

Healthy eating index and cardiovascular risk factors among Iranian elderly individuals

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Original Article

Abstract

BACKGROUND: Concurrent with increase in life expectancy, the prevalence of chronic diseases such as cardiovascular diseases (CVD) has also increased. Therefore, the aim of this study was to evaluate the association between healthy eating index (HEI) score and CVD risk factors among Iranian elderly.

METHODS: This cross-sectional study was performed on a sample of elderly persons from Isfahan, Iran, in 2013. Totally, 107 retired subjects were entered in statistical analysis. A semi-quantitative food frequency questionnaire was used to assess the dietary intake of participants. Anthropometric measurements and blood pressure of participants were determined. Fasting blood samples were taken for biochemical assessments.

RESULTS: The results of linear regression determined a significant inverse association between HEI score and homeostasis model assessment of insulin resistance [HOMA-IR, $\beta = -0.238$ (-0.426, -0.048)], fasting blood glucose [$\beta = -0.194$ (-0.383, -0.004)], and high-sensitivity C-reactive protein [hs-CRP, $\beta = -0.196$, (-0.386, -0.005)]. In addition, a significant positive association was observed between HEI score and high density lipoprotein cholesterol [HDL-C, $\beta = 0.196$ (0.006, 0.385)] levels. However, after adjusting for confounding variables, these significant associations were disappeared except for hs-CRP [$\beta = -0.074$ (-0.145, -0.003)].

CONCLUSION: Healthy eating index was associated with reduced risk of cardiovascular risk factors in old people. It seems that more adherence with healthy eating index could provide cardio-protective effects in elderly persons.

Keywords: Healthy Diet, Risk Factors, Cardiovascular Diseases, Iran

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Introduction

It has been reported that ageing (more than 60 years) is increasing rapidly worldwide and this increment is more than other age groups. It is estimated that from 1970 to 2025 a growth of 223% will occur in elderly subjects,¹ and the elderly population of the world will grow from 420 million to 973 million during 2000 to 2030.² Approximately, half of the elderly individuals live in developing countries. In Iran, the second largest country of the Middle East, the aging of population has become a concern. About 8.2% of Iranians are old and it is estimated that the elderly population will reach to 26% by 2050.³

Concurrent with increase in the life expectancy,

the prevalence of chronic diseases such as cardiovascular diseases (CVD) has also increased.⁴ Cardiovascular diseases are considered as the main cause of death throughout the world and about 30% of deaths are attributed to CVD.^{1,5} To date, several risk factors have been identified for CVD, and it is well established that nutritional habits and dietary intakes are strongly related to CVD events.⁴

In this context, most of the previous studies have focused on macro-nutrients (carbohydrate and protein) or single foods (yogurt, rice, and legumes).⁶⁻⁹ However, dietary intakes are complex and may have different effects on the risk of chronic diseases rather than single foods. Therefore, studying diet quality scores may be a practical approach in the

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field of diet and health associations, particularly among elderly. So far, few studies have focused on diet quality of elderly and showed the protective effects of high quality diets against CVD risks and mortality rate.^{4,10,11} Almost all earlier studies have shown that the diet of the majority of elderly persons needs improvement.^{12,13} However, to the best of our knowledge, there is no report regarding the diet quality of Iranian elderly and its association with CVD risk factors whereas Iran would be the third fastest aging nation worldwide after United Arab Emirates and Bahrain between 2010 and 2050.¹⁴

Due to the direct link between ageing and suffering from a variety of chronic diseases like CVD, hypertension, stroke and dyslipidemia,¹ it is necessary to identify major health hazards in this population and inform public health policy makers to develop some strategies to reduce the economic burden of such preventable chronic diseases. Therefore, the aim of this study was to evaluate the association between healthy eating index (HEI) score and CVD risk factors among Iranian elderly.

Materials and Methods

This cross-sectional study was performed on a sample of elderly people from Isfahan, Iran, in 2013. Totally, 120 retired subjects (male and female) aged more than 60 years were enrolled from Shahid Motahari Hospital, Fooladshahr, Isfahan, using simple random sampling method during January 2014 to January 2015. Exclusion criteria were as follows: being on a specific diet, suffering from an inflammatory disease, and receiving hypoglycemic or hypolipidemic agents. Furthermore, those who reported daily energy intake out of range of 800-4200 kcal and those who did not complete more than 70 items of food frequency questionnaire (FFQ) were excluded from study. Finally, 107 retired persons (84.4% male) were included in the analyses. Enough sample size was calculated based on high-sensitivity C-reactive protein (hs-CRP) as the main dependent variable.¹⁵ Ethics Committee of Isfahan University of Medical Sciences approved the study protocol. All participants completed a written informed consent before entering the study.

Using a validated 168-item semi-quantitative FFQ, dietary intake of participants were assessed.¹⁶ The FFQ considered the frequency of consumption of each food item in scale of usual portion size. A trained dietitian completed all FFQs via face to face interview. The mean intake of each food item (in gram) was estimated through multiplying accurate

portion sizes, obtained from household measures, by mean frequency intake. By using a modified version of Nutritionist IV software for Iranian foods (version 7.0, N-Squared Computing, Salem, OR, USA), the mean intake of macronutrients and micronutrients were calculated. To calculate HEI, 10 components were considered.¹⁷ The frequency of consumption of cereals, vegetables, fruits, meats and total dietary diversity was scored 10 and 0 in the highest and lowest consumption, respectively. The frequency of consumption of total fat, saturated fatty acids, cholesterol and sodium was scored 10 and 0 in the lowest and highest consumption, respectively. Total HEI score was obtained from summing the scores of these 10 components. For dietary diversity score (DDS) calculation, several subgroups were considered for each five main food groups.¹⁸ Grains were subdivided to refined bread, biscuits, macaroni, wholegrain bread, corn flakes, rice and refined flour. Vegetables were subdivided to vegetables, potato, tomato, other starchy vegetables, legumes, yellow vegetables and green vegetables. Fruits were classified as fruit and fruit juice, berries and citrus. Meats consisted of red meat, poultry, fish and eggs. Dairy products were subdivided to milk, yoghurt and cheese. If a person consumes at least once a day from each subgroup, he/she will get the full score of that subgroup.¹⁹ The score of each main food group was calculated by summing the consumption frequency of each subgroup divided by the number of subgroups and then multiplied by 2. Total DDS score was obtained from sum of the scores of each 5 main food groups.

Body weight, waist circumference and height were measured by an expert. Weight was measured using a calibrated digital scale while participants wore light clothing and was recorded to the nearest 100 grams. Height was measured to the nearest 0.5 centimeter using an un-stretched tape while participants were barefoot. Waist circumference (WC) was measured to the nearest 0.5 centimeter at the narrowest level by an un-stretched tape without any pressure to body surface over light clothing. Body mass index (BMI) was calculated as body weight in kilogram divided by height squared in meter. For blood pressure measurement, a standard mercury sphygmomanometer was used. Blood pressure was measured in a sitting position and after 10 min rest. Blood pressure was measured twice with at least a 30 seconds interval and finally the mean of two measurements were entered to analysis.

By using a 3-day physical activity record, physical activity level of participants was measured and

presented in metabolic equivalent-hours per week (MET-hour/week). Socioeconomic status (SES) of participants was assessed through a validated Persian version questionnaire.²⁰ This questionnaire contained several questions about income, education, occupation, family number, house ownership, car ownership, the number of states, the number of traveling abroad in the last year, the number of traveling inside the country, the number of rooms at home, and having modern furniture at home. Based on completed physical activity questionnaires, tertiles of SES were used to classified participants into three groups: weak (score < 33%), moderate (33 < score < 66%) and strong (score > 66).

After 12-hours overnight fasting, blood samples were collected for biochemical analysis. Fasting blood sugar (FBS) was measured on the day of blood sampling using commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran). Serum levels of total cholesterol (TC), low density lipoprotein cholesterol (LDL-C) and triglyceride (TG) were quantified using commercially available enzymatic kits (Pars Azmoon, Tehran, Iran) by using an auto-analyzer system (Selectra E, Vitalab, Holliston, the Netherlands). Enzyme-linked immunosorbent assay (ELISA) method (Diagnostic Biochem Canada, Inc., Montreal, Canada) was used to assess serum insulin concentrations. By using fasting insulin and glucose levels, insulin resistance indices including homeostasis model assessment of insulin resistance (HOMA-IR)²¹ and quantitative insulin sensitivity check index (QUICKI)²² were estimated. Serum levels of hs-CRP were measured through an ultrasensitive latex-enhanced immunoturbidimetric assay (Randox Laboratory Ltd., Belfast, United Kingdom). Plasma levels of fibrinogen were determined by Clauss method

which records the rate of fibrinogen conversion to fibrin by adding thrombin. Serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) were measured using commercially available enzymatic reagents (Pars Azmoon).

Kolmogorov-Smirnov test and histogram were used to determine normal distribution of all variables. The median cut point of HEI (77.19) was calculated and participants were stratified into two categories accordingly, participants in the low category (≤ 77.19) had lower adherence to HEI pattern in comparison with those in high category (> 77.19). To compare general characteristics of participants between low category and high category, chi-square and Student's independent t-test were performed. Analysis of covariance adjusted for age, sex and energy intake was run to compare dietary intakes and biochemical markers of participants between the two categories. In addition, to compare the biochemical factors between the median of HEI score, further adjustment for BMI was considered. Linear regression in crude and adjusted models (adjusted for age, sex, energy intake and BMI) was applied to determine the significant association between HEI score and CVD risk factors. Statistical analysis was performed by SPSS for Windows (version 18, SPSS Inc., Chicago, IL, USA). P-values less than 0.05 were considered as significant level.

Results

General characteristics of participants are presented in table 1. Participants in higher median of HEI were significantly older ($P = 0.042$) and had elevated systolic blood pressure than participants in lower median of HEI ($P = 0.043$).

Table 1. Comparison of general characteristics of participants by median of healthy eating index *

Variables	HEI		P**
	Lower median (n = 53)	Higher median (n = 54)	
Male (%)	77.8	92.6	0.030
Age (year)	61.86 (1.02)	64.62 (0.87)	0.042
Height (cm)	166.85 (1.20)	168.58 (1.04)	0.277
Weight (kg)	71.74 (1.56)	74.88 (1.56)	0.159
BMI (kg/m ²)	25.64 (0.53)	26.31 (0.52)	0.379
WC (cm)	97.64 (1.35)	98.49 (1.20)	0.642
SBP (cmHg)	12.32 (0.19)	12.97 (0.24)	0.043
DBP (cmHg)	7.74 (0.13)	7.91 (0.11)	0.317

HEI: Healthy eating index; BMI: Body mass index; WC: Waist circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure

* Data are means (SE) and percent (%); ** By using independent sample t-test and chi-square test

Table 2. Comparison of dietary intakes of participants by median of healthy eating index*

Variables	HEI		P [†]
	Lower median (n = 53)	Higher median (n = 54)	
Protein (g/d)	231.39 (14.55)	132.07 (14.12)	< 0.001
Carbohydrate (g/d)	256.37 (13.71)	387.45 (13.31)	< 0.001
Fat (g/d)	78.94 (2.32)	65.41 (2.26)	< 0.001
Cholesterol (mg/d)	589.66 (33.99)	280.49 (32.99)	< 0.001
Saturated fatty acids (g/d)	20.75 (0.79)	17.93 (0.77)	0.014
Total dietary fiber (g/d)	13.87 (0.76)	21.56 (0.74)	< 0.001
Fruits	362.20 (28.69)	535.36 (27.85)	< 0.001
Vegetables	286.45 (22.67)	441.98 (22.01)	< 0.001
Red meat	14.07 (2.27)	19.42 (2.21)	0.101
Legumes	12.25 (1.38)	16.71 (1.34)	0.025
Dietary diversity score	3.61 (0.41)	7.96 (0.27)	< 0.001

HEI: Healthy eating index

* Data are means (standard error); [†] By using analysis of covariance adjusted for age, sex and energy intake

Other general characteristics including height, BMI, waist circumference and diastolic blood pressure had no significant differences between two categories of HEI score ($P > 0.050$).

Table 2 shows dietary intakes of participants between two categories of HEI. Participants in top category of HEI consumed lower amounts of dietary protein, fat, cholesterol, ($P < 0.001$), and saturated fatty acids ($P = 0.014$) and higher amounts of carbohydrate, dietary fiber, fruit, vegetables, ($P < 0.001$), and legumes ($P = 0.025$). Furthermore, participants in higher category of HEI had greater dietary diversity score in comparison with lower category of HEI ($P < 0.001$).

Mean and standard errors (SE) of biochemical markers in crude and adjusted models are indicated in table 3. Participants in the top category of HEI score had marginally significant lower levels of hs-CRP and ALP in crude model ($P = 0.052$ and $P = 0.076$, respectively). However, after adjusting for age, sex, energy intake and BMI, this marginal association was disappeared. The mean values of other biochemical markers were not significantly different between the two categories of HEI score ($P > 0.05$).

The results of linear regression analysis are presented in table 4. There were significant inverse associations between HEI score and HOMA-IR [β in crude model = -0.238 (-0.426, -0.048); $P = 0.015$], fasting blood glucose [β in crude model = -0.194 (-0.383, -0.004); $P = 0.047$], ALP [β in model I = -0.156 (-0.256, -0.057); $P = 0.002$] and hs-CRP [β in crude model = -0.196 (-0.386, -0.005); $P = 0.046$, β in model I = -0.074 (-0.145, -0.003); $P = 0.041$]. A significant positive association was observed between HEI score and high density

lipoprotein cholesterol (HDL-C) levels [β in crude model = 0.196 (-0.386, -0.005); $P = 0.044$]. Other CVD risk factors had no significant association with HEI score ($P > 0.050$).

Discussion

This cross-sectional study showed a desirable significant association between HEI score and some of cardiovascular risk factors including HOMA-IR, FBS, hs-CRP and HDL-C levels among elderly persons from Isfahan. However, other CVD risk factors were not statistically related to adherence to HEI score. According to our knowledge, this is the first time that the association of HEI score and CVD risk factors are assessed among Iranian old persons.

Nowadays, it is well established that those elderly persons who consumed high quality diets had lower risk for all-cause mortality, CVD mortality, coronary heart disease events or having at least one of the CVD risk factors including obesity, hypertension, hypercholesterolemia and diabetes mellitus.^{1,4,10,23}

Consistent with our results, several previous studies have documented an association between higher scores of HEI and better control of glycemic indices.^{24,25} Older men in the highest tertile of a modified-HEI had 75% decreased risk of incidence of impaired fasting glucose. In addition, a 52% reduction in the risk of 10-year incidence of impaired fasting glucose was observed by each 2-times increment in modified-HEI score among older men.²⁴ Furthermore, the results of a case-cohort study showed a tendency towards an inverse association between alternative-HEI and diabetes in countries with higher mean age.²⁵

Table 3. Crude and adjusted means and standard errors of biochemical markers by median of healthy eating index in elderly subjects from Isfahan, Iran

Variables	HEI		P*
	Lower median (n = 53)	Higher median (n = 54)	
HOMA-IR			
Crude	74.09 (15.810)	71.22 (13.190)	0.889
Model I [†]	71.27 (15.370)	74.97 (14.910)	0.866
Model II [‡]	64.26 (14.270)	72.28 (13.660)	0.691
QUICKI			
Crude	0.34 (0.010)	0.33 (0.010)	0.680
Model I	0.34 (0.007)	0.33 (0.006)	0.663
Model II	0.34 (0.007)	0.34 (0.006)	0.616
Insulin (UIU/ml)			
Crude	12.84 (2.250)	13.69 (2.050)	0.780
Model I	12.35 (2.280)	14.22 (2.210)	0.565
Model II	12.35 (2.390)	14.17 (2.290)	0.591
Fasting blood sugar (mg/d)			
Crude	119.05 (8.960)	107.40 (4.060)	0.228
Model I	119.26 (7.180)	108.03 (6.960)	0.274
Model II	113.12 (5.850)	106.50 (5.600)	0.424
Triglyceride (mg/dl)			
Crude	156.31 (10.500)	178.23 (22.140)	0.385
Model I	157.86 (19.530)	179.30 (18.940)	0.441
Model II	157.50 (20.630)	179.46 (19.760)	0.452
Total cholesterol (mg/dl)			
Crude	194.74 (6.970)	193.10 (4.970)	0.847
Model I	194.41 (6.510)	195.26 (6.320)	0.928
Model II	196.79 (6.620)	196.96 (6.340)	0.985
LDL-C (mg/dl)			
Crude	99.31 (3.960)	97.05 (3.110)	0.653
Model I	99.53 (3.830)	98.16 (3.720)	0.802
Model II	100.92 (3.880)	99.65 (3.710)	0.816
HDL-C (mg/dl)			
Crude	49.07 (1.670)	49.87 (1.030)	0.683
Model I	49.34 (1.460)	49.79 (1.410)	0.827
Model II	50.49 (1.390)	50.42 (1.330)	0.975
hs-CRP (µg/ml)			
Crude	5.55 (1.800)	2.11 (0.200)	0.052
Model I	4.67 (1.210)	2.99 (1.180)	0.335
Model II	2.79 (0.500)	2.15 (0.470)	0.364
Fibrinogen (mg/dl)			
Crude	279.61 (8.580)	274.18 (6.580)	0.614
Model I	276.51 (7.850)	276.16 (7.610)	0.975
Model II	275.76 (8.260)	276.53 (7.910)	0.947
AST (IU/l)			
Crude	23.49 (2.750)	20.32 (0.770)	0.256
Model I	23.09 (2.000)	20.90 (1.930)	0.442
Model II	21.43 (1.450)	20.23 (1.390)	0.562
ALT (IU/l)			
Crude	21.76 (2.650)	18.18 (1.120)	0.205
Model I	21.64 (2.040)	18.68 (1.980)	0.310
Model II	20.10 (1.640)	17.92 (1.570)	0.350
ALP (IU/l)			
Crude	266.43 (40.110)	194.92 (9.430)	0.076
Model I	264.42 (30.010)	202.16 (29.100)	0.147
Model II	230.89 (16.420)	192.59 (15.730)	0.101

HEI: Healthy eating index; HOMA-IR: Homeostasis model assessment of insulin resistance; QUICKI: Quantitative insulin sensitivity check index; LDL-C: Low-density lipoprotein cholesterol; HDL-C: High-density lipoprotein cholesterol; hs-CRP: High-sensitivity C-reactive protein; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; ALP: Alkaline phosphatase

* P-values of crude model is resulted from independent sample t-test and P-values of model I and II are resulted from analysis of covariance (ANCOVA); [†] Model I is adjusted for energy intake, sex and age; [‡] Model II is adjusted for energy intake, sex, age and body mass index.

Table 4. Crude and adjusted correlation of healthy eating index scores and cardiovascular risk factors in elderly subjects from Isfahan, Iran

Variable [†]	HEI ^{*,†}	
	β^{\ddagger} (95% confidence interval)	P [§]
HOMA-IR	-0.238 (-0.426, -0.048)	0.015
Model I	-0.170 (-0.347, 0.006)	0.059
QUICKI	0.128 (-0.065, 0.320)	0.194
Model I	0.099 (-0.098, 0.297)	0.321
Insulin (UIU/ml)	-0.149 (-0.340, 0.044)	0.132
Model I	-0.128 (-0.330, 0.074)	0.212
Fasting blood sugar (mg/d)	-0.194 (-0.383, -0.004)	0.047
Model I	-0.122 (-0.277, 0.032)	0.120
Triglyceride (mg/dl)	0.142 (-0.049, 0.334)	0.146
Model I	0.149 (-0.057, 0.354)	0.154
Total cholesterol (mg/dl)	0.164 (-0.027, 0.355)	0.092
Model I	0.167 (-0.031, 0.365)	0.098
LDL-C (mg/dl)	0.119 (-0.074, 0.311)	0.226
Model I	0.116 (-0.083, 0.315)	0.249
HDL-C (mg/dl)	0.196 (0.006, 0.385)	0.044
Model I	0.164 (-0.017, 0.345)	0.076
hs-CRP (μ g/ml)	-0.196 (-0.386, -0.005)	0.046
Model I	-0.074 (-0.145, -0.003)	0.041
Fibrinogen (mg/dl)	-0.083 (-0.276, 0.112)	0.406
Model I	-0.070 (-0.272, 0.133)	0.496
AST (IU/l)	-0.129 (-0.321, 0.063)	0.186
Model I	-0.120 (-0.252, 0.012)	0.074
ALT (IU/l)	-0.087 (-0.280, 0.106)	0.376
Model I	-0.071 (-0.220, 0.079)	0.350
ALP (IU/l)	-0.189 (-0.379, 0.001)	0.053
Model I	-0.156 (-0.256, -0.057)	0.002
Weight (kg)	0.013 (-0.181, 0.207)	0.893
Model I	0.005 (-0.197, 0.207)	0.959
BMI (kg/m ²)	-0.008 (-0.201, 0.186)	0.939
Model I	0.011 (-0.188, 0.210)	0.911
WC (cm)	-0.070 (-0.261, 0.124)	0.485
Model I	-0.045 (-0.242, 0.153)	0.654
SBP (mmHg)	0.048 (-0.145, 0.241)	0.625
Model I	0.019 (-0.176, 0.214)	0.846
DBP (mmHg)	0.019 (-0.174, 0.212)	0.848
Model I	0.010 (-0.170, 0.190)	0.914

HEI: Healthy eating index; HOMA-IR: Homeostasis model assessment; QUICKI: Quantitative insulin sensitivity check index; LDL-C: Low-density lipoprotein cholesterol; HDL-C: High-density lipoprotein cholesterol; hs-CRP: High-sensitivity C-reactive protein; AST: aspartate aminotransferase; ALT: Alanine aminotransferase; ALP: Alkaline phosphatase; BMI: Body mass index; WC: Waist circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure

* HEI was considered as an independent variable for all cardiovascular risk factors.

[†] Dependent variable; each cardiovascular risk was entered into separate regression models; [‡] Standardized β -coefficient; [§] Resulted from linear regression; ^{||} Model I is adjusted for age, sex, energy intake and body mass index, except for weight, waist circumference and body mass index which were not adjusted for body mass index

It must be taken into account that due to relatively higher body fat mass and abdominal adiposity, Asian people have more risk for diabetes than white people in the same body mass index level.²⁶⁻²⁸ Therefore, the findings of the present study are remarkable in this regard, since a previous study has shown that 22% of Iranian old persons

have diabetes and 27.5% of diabetic patients are not aware of their disease.³ Although we did not find any association between HEI score and body weight, BMI, and waist circumference, top category of HEI was inversely associated with FBS and insulin resistance that is shown by HOMA-IR. Lower glycemic load of healthy dietary patterns due

to high content of fruits and vegetables could modify β -cell function and reduce serum levels of blood glucose.²⁴ Furthermore, high content of fruits, vegetables and whole grains are associated with reduced levels of C-reactive protein (CRP).²⁴ It is shown that high levels of inflammatory markers are related to β -cell dysfunction and insulin resistance.²⁹ Moreover, healthy dietary patterns have high content of antioxidants due to higher amounts of fruits, vegetables and whole grains. The protecting effects of antioxidants against insulin resistance and elevated levels of blood glucose was reported previously.³⁰

In the present study, higher score of HEI was related to the higher levels of HDL-C among elderly persons. The results of a cross sectional study on postmenopausal women indicated that women in high physical activity energy expenditure-high Canadian-HEI score had 10% higher amounts of HDL-C than women in the low physical activity-low Canadian-HEI group.³¹ Other previous studies have determined beneficial association between HEI score and HDL-C levels among adults.^{32,33} It had been shown that adults with better adherence to HEI were 21% less likely to have decreased levels of HDL-C.³³ However, two observational studies performed on Iranian adults could not detect impressive association between HEI score and HDL-C levels.^{34,35} Higher adherence to healthy eating index is simultaneous with increased consumption of fruit, vegetables, whole grains, low-fat dairy foods, lean meats and legumes and lower intakes of total fat, saturated fatty acids and cholesterol. All these dietary factors are associated with improvement in lipid profile.^{33,34}

In this cross-sectional study a negative association was found between HEI score and hs-CRP levels among elderly persons. Previous studies have documented inconsistent results. A study performed among elderly participants did not document an inverse association between HEI and CRP levels.³⁶ However, another study that was performed on overweight and obese postmenopausal women indicated 28% lower hs-CRP levels in high physical activity energy expenditure-high Canadian-HEI compared with low physical activity-low Canadian-HEI group.³¹ However, other studies confirmed an inverse association between HEI score and hs-CRP levels among adults.^{37,38} Recently, several studies have declared a significant inverse relation between HDL-C and hs-CRP concentrations. However, the underlying possible mechanism between HDL-C

and hs-CRP is not clear.^{39,40} In the current study HDL-C and CRP had significant positive and inverse association with HEI score, respectively. Previous studies have demonstrated negative association between fruit and vegetable,⁴¹ legumes⁴² and fiber intake⁴³ with CRP levels.

It is shown that 3.3% and 9.2% of old persons have abnormal tests of AST and ALP, respectively.⁴⁴ Fleming et al. demonstrated that elevated concentrations of AST and ALP were associated with increased risk of death from liver disease among elderly population. AST was associated with seven times increased risk of death and ALP was associated with six times increased risk of death from liver diseases.⁴⁴ In addition, it had been shown that high serum levels of AST, ALT and ALP was associated with increased risk of all-cause mortality among old subjects.⁴⁵ Based on our literature review, there is no previous study about the association of HEI score and hepatic enzymes. In the current study, an inverse association between HEI score and ALP and AST levels was observed. Higher scores of HEI are simultaneous with higher consumption of fruit and vegetables. It is well known that these food groups could be considered as a main source of antioxidants.³⁰ A previous study had shown an inverse association between total antioxidant capacity (TAC) and AST levels among obese adults.⁴⁶ Furthermore, healthy dietary patterns including Mediterranean dietary pattern could improve liver function by reducing insulin resistance and consequently reducing liver fat accumulation.⁴⁷ Now, it is established that HEI might be a beneficial approach for reducing insulin levels as well as insulin resistance.^{48,49} In the present study, HEI score had a significant inverse association with HOMA-IR in crude model and a marginally inverse association in model I.

Previous studies have established that elderly peoples have several nutritional inadequacies and are malnourished or at risk of malnutrition.^{50,51} Therefore, determining an applicable nutritional strategy among elderly people who are at great risk of dietary insufficiencies is of great interest. In the present study, participants with the most adherences with HEI score profited from cardio-protective effects of this dietary pattern. Higher scores of HEI with noticeable amounts of fruit, vegetables and whole grains provide a diet that has low density of energy. It has been declared that low-energy-dense diets have the capacity to provide dietary recommendations for macro- and micro-nutrients in elderly persons.⁵²

In this cross-sectional study we presented the associations between HEI score and cardiovascular risk factors among Iranian elderly for the first time. We randomly included retired subjects from different socioeconomic status, which to some extent, could be a representative sample of elderly population in Isfahan. However, several limitations must be considered for the present study. First, due to cross-sectional nature of the study, the inference of causal association was impossible. Second, relatively small sample size of participants made it difficult to detect the exact associations between HEI score and CVD risk factors. Third, in this study dietary intakes of participants were assessed by a semi quantitative FFQ. Due to recall bias of this dietary tool, misclassification of participants is inevitable. At last, it is possible that there are unknown confounders that we did not enter as covariates in statistical analysis.

Conclusion

In conclusion, the results of this study showed a significant favorable association between HEI score and several CVD risk factors including HOMA-IR, FBS, hs-CRP and HDL-C levels among elderly persons from Isfahan. Large prospective cohort studies are needed to prove the observed relationship among Iranian old population.

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Conflict of Interests

Authors have no conflict of interests.

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