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Original Article

Dietary Quality Index and Cardiometabolic Risk Factors among Adult Women

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Abstract

Background: The prevalence of cardiovascular disease is dramatically increasing particularly in developing countries. Among the different factors, diet has an important role in the pathogenesis of these diseases. This study aimed to assess the relationship between dietary quality index-international (DQI-I) and cardiovascular risk factors in adult Iranian women.

Methods: This was a cross-sectional study of 371 participants, aged 20-50 yr, and recruited from 10 health centers from health centers affiliated with Tehran University of Medical Sciences (TUMS), Tehran, Iran in 2018. Usual dietary intake was evaluated by a validated and reliable 168-items food frequency questionnaire (FFQ). To assess overall quality of diet, the Dietary Quality Index-International (DQI) was used. Anthropometric measurements, blood pressure, and fasting blood of samples were taken to assess biochemical parameters related to cardiovascular disease.

Results: The results of linear regression showed that DQI-I score was inversely and directly associated with serum level of total cholesterol (TC) (0.27, confidence interval (CI): 0.13-0.58; *P*<0.001) and high-density lipoprotein cholesterol (HDL-C) (2.53, CI: 1.42-4.52; *P*=0.001), respectively. However, there was no significant association between DQI-I and other cardiovascular risk factors.

Conclusion: A greater DQI-I score was associated with preferable lipid profile including TC and HDL-C. Future large-scale, prospective cohort or clinical studies are required to confirm these findings.

Keywords: Dietary quality index-international (DQI); Risk factors; Cardiovascular diseases; Iranian women

Introduction

Cardiovascular diseases (CVDs) are the most common cause of mortality worldwide (1) that is dramatically increasing. There is a strong association between CVDs and metabolic disorders including dyslipidemia, obesity, hypertension, and high glucose levels (2). Although some leading factors of CVDs such as age, sex and genetic are non-modifiable (3), there are several modifiable factors including physical inactivity, obesity, smoking, and diet, which are responsible for more than 70% of the risk of CVDs (4).

Nutrition and diet has a critical role in the etiology of chronic diseases such as CVDs (5). For example, consumption of fruits and vegetables (6), nuts and legume, seeds, polyunsaturated fatty acids, vitamins, mineral, and phytochemicals reduce cardiometabolic risk factors such as total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triacylglycerols (TG) (7). In contrast, intake of red meats, fast foods, sugar-sweetened beverages is associated with risk of metabolic syndrome and inflammation (8, 9). However, a focus on dietary patterns rather than individuals' foods items is needed to evaluate the association between diet and the risk of diseases (10). There are various indices to evaluate dietary quality such as the dietary quality index-international (DQI-I), healthy diet indicator (HDI), healthy eating index (HEI), dietary approaches to stop hypertension (DASH), Mediterranean diet Score (MDS), and dietary inflammatory index (DII) (11, 12). An HEI score was associated with reduced the risk of some cardiovascular risk factors (13). In addition, the DASH diet had a positive effect on risk factors (14).

DQI-I is an indicator that assesses diet quality and could be used for cross-national comparisons (15). Cross-sectional studies in populations with gestational diabetes and type-2 diabetes showed that a high DQI-I score was associated with improved glycemic status (16, 17). Furthermore, the DQI-I score is inversely associated with body composition abnormalities (18). On the other hand, some studies did not find a significant association between DQI-I and lipid profile, obesity, and chronic disease risk factor in middle-aged adults (19-21). There are few reports comparing DQI-I and cardiometabolic risk factors.

Therefore, the objective of the present study was to evaluate the association between DQI-I and cardiometabolic risk factors in a sample of middle-aged Iranian women.

Methods

Study population

This cross-sectional study was carried out on a sample of Iranian women aged 20 to 50 yr from health centers affiliated with Tehran University of Medical Sciences (TUMS), Tehran, Iran in 2018. The sample size was calculated based on the following equation: $n= [(Z_{1-\alpha/2})^2 \times S^2]/d^2$. Using SD=11.32, d=1.84, α=0.05 and β=0.8, we required 267 participants. However, due to the availability of data, 371 individuals were included using the cluster sampling method. We excluded persons who had a history of chronic diseases such as diabetes, cardiovascular, renal, liver and cancer, and those who were pregnant or lactating. Participants who reported abnormal daily energy intake (<600 or >3500 kcal/day)(22) or did not complete questionnaires were excluded. All participants provided informed written consent. The study protocol was approved by the Review Board and the Ethical Committee of the National Institute for Medical Research Development (NIMAD), Tehran, Iran (Number: IR.NIMAD.REC.1397.289).

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Dietary assessment

Dietary intake of individuals was assessed from a validated 168-item semi-quantitative food frequency questionnaire (FFQ) which estimated the frequency of consumption of each food item over the past year. FFQs of all participants were completed by an experienced dietitian through face-to-face interviews. Mean daily intake of each food was estimated by converting the usual portion size to grams by using household measures. Finally, we calculated the amount of total energy, macronutrient, and micronutrient intake by using a modified version of Nutritionist IV software for Iranian foods.

Dietary Quality Index-International assessment (DQI-I)

We followed the methodology of Kim et al. to calculate dietary quality (15). DQI-I is comprised of four main dietary components, including variety (0-20 points), adequacy (0-40), moderation (0-30), and overall balance (0-10). Variety consists of two parts: an overall variety of five food groups (0-15 points) and a variety of protein sources (0-5). The adequacy component that includes eight elements of diet must be included in order to provide a healthy diet. They include fruit, vegetable, and grains, fiber, protein, iron, calcium and vitamin C with a score between 0-5 for each. The moderation component assesses the intake of total fat, saturated fat, cholesterol, sodium, and empty calorie foods that are associated with chronic disease and the score of each component ranged between 0-6. Overall, balance evaluates the proportion of each macronutrient from total energy intake (0-6 points), and fatty acid ratio according to three types of fatty acids including saturated fatty acid (SFA), monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) (0-4 points).

Measurements

A calibrated digital scale to the nearest 0.1 kg (SECA, Hamburg, Germany) was used to assess body weight. To assess height, participants were barefoot and staff members used an un-stretched tape measure with an accuracy of 0.5 centimeters. Waist circumference was measured using un-stretched tape measure, which has an accuracy of 0.5 centimeters at the narrowest area of the abdomen without any pressure to body surface over light clothing. BMI was calculated by dividing weight to height squared (kg/m^2). Blood pressure was measured by a standard mercury sphygmomanometer after 10 min rest period while participants were seated. Blood pressure was measured twice with at least a 30-sec interval between measurements and the mean of two measurements was used for statistical analysis.

Physical activity level was evaluated using a 3-day physical activity recall and estimated in metabolic equivalent hours per day (MET-h/day) (23). A validated questionnaire was used to assess socio-economic status (SES) of participants (24). This questionnaire was comprised of several questions related to income, education, occupation, family number, home ownership, car ownership, number of times traveled abroad in the last year, the number of times participants traveled within the country, the number of rooms at home, and having modern furniture at home. Based on completed questionnaires, tertiles of SES were used to categorize participants into three groups: weak (score<33%), moderate (33<score<66%) and wealthy (score>66).

To analyze biochemical data, blood samples were collected from participants after a 12-hour overnight fasting. Fasting blood sugar (FBS) was measured on the day of blood sampling using commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran). Serum levels of TC, LDL-C, HDL-C, and TG were determined using commercially available enzymatic kits (Pars Azmoon, Tehran, Iran) by using an auto-analyzer system (Selectra E, Vitalab, Holliston, the Netherlands). An enzyme-linked immunosorbent assay (ELISA) (Diagnostic Biochem Canada, Inc., Montreal, Canada) was used to assess serum insulin concentrations.

Statistical analysis

One-way analysis of variance (ANOVA) was used to assess the differences in continuous variables across tertiles of the DQI-I score. Chi-square test was applied to assess the distribution of categorical variables between the demographic characteristics of the participants and tertiles of the DQI-I score. Intake of macro- and micronutrients, as well as DQI-I components according to different tertiles of the DQI-I score, were assessed by ANCOVA by adjusting for energy intake. Then, binary logistic regression in crude and adjusted models was used to assess cardiometabolic risk factors across tertiles of the DQI-I score. In the first adjusted model, energy intake was controlled. In the adjusted second model, age, BMI, physical activity, socioeconomic status, and consuming supplements or medication were controlled. In all analyses, the first tertile of DQI-I score was considered as the reference category. Statistical analyses were performed using SPSS for windows (ver. 16.0, Inc., Chicago IL). *P*-values were considered significant at *P*<0.05.

Results

General characteristics of participants are shown in Table 1. The mean age, weight, BMI, waist circumference, and physical activity of women was 30.6 yr, 64.1 kg, 24.3 kg/m^2, 84.0 cm, and 27.56MET-h/day, respectively. Participants in the third tertile of DQI-I compared with those in the first tertile were older and had higher weight, BMI, and physical activity level. In addition, the association between weight and BMI with DQI-I remained significant even after adjusting for various factors such as socioeconomic status and age.

Table 1: Demographic characteristics of women in different tertiles of DQI-I scores[1] (N=371)

Variables	*All*	*Tertiles of DQI-I*			
		1 Cut-point: <33.33	*2* Cut-point: 33.33-66.66	*3* Cut-point: > 66.66	*P value*[2]
Number	371	126	126	119	-
Age (yr)	30.59 ± 7.10	30.06 ± 6.14	29.82 ± 6.81	31.97 ± 7.91	0.034
Weight (kg)	64.13 ± 10.65	64.46 ± 10.01	61.20 ± 10.01	66.88 ± 11.25	<0.0001
		64.68 ± 0.90	61.51 ± 0.90	66.33 ± 0.93	0.001 [3]
BMI (kg/m²)	24.26 ± 4.03	23.85 ± 3.94	23.29 ± 3.83	25.71 ± 3.97	<0.0001
		23.96 ± 0.33	23.44 ± 0.33	25.44 ± 0.34	<0.0001 [3]
Waist Circumference (cm)	84.04 ± 10.96	84.00 ± 11.71	82.81 ± 10.66	85.37 ± 10.39	0.189
		84.29 ± 0.90	83.24 ± 0.90	84.61 ± 0.93	0.544 [3]
Physical activity (met.min/day)	27.56 ± 4.15	26.97 ± 3.76	28.50 ± 4.83	27.20 ± 3.57	0.007
SES (n)					
Poor	106	33	29	44	0.091
Moderate	139	49	55	35	
Rich	126	44	42	40	

[1] Data presented as Mean ± SD or number of individuals.
[2] P values presented resulted from analysis of one-way ANOVA and Chi-square test for quantitative and qualitative variables.
[3] P value presented resulted from ANCOVA analysis and adjusted for age and SES. In addition, data presented as Mean ± SE.
- DQI-I: diet quality index- international; BMI: body mass index; SES: Socio-economic status

The energy-adjusted dietary intakes of subjects across tertiles of DQI-I are presented in Table 2. Participants in the highest tertile of DQI-I had lower energy intake, fat, polyunsaturated fatty acid (PUFA), and monounsaturated fatty acid (MUFA), but higher carbohydrate, protein, fiber, iron, magnesium, zinc, folate, potassium, phosphorus, calcium, vitamins C, B1, B2, B3, B6, and vitamin A compared to the lowest tertile., Participants who were in the highest tertile of the DQI-I had greater variety, adequacy, moderation, and balance in comparison with the lowest tertile of DQI-I (*P*<0.001).

Table 2: Dietary intakes of participants in different tertiles of the DQI-I scores (n=371)

Variables	*Tertiles of DQI-I*			*P value**
	1 *N= 126*	*2* *N= 126*	*3* *N= 119*	
Energy (kcal/day)	2613.89 ± 837.54	2354.83 ± 708.60	2571.84 ± 718.84	0.015
Nutrients				
Carbohydrate (gr/d)	365.89 ± 3.37 £	371.96 ± 3.39	392.80 ± 3.46	<0.001
Protein (gr/d)	86.82 ± 1.43	91.01 ± 1.43	93.94 ± 1.46	0.002
Fat (gr/d)	83.18 ± 1.23	78.88 ± 1.24	70.53 ± 1.26	<0.001
SFA (g/d)				
PUFA (g/d)	20.98 ± 0.60	20.01 ± 0.61	16.78 ± 0.62	<0.001
MUFA (g/d)	26.47 ± 0.44	24.70 ± 0.45	22.48 ± 0.46	<0.001
Dietary fiber (g/d)	16.01 ± 0.38	19.29 ± 0.39	23.55 ± 0.39	<0.001
Iron (mg/d)	18.59 ± 0.24	18.76 ± 0.24	19.73 ± 0.25	0.003
Magnesium (mg/d)	261.25 ± 4.68	299.05 ± 4.70	318.82 ± 4.80	<0.001
Zinc (mg/d)	9.47 ± 0.24	10.40 ± 0.24	10.52 ± 0.24	0.004
Folate (mcg/d)	297.66 ± 9.43	340.27 ± 9.47	401.78 ± 9.69	<0.001
Potassium (mg/d)	3038.97 ± 68.18	3449.47 ± 68.47	4032.95 ± 70.01	<0.001
Phosphorus (mg/d)	1293.74 ± 26.32	1409.30 ± 26.44	1412.80 ± 27.03	0.002
Calcium (mg/d)	934.20 ± 24.88	1110.28 ± 24.99	1084.19 ± 25.55	<0.001
Vitamin C (mg/d)	107.96 ± 6.07	141.05 ± 6.10	185.99 ± 6.23	<0.001
Vitamin E (mg/d)	13.70 ± 0.52	13.38 ± 0.52	12.03 ± 0.53	0.061
Vitamin B1 (mg/d)	2.20 ± 0.03	2.31 ± 0.03	2.38 ± 0.03	0.001
Vitamin B2 (mg/d)	2.01 ± 0.04	2.27 ± 0.04	2.28 ± 0.04	<0.001
Vitamin B3 (mg/d)	25.92 ± 0.40	25.57 ± 0.40	27.36 ± 0.41	0.006
Vitamin B6 (mg/d)	1.82 ± 0.04	1.97 ± 0.04	2.17 ± 0.04	<0.001
Vitamin B_{12} (mcg/d)	3.86 ± 0.14	4.36 ± 0.14	4.09 ± 0.14	0.059
Vitamin A (IU/d)	1101.04 ± 62.45	1366.96 ± 62.72	1771.30 ± 64.13	<0.001
DQI-I components score				
Variety	5.92 ± 0.29	9.09 ± 0.29	12.12 ± 0.30	<0.001
Adequacy	13.98 ± 0.42	19.98 ± 0.43	27.24 ± 0.44	<0.001
Moderation	13.58 ± 0.44	16.60 ± 0.44	19.98 ± 0.45	<0.001
Balance	1.35 ± 0.26	2.65 ± 0.26	2.81 ± 0.26	<0.001

Energy intake presented as mean and SD.
* Calculated by multivariate analysis of variance.
£ All value from this row is adjusted for energy intake and presented as mean and SE.
- DQI-I: dietary quality index- international, SFA: saturated fatty acid, MUFA: monounsaturated fatty acid, PUFA: polyunsaturated fatty acid

Table 3 represents the odds ratios and 95% confidence intervals for CVD risk factors in crude and adjusted models across tertiles of the DQI-I score. Participants in the top tertile of DQI-I were more likely to have a lower level of TC and a higher level of HDL-C in comparison with the first tertile in the crude and all adjusted multivariable models. Individuals in the highest tertile of the DQI-I in comparison with the lowest tertile had a higher serum level of TG. However, this association became insignificant in the adjusted model.

Table 3: Odd ratio and 95% confidence interval for having different CVD risk factors according to tertiles of DQI-I score (n=371)

Variables	*Tertiles of DQI-I*			
	1 *N=126*	*2* *N=126*	*3* *N=119*	*P trend**
TC ≥ 200 (n= 75)				
Crude	1	0.52 (0.28-0.95)	0.49 (0.26-0.92)	0.021
Model 1¥	1	0.49 (0.26-0.94)	0.33 (0.16-0.67)	0.002
Model 2€	1	0.38 (0.19-0.76)	0.27 (0.13-0.58)	<0.0001
TG ≥ 150 (n= 47)				
Crude	1	1.20 (0.51-2.79)	2.50 (1.16-5.39)	0.015
Model 1¥	1	1.25 (0.51-3.06)	1.65 (0.72-3.76)	0.224
Model 2€	1	0.99 (0.38-2.61)	1.41 (0.58-3.43)	0.414
HDL ≥ 50 (n= 167)				
Crude	1	1.73 (1.05-2.87)	1.65 (0.99-2.75)	0.052
Model 1¥	1	1.73 (1.03-2.91)	2.02 (1.18-3.46)	0.009
Model 2€	1	2.47 (1.39-4.38)	2.53 (1.42-4.52)	0.001
FBS ≥ 110 (n= 10)				
Crude	1	2.56 (0.48-13.45)	1.60 (0.26-9.76)	0.640
Model 1¥	1	3.31 (0.58-18.82)	1.17 (0.17-7.84)	0.973
Model 2€	1	1.26 (0.15-10.26)	0.69 (0.07-6.20)	0.711
BMI> 30(n= 43)				
Crude	1	0.81 (0.34-1.97)	2.03 (0.95-4.34)	0.053
Model 1¥	1	0.88 (0.35-2.21)	1.69 (0.75-3.76)	0.174
Model 2€	1	0.83 (0.32-2.11)	1.52 (0.67-3.45)	0.283
WC ≥ 88cm (n= 120)				
Crude	1	1.08 (0.62-1.85)	1.57 (0.92-2.68)	0.095
Model 1¥	1	4.59 (1.68-12.54)	0.69 (0.27-1.73)	0.427
Model 2€	1	3.42 (1.11-10.48)	0.65 (0.23-1.79)	0.377

CVD, cardiovascular disease; DQI-I, dietary quality index-international; TC, total cholesterol; TG, triglyceride; FBS, fasting blood glucose; BMI, body mass index; WC, waist circumference
* P value was calculated by logistic regression.
¥ Model 1: adjusted for age, BMI (except for the BMI and WC) and energy intake.
€ Model 2: model 1 + supplements and drugs consumption, socioeconomic status and physical activity.
Risk of high metabolic factors was defined by ATPIII guideline: 1) abdominal obesity (WC≥ 88cm); 2) high serum triglycerides levels (≥ 150 mg/dl); 3) abnormal serum glucose levels (FBS ≥ 110 mg/dl); 4) high serum total cholesterol levels (≥ 200 mg/dl)
- DQI-I: diet quality index- international

Discussion

In the present study, we evaluated the association of DQI-I with cardiometabolic risk factors in Iranian women. Participants with a higher DQI-I score had lower serum concentrations of TC and higher HDL-C. However, a significant association was not found between the DQI-I score and other CVD risk factors including TG, FBS, BMI, and WC.

We observed that a higher DQI-I score was associated with lower level of TC and a higher level of HDL-C. The putative mechanism is that this score is associated with a lower intake of fat and cholesterol, hence reduced TC (25, 26). Fruits, vegetable, and vitamin C as the main source of dietary antioxidants (27) are common components of this diet score. High fruit and vegetable intake are related to higher HDL-C concentrations (28). Moreover, greater total anti-oxidant capacity particularly vitamin C was associated with increased HDL-C concentrations (27). Increased levels of HDL-C may also be due to higher intake of the protein (29) and fiber (30, 31), while less influenced by monounsaturated and polyunsaturated fatty acid intake (32, 33). A cohort study investigated the association between DQI-I and lipid profile in both men and women (19). Higher a higher DQI-I score was associated with reduced HDL-C concentration only in men, while no significant association was observed in women. In contrast to our results, they failed to find a significant association between DQI-I and TC (19). However, a higher DQI-I score in a population of healthy Luxembourgian adults was related to lower level of TC, as well as HDL-C concentrations (12). Higher DQI-I scores were not associated with improved lipid profile in a population of Guatemalan young adults (21).

Based on our findings, the DQI-I score was not related to the serum level of fasting blood sugar. The lack of a significant association between DQI-I and glycemic status may be due, in part, to the study population whose fasting blood glucose concentrations were within the normal range. In contrast, the DQI-I score was inversely associated with glycemic status in a population of Korean with type 2 diabetes (16). Consist of our results, Gregory et al. did not find a significant association between the DQI-I score and serum glucose concentration (21).

DQI-I was not associated with BMI or WC in this study and is consistent with a lack of statistical association between DQI-I and anthropometric indices of obesity in a longitudinal study of Iranians population at 6.7 yr of follow-up (20). In addition, Cheung et al. did not observe an association between DQI-I and obesity (16). Contrary to our results, higher adherence to the DQI-I in middle-aged and older women was associated with lower risk of body composition abnormalities (18). However, a cross-sectional study in Guatemalan adults demonstrated a positive association between DQI-I score and BMI and waist circumference (21).

The present study has some limitations including the small sample size, recommendation for energy intake were not considered in DQI-I score, the inability to assess cause and effect due to cross-sectional nature of the study design, the known limitations of using FFQ and the inability of the DQI-I to discern differences between high- and low-fat dairy products, or between whole and refined grains, which have important role in diet quality. In DQI-I score, refined grains take positive score, while it has direct association with increased lipid profile.

Conclusion

A higher DQI-I score was associated with preferable lipid profile biomarkers such as TC and HDL-C. Future large-scale, prospective cohort or clinical studies are required to confirm these findings.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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