the knowledge of people regarding the components of such dietary pattern and their harmful health effects, increasing the availability of healthy foods in restaurants and substitute harmful constituents of fast foods with healthy components. Providing special healthy menus like preparing pizza with low calorie, low fat cheese and high amounts of vegetable are examples of interventions to reduce the rate of harmful effects following fast food intake.

In the present study, the odds ratios of having high CVD risk factors decreased across increasing quartiles of semi healthy dietary pattern and healthy fat dietary pattern, however the significant association was not found. In the current investigation dietary patterns were identified with using 48-item FFQ. Lack of considering the real variation of food choices might be the possible reason for non-significant association between semi healthy dietary patterns and CVD risk factors. Moreover some harmful food like red meat and animal fats were also loaded in the semi healthy patterns which may further attenuate significant relationship.

The current study was conducted on a large population-based sample size; it is the important strength which improves external validity of our findings. Furthermore, this investigation is the first one assessed the correlations between dietary patterns and cardiovascular risk factors in middle-east region. However, we should consider some limitations in interpretation of the results. As this study was the cross-sectional one the causal relationship cannot be inferred. Although these kinds of study designs are needed to identify disease related to dietary intakes, further studies with other designs in particular prospective cohort design, are required to confirm our findings. Although several risk factors were considered in the current study, the potential bias of residual confounding cannot be excluded. As 48-items FFQ was applied in the present study, detailed dietary intakes of participants cannot be achieved. So, general food items were used to identify dietary patterns for example because FFQ contained all kinds of grains as one group we could not classify refined and whole grains as two separate groups.

Conclusion

In the present study of Iranian adults, our evidence supports the significant direct association between western dietary pattern and dyslipidemia. Further longitudinal investigations are warranted to confirm these results.

Competing interests

None declared.

Ethical approval

Both World Health Organization collaborating center in Isfahan and Ethics Committee of the Research Council of Isfahan Cardiovascular Research Center, approved the current study (Ethi-cal Code: 85135).

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