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A Western dietary pattern is associated with elevated level of high sensitive C-reactive protein among adolescent girls

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Abstract

Background/Objective: Serum high sensitive C-reactive protein (hs-CRP), is an indicator of low-grade inflammation, and is associated with several non-communicable diseases. The effects of diet on inflammation have not been extensively investigated, particularly among adolescents. We aimed to examine the association between major dietary patterns and elevated serum level of hs-CRP among Iranian adolescent girls.

Methods: In this cross-sectional study, a total of 670 adolescent girls were recruited from several schools in different areas of Mashhad and Sabzevar cities, Iran. The dietary intakes of study participants were collected using a 147-item Food Frequency Questionnaire. To identify major dietary patterns based on the 40 food groups, we used principal component analysis. Serum concentration of hs-CRP was measured using commercial kits and the BT-3000 auto-analyzer. To investigate the association between dietary patterns and elevated serum level of hs-CRP, we used logistic regression analysis.

Results: Three specific dietary patterns were identified: (i) healthy, (ii) traditional and (iii) western dietary patterns. A significant association was found between more adherence to western dietary pattern and elevated serum level of hs-CRP (OR: 1.58; 95% CI: 1.02-2.42, $p_{trend=}$ 0.03); these association remained significant after adjustment for potential confounders. However, there was no significant relationship between healthy and traditional dietary patterns and elevated serum level of hs-CRP**.**

Conclusion: Our results indicate that there is a significant positive association between more adherence to Western dietary pattern and higher serum levels of hs-CRP among Iranian adolescent girls. Further studies, particularly longitudinal intervention studies may be required to clarify these relationships.

Keywords: Dietary pattern; hs-CRP; Cardiovascular disease; Adolescent.

Introduction

A state of low grade inflammation is associated with several non-communicable conditions that include: obesity [1, 2], diabetes [3, 4], metabolic syndrome [4, 5] and cardiovascular disease (CVD) [2, 5-7]. Serum high sensitivity C-reactive protein (hs-CRP) is a well-known inflammatory marker, which is secreted by liver under the control of interleukin 6 (IL-6) and appears to be associated with several chronic diseases in both young people and adults [7-11].

It has been shown that the origin of atherosclerosis begins in childhood and after progression its clinically symptoms may appear in young adulthood [12, 13]. In a previous study, it has been reported that there is a significant association between aortic pulse wave velocity (aPWV), one of the most often used measures of arterial stiffness and serum hs-CRP concentrations in young people who are either obese or have type 2 diabetes [7]. Several factors include smoking [14], BMI [2, 15], waist circumferences [4, 15] and physical inactivity [16] have been shown to be directly related to serum hs-CRP in both young people and adults; the role of diet in influencing serum hs-CRP, particularly among adolescents, remains unclear. A randomized controlled trial has shown that life-style modification, that included diet and physical activity, reduced serum hs-CRP, IL-6 and fibrinogen significantly in obese adolescents [17]. However, there are little data on the relationship between some food items and nutrients and serum hs-CRP concentrations in adolescents. Because of the potential interaction between the elements of the diet and the fact that people consumed a variety of foods rather than an isolated food item [18], we considered evaluating the relationship between serum level of hs-CRP and dietary patterns, which is an indicator of overall pattern of foods consumed [19]. Although the association between dietary patterns and serum level of hs-CRP in adults was reported in some earlier studies [20, 21], we are aware that there have been no studies among adolescents that have evaluated the association between adherence to major dietary patterns and serum concentration of hs-CRP. Our hypothesis was that some dietary patterns might influence serum level of hs-CRP concentration among adolescents, and it may be helpful to prevent several chronic diseases related to the elevated hs-CRP. This study was conducted to assess the relationship of major dietary patterns and elevated serum level of hs-CRP within a sample of adolescent Iranian girls.

Method and material

Study population

A total of 750 adolescent girls were recruited using a random cluster sampling method from several schools in different areas of Mashhad and Sabzevar cities, northeastern Iran. Only students who were between 12-18 years of age were included. We excluded those with any autoimmune diseases, cancer, metabolic bone disease, hepatic or renal failure, cardiovascular disorders, malabsorption or thyroid, parathyroid, adrenal diseases and anorexia nervosa or bulimia. In addition, individuals with taking anti-inflammatory, anti-depressant, anti-diabetic, or anti-obesity drugs, vitamin D or calcium supplement use and hormone therapy within the last 6 months were not included. All study participants completed written informed consent forms prior to study enrolment. The Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran, approved this study. Reporting of the study conforms to STROBE statement along with references to STROBE statement and the broader EQUATOR guidelines [22].

Demographic and dietary assessment

Demographic information including age, smoking status, menstruation status, medical history and drug use was obtained per by experienced interviewers. Physical activity was assessed through validated questionnaire [23] and provided as metabolic equivalents (METs) in hours per day. A validated food frequency questionnaire (FFQ), that contained 147 food items, was used to obtain the dietary intakes of the study participants [24, 25]. To estimate energy and nutrient intakes, the reported portion size in food frequency questionnaire was converted to grams using household measures and then was entered to the Nutritionist IV software. In order to minimize the influence of under- and over reporting of energy intakes, subjects were omitted, if they reported the total energy intake out of the range of 800 to 4200 kcal/day [26] (n= 80). Therefore, data from 670 participants were included in the final statistical analysis. Forty predefined food groups were determined to identify the major dietary patterns (Table 1). Based on the similarity of nutrients and their correlation with serum levels of hs-CRP, certain food groups were created.

Anthropometric and biochemical assessment

Anthropometric variables include weight, height and waist circumference (WC) were obtained using standard protocol. Weight was measured in subjects wearing minimum clothing and without shoes using a Seca digital scale. Height was measured in subjects without shoes and standing position. Body mass index (BMI) was calculated as weight (in kg) divided by square of height (in m). WC were measured with flexible tape measure from the narrowest point between the lowest rib and the iliac crest. Blood pressure was measured two times using a standardized protocol. The mean of two recorded measurements was reported as subject’s blood pressure. Blood samples were collected after subjects had fasted for 12-14 hours and were taken between 8-10 am by venipuncture from an antecubital vein. According to the standard protocol, vacuum tubes (20 ml) were used for collecting blood specimens from subjects in a sitting position. Blood samples were centrifuged at room temperature and serum, or plasma separated within 30-45 minutes. Serum fasted triglycerides, total cholesterol, high-density lipoprotein cholesterol (HDL-C), fasting blood glucose (FBG) and hs-CRP were obtained via enzymatic methods (Pars Azmun, Karaj, Iran) using an auto-analyzer. LDL-C was calculated using Friedewald formula if serum TGs concentrations were lower than 4.52 mmol/L.

Statistical methods

An elevated serum hs-CRP was defined as >1 mg/dl. The median cut off for serum levels of hs-CRP was determined to be 1 mg/dl, as well. To identify major dietary patterns based on the 40 food groups, factors were rotated by varimax rotation, and principal component analysis was used. With regard to Eigen values >1.5 and interpretation of the Scree plot, three factors were determined. We identified three major dietary patterns and these were labeled based on our interpretation of the data and of the previous studies. Summing intakes of foods weighted for their factor loading, we obtained the factor scores of each derived pattern for all subjects. We categorized individuals by tertiles of dietary pattern scores. One-way analysis of variance was performed to examine the differences in continuous variables (age, weight, BMI) across tertiles categories of dietary pattern scores. A covariance analysis across tertiles of dietary patterns was applied to examine the energy-adjusted intakes of foods and nutrients. Moreover, to investigate the relationship between dietary patterns and elevated serum level of hs-CRP, we used logistic regression in various models. Age and energy were controlled in the first model. Further adjustments were applied for passive smoking, physical activity and menstruation in the second model and in the last model, we controlled BMI, in addition to the previous factors. All data were analyzed using the Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL, USA), version 15 at significant level of less than five percent.

Results

Identified major dietary patterns

Applying factor analysis to determine dietary food patterns, three major dietary patterns were identified that we labelled as: healthy, traditional and western dietary patterns. A healthy dietary pattern was characterized by a high intake of legumes, vegetables, fish, egg, yoghurt, cruciferous vegetables, tomatoes, green leafy vegetables, garlic, fruits, olives, mayonnaise, low and full-fat dairy products. In the traditional dietary pattern, the intake of potatoes, snacks, hydrogenated fats, vegetable oils, sugars, soft drinks, sweets and desserts, tea, salt and spices was higher than other dietary patterns. The western dietary pattern was high in refined grains, snacks, red meats, poultry, fish, organ meat, pizza, fruit juices, industrial juice and compote, mayonnaise, nuts, sugars, soft drinks, sweets and desserts, coffee and pickle. The factor-loading matrixes for three dietary patterns are shown in Table 2.

General characteristics and dietary intakes of study participants

General characteristics, anthropometrics and clinical parameters of the study participants across tertiles of major dietary patterns are shown in Table 3.There were no significant differences between age, weight, waist circumference, systolic and diastolic blood pressure, smoking statues, menstruation, total cholesterol, LDL-Cholesterol, HDL-Cholesterol and triglyceride across tertiles of different dietary pattern scores (Table 3.). However, BMI was higher in the first tertile of traditional dietary pattern than in the third tertile (p=0.04). In addition, participants in the third tertile of healthy dietary pattern were more likely to be physically active in comparison to those in the first tertile (p=0.06). Moreover, serum hs-CRP was higher among individuals in the highest tertile of western dietary pattern than others in the lowest tertile (p=0.005). Nevertheless, fasting blood glucose was higher among subjects in the first tertile of western dietary pattern compared to the participants in the third tertile (p=0.02). Dietary intakes of food groups and nutrients across tertile categories of dietary pattern scores are shown in Table 4. Consumption of red meat, low and high fat dairy products, fruits, vegetable oil, legumes, coffee, energy, protein, total fat, saturated fatty acids, cholesterol, vitamin C and A were significantly higher among individuals in the third tertile of healthy dietary pattern in comparison to those in the first tertile. Similarly, energy, protein, total fat, saturated fatty acids, cholesterol, vitamin C and A were more consumed by subjects in the highest tertile of this pattern compared to those in the lowest tertile. Nevertheless, refined grains among food items and total carbohydrate, total fibers and total polyunsaturated fatty acids among nutrients were eaten significantly more frequently in the lowest tertile of healthy pattern than in the highest tertile of this pattern. Higher intake of red meat, vegetables oil, legumes, spices, nuts, salt, energy, sucrose, total fat, total mono unsaturated fatty acids, total polyunsaturated fatty acids, vitamin C and E was seen in the highest tertile of traditional pattern in comparison to the lowest tertile. However, intake of protein and fat were higher in the lowest tertile of traditional dietary pattern than in the highest tertile. In comparison to individuals in the lowest tertile, those in the highest tertile of western dietary pattern intake, higher amounts of red and processed meat, high fat dairy, fruit, coffee, refined grains, nuts, energy, total carbohydrate and vitamin C though lower intake of total fiber, mono-, and poly-unsaturated fatty acids and vitamin E in comparison to the first tertile.

The relationship between major dietary patterns and elevated serum level of hs-CRP

Multivariable-adjusted odds ratio (OR) for elevated serum hs-CRP across tertiles of dietary pattern scores are presented in Table 5. Overall, no significant association was found between elevated serum level of hs-CRP and healthy and traditional dietary patterns using crude or adjusted models. However, individuals in the third tertile of western dietary pattern 58% more likely to have elevated hs-CRP than in the lowest tertile (OR: 1.58; 95% CI: 1.03, 2.42, $P\text{-trend}_{=}$ 0.03). Similar results were found after adjusting for age and energy intake and further adjusting for passive smoking, physical activity and menstruation (OR: 1.58; 95% CI: 1.02-2.44, $P\text{-trend}_{=}$ 0.03), (OR: 1.58; 95% CI: 1.01-2.46, $P\text{-trend}_{=}$ 0.04), respectively. Moreover, after further adjusting for BMI, the likelihood of elevated serum hs-CRP in the subjects in the highest tertile of the Western dietary pattern was 1.68 compared to those in the first tertile (OR: 1.68; 95% CI: 1.05-2.69, $P\text{-trend}_{=}$ 0.03).

Discussion

The main finding of the current study was that among three major dietary patterns, "healthy, traditional and western dietary patterns", only the Western dietary pattern had a significant positive association with serum hs-CRP among Iranian adolescent girls. However, no significant association was found among healthy and traditional dietary patterns and serum hs-CRP. To the best of our knowledge, this is the first study conducted among adolescent investigating association between major dietary patterns and serum concentration of hs-CRP.

There is growing evidence to suggest that an elevated serum hs-CRP, is an indicator of low grade inflammation, and is associated with several non-communicable diseases including cardiovascular disease [9-11, 27], while the role of diet in inflammation has only been investigated to a limited degree, particularly among children and adolescents. It is worth noting that the process of atherosclerosis begins in early childhood and both low grade inflammation and diet are salient factors affecting this process [12, 13]. Thus, it would be important to pay more attention to relationship between food intake and inflammatory factors in children and adolescents may prevent the clinical manifestations of cardiovascular disease in the middle age.

In our study, the Western dietary pattern, which contains high levels of refined grains, snacks, red meats, poultry, fish, organ meat, pizza, fruit juices, industrial juice and compote, mayonnaise, nuts, sugars, soft drinks, sweets and desserts, coffee and pickle, has a significant association with elevated hs-CRP among adolescents. In line with our result, in some earlier studies which were conducted among adults in different regions of world, a positive association between a Western dietary pattern and low grade inflammation, specifically serum hs-CRP was reported [20, 21]. High intakes of red meat, refined grains, processed meat, sweets and desserts, pizza and soft drinks is the main catachrestic of Western dietary pattern in almost all of these studies. In our study, within the Western dietary pattern, several unhealthy food items were present, that included refined grains, red meat, organ meat, pizza, mayonnaise, sugars, soft drinks, sweets and desserts were collected, which all are highly sources of simple sugars, cholesterol, saturated and trans fatty acids, the harmful nutrients for metabolic syndrome and cardiovascular health [28, 29]. The findings from the Tehran Lipid and Glucose Study (TGLS) in Iran have indicated more consumption of fast food [30] and sugar-sweetened beverages [31] were related to higher incidence of metabolic syndrome; while more adherence to dietary approaches to stop hypertension (DASH) dietary pattern was associated with reduced incidence of metabolic syndrome in children and adolescents [32]. In a previous study which was undertaken among urban Asian Indian adolescents and young adults, a significant positive association was found between consumption of saturated fatty acids and plasma hs-CRP, suggesting CRP level decreases by 0.14 mg/L, when young individuals reduced saturated fat intake by one percent [33]. Therefore, following a high quality diet and avoiding an unhealthy diet may be effective in preventing an elevated inflammatory factors namely hs-CRP in early life and several chronic diseases in the in adulthood and latening life. In our study, fish was on both healthy and western dietary patterns, with greater factor loading in the western pattern (0.31), compared to the healthy pattern (0.23). There are conflicting data on the effect of fish consumption on hs-CRP concentration, and this may be determined by the type of fish consumed. Although in some previous study a inverse association was seen between fish oil consumption and serum hs-CRP [34, 35], in some other studies no correlation was found between intake of fish and hs-CRP level [36, 37]. Furthermore, results of a previous study indicate that unexpectedly seafood dietary pattern contained high intakes of shellfish, squid, octopus, shrimp, crab, fish roe, and fish had a significant direct association with serum hs-CRP among Japanese adult men [19]. Generally, it is proposed that although consumption of n-3 fatty acids present in fish has a protective effect on heart disease risk, the current available data do not support the beneficial effect of intake of n-3 fatty acids from fish on elevated hs-CRP [37].

Unexpectedly, results of the current study found no association between healthy dietary pattern and serum hs-CRP. In contrast to our results, previous studies have shown an inverse association between healthy dietary pattern and serum hs-CRP among adults [20, 38]. Nevertheless, no association was found between healthy dietary pattern and plasma hs-CRP after adjusting for potential confounders among Japanese adult women [19]. We are aware that there are no previous studies among children and adolescent investigating dietary patterns and inflammation markers. However, in a previous study conducted among adolescent, although the intake of fruits and total fruits and vegetables had an inverse correlation with serum hs-CRP, no association was found between consumption of vegetables, legumes, beta carotene and flavonoids and serum hs-CRP level [39]. Intakes of antioxidant vitamins (vitamins E and C and β-carotene) were not found to be significant predictors

for serum hs-CRP in 6-14 years old Swiss children [40]. Nevertheless, in several earlier studies fruits and vegetable consumption had an inverse correlation with hs-CRP concentration among adults [41, 42]. This difference between young people and adults, might be due to the fact that the duration of low grade inflammation is lower among children and adolescents than adults [39]. Moreover, it should be noted that in our study some unhealthy foods such as mayonnaise and full-fat dairy products, which both contain high amounts of saturated and trans fatty acids, were categorized within the healthy dietary pattern, which may attenuate the effects of healthy dietary pattern on serum hs-CRP.

We found that the traditional dietary pattern had no significant association with serum hs-CRP. Tea and spices, which are both important in this dietary pattern, have anti-inflammatory properties [43, 44]. Furthermore, it has been shown that vegetable oils have an inverse effect on the hs-CRP concentration. On the other hand, as earlier report showed, other food items included potatoes, snacks, hydrogenated fats, sweets and desserts, sugars, soft drinks [20, 45] and salt [19] which were identified in this pattern, and may have had a positive association with elevated inflammatory markers such as serum hs-CRP. Taken together, finding no association between traditional dietary pattern and elevated hs-CRP in this study is not surprising. This study has several limitations that should be considered. First of all, due to cross-sectional design of this study, determining relationship between cause and effect is not possible. Secondly, dietary intakes of study participants were collected through self-report FFQ, which shows measurement bias and misclassification. Finally, like other observational studies, several unmeasured confounders may be existing in this study, which we are unable to control them.

Conclusion

We have found that a Western dietary pattern, which is high in refined grains, snacks, red meats, poultry, fish, organ meat, pizza, fruit juices, industrial juice and compote, mayonnaise, nuts, sugars, soft drinks, sweets and desserts, coffee and pickle may be associated with an increased serum hs-CRP among large population of Iranian adolescent girls. However, no significant association between healthy and traditional dietary patterns with elevated serum concentration of hs-CRP was found among study participants. Further studies, especially longitudinal studies using a larger sample sizes are needed to examine the effect of major dietary patterns on inflammatory markers, namely hs-CRP among children and adolescents.

Conflict of interest: The authors state that there is no conflict of interest.

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Table 1. Food grouping used in the dietary patterns

Food groups	**Food items**
Refined grains	White breads (lavash, baguettes), rice, Macaroni, noodles
Whole grains	Dark breads (Iranian), corn, Barley, bulgur
Potatoes	Potatoes
Snacks	French fries, chips, crackers
Legumes	Beans, peas, lentils, soy, mung, split peas
Other vegetables	broad beans, Cucumber, mixed vegetables, eggplant, celery, green peas, green beans, Sweet pepper, turnip, squash, mushrooms, carrots, onions
Red meats	Beef, hamburger, lamb, minced meat
Poultry	Chicken
Fish	Canned tuna fish, other fish
Organ meats	Heart, liver and kidney, intestine and viscera
Processed meats	Sausages
Eggs	Eggs
pizza	Pizza

Low fat dairy products	Skim or low-fat milk, low-fat yogurt
High fat dairy products	High-fat milk, whole milk, chocolate milk, cream, high-fat yogurt, cream yogurt, cream cheese, other cheeses, ice cream
Yoghurt drink	Doogh
Butter	Butter
Margarine	Margarine
Cruciferous vegetables	Cabbage, cauliflower, Brussels sprouts, Kale
Tomatoes	Tomatoes, red sauce
Green leafy vegetables	Spinach, lettuce
Garlic	Garlic
Fruits	Orange, tangerine, lemon, lime, grapefruit, banana, apple, pear, strawberry and other berries, peach, cherries, fig, melon, watermelon and Persian melon, cantaloupe, raisins or grapes, kiwi, apricots, nectarine, mulberry, plums, persimmons, pomegranates, date
Dried fruits	Raisins, dried berries, other dried fruits
Fruit juice	Lemon juice, All types of juice
industrial Juice and fruit compote	industrial Juice, fruit compote
Olives	Olives, olive oils
Hydrogenated fats	hydrogenated vegetable oils, animal oils
Vegetables oil	Vegetable oils (except for olive oil)
Mayonnaise	Mayonnaise
Nuts	Walnut, all types of nuts
Sugars	Sugar, candy
Soft drinks	Soft drinks
Sweets and desserts	Jam, Iranian confectioneries (gaz, sohan), chocolates, biscuits, Cakes, confections
Honey	Honey
Tea	Tea
Coffee	Coffee
Salt	Salt
Pickle	Pickle
Spices	Spices, green pepper

Table 2. Food loading matrix for major dietary patterns*			
	Dietary patterns		
Food groups	Healthy	Traditional	Western
Refined grains	-	-	0.22
Whole grains	-	-	-
Potatoes	-	0.21	-
Snacks	-	0.23	0.50
Legumes	0.25	-	-
Other vegetables	0.71	-	-
Red meats	-	-	0.35
Poultry	-	-	0.36
Fish	0.23	-	0.31
Organ meats	-	-	0.20
Eggs	0.32	-	-
Pizza	-	-	0.31
Yoghurt	0.40	-	-
Butter	-	-	-
Margarine	-	-	-
Cruciferous vegetables	0.44	-	-
Tomatoes	0.62	-	-
Green leafy vegetables	0.61	-	-
garlic	0.33	-	-
Fruits	0.32	-	-
Dried fruits	-	-	-
Fruit juices	-	-	0.30
Industrial juice and	-	-	0.48

compote			
Olives	0.25	-	-
Hydrogenated fats	-	0.37	-
Vegetables oil	-	0.26	-
Mayonnaise	0.23	-	0.26
Nuts	-	-	0.28
Sugars	-	0.63	-
Soft drinks	-	0.28	0.45
Sweets and desserts	-	0.25	0.43
Honey	-	-	-
Tea	-	0.65	-
Coffee	-	-	0.26
Low fat dairy products	0.39	-	-
High fat dairy products	0.35	-	-
Salt	-	0.62	-
Pickle	-	-	0.22
Spices	-	0.65	-
Percent of variance explained	8.69	5.59	4.1
*Values less than 0.20 are not reported.			

Table 3. General characteristics of study participants by tertiles categories of dietary pattern score

	Healthy pattern		P- value†	Traditional pattern		P- value	Western pattern		P- value
	Tertile 1	Tertile 3		Tertile 1	Tertile 3		Tertile 1	Tertile 3	
Age (y)	14.5±1.5	14.5±1.5	0.9	14.4±1.6	14.6±1.5	0.24	14.4±1.4	14.4±1.5	0.19
Weight (kg)	51.6±12.4	53.7±11.9	0.19	53.9±13.2	52.8±13.4	0.1	53.6±14.7	52.9±11.5	0.21
BMI (kg/ m^2)	20.6±3.7	21.6±5.04	0.05	21.7±4.6	21.2±4.8	0.04	21.5±5.4	21.2±4.05	0.3
Waist circumference (cm)	69.8±8.1	70.9±9.1	0.41	70.8±9.5	70±9.3	0.45	70.7±9.6	70.5±8.4	0.25
Physical activity (MET.h/week)	44.8±2.8	45.8±3.9	0.006	45.1±3.3	45.3±3.5	0.64	44.9±2.7	45.5±3.8	0.1
Systolic blood pressure (mmHg)	96.8±13.3	97.4±13.9	0.32	96.4±13.9	95.6±13.1	0.31	96.9±14.1	95.9±15.3	0.67
Diastolic blood pressure (mmHg)	62.8±12.2	62.8±13.3	0.99	62.6±13.5	62.5±13.3	0.76	61.9±13.3	62.8±13.6	0.31
hs-CRP	1.1±1.1	1.3±1.4	0.34	1.2±1.3	1.3±1.4	0.74	0.98±1.07	1.3±1.4	0.005
Passive smoker (%) (yes)	35.6	27.8	0.18	29.3	30.2	0.33	32	31.4	0.98
Menstruation (%) (yes)	87	87.8	0.91	86.7	85.8	0.2	85.5	87.5	0.28
Fasting blood glucose (mg/dl)	86.2±11.05	85.9±12.4	0.91	85.6±12.6	86.5±11.56	0.69	87.6±10.9	86.2±11.8	0.02
HDL-c (mg/dl)	46.8±8.5	46.3±8.4	0.37	47.1±8.2	46.2±8.5	0.35	47.09±8.7	47.2±8.8	0.56
LDL-c (mg/dl)	99.9±26.4	99.1±27.1	0.86	101.1±26.4	98.8±26.9	0.63	98.6±22.8	101.6±27.03	0.42
Total cholesterol (mg/dl)	160.9±28.3	159.3±30.8	0.47	163.1±28.7	158.3±29.8	0.21	160.5±27.3	162.4±30.02	0.65
Triglyceride (mg/dl)	81.5±35.3	87.5±43.9	0.25	86.3±39.7	83.2±39	0.68	86.8±39.3	86.4±39.1	0.3

†ANOVA for continuous variables and Chi-squared test for categorical variables

Table 4. Dietary intakes of study participants across tertiles categories of dietary pattern scores									
	Healthy pattern		P- value†	Traditional pattern		P- value	Western pattern		P- value
	Tertile 1	Tertile 3		Tertile 1	Tertile 3		Tertile 1	Tertile 3	
Food groups (g/d)									
Red meat	11.5±13.8	16.6±17.8	0.001	13.1±12.4	13.1±13.3	0.04	7.7±7.4	20.8±20.6	<0.001
Processed meat	4.4±6.3	5.7±9.05	0.12	4.9±8.5	4.7±5.8	0.61	1.9±2.5	9.04±10.57	<0.001
Low fat dairy	122.1±117.1	306.4±246.9	<0.001	200.9±173.3	223.6±220.2	0.34	207.6±201.1	228.4±189.01	0.45
High fat dairy	105.1±104.6	242.1±210.1	<0.001	177.7±179.8	161.5±147.7	0.54	123.7±129.6	202.6±159.6	<0.001
Fruit	143.9±120.07	292.6±218.8	<0.001	189.6±179.7	161.5±147.7	0.1	157.1±125.5	267.8±220.3	<0.001
Vegetables oil	4.3±6.6	5.5±6.7	0.04	3.4±4.5	6.9±8.6	<0.001	5.02±7.5	5.2±6.2	0.87
Legumes	70.8±60.4	103.9±80.1	<0.001	74.5±70.1	89.2±65.7	0.03	74.7±57.1	93.8±71.6	0.005
Coffee	4.3±11.08	6.4±13.1	0.03	5.8±12.9	4.96±10.6	0.16	2.7±7.8	7.8±13.9	<0.001
Whole grains	194.9±180.3	206.8±166.6	0.67	198±180.1	200.9±175.2	0.73	206.9±189.1	210.6±169.6	0.42
Refined grains	315.4±221.6	257.4±131.9	0.001	293.8±219.5	271.3±144.7	0.35	222.6±133.4	332.9±211.4	<0.001
Spices	2.5±3.05	3.06±2.8	0.05	1.37±1.3	4.3±4.01	<0.001	2.5±2.8	3.03±3.07	0.08
Nuts	15.2±36.3	19.2±26.1	0.18	11.2±18.8	21.4±37.6	0.001	10.2±16.9	25.3±41.8	<0.001
Salt	2.6±2.5	3.1±3.1	0.19	1.49±1.44	4.5±4.02	<0.001	2.8±2.9	2.9±3.2	0.88
Nutrients									
Energy (Kcal/d)	2414.8±846.1	3101.1±731.1	<0.001	2359.9±830.6	3049.5±770.4	<0.001	2237.6±776.6	3301.2±662.7	<0.001

Protein (g/d)	85.4±14.3	95.7±17.3	<0.001	98.03±13.8	81.9±15.7	<0.001	90.3±14.4	90.4±17.6	0.73
Total carbohydrates (g/d)	384.7±51.4	357.2±53.3	<0.001	382.2±46.9	357.3±59.8	<0.001	365.3±50.7	376.7±56.2	0.04
Total fiber (g/d)	47.01±18.5	43.3±15.6	0.03	46.7±16.7	43.2±17.2	0.05	47.5±14.3	42.5±17.8	0.003
Sucrose (g/d)	22.6±13.9	23.7±12.5	0.31	16.4±9.2	29.9±15.6	<0.001	22.1±11.8	23.6±15.2	0.4
Total fat (g/d)	97.7±24.6	105.7±24.9	0.001	93.3±20.6	111.7±27.9	<0.001	104.9±24.8	99.03±25.3	0.01
Total SFAs (g/d)	25.9±7.5	33.04±11.5	<0.001	29.1±9.09	29.8±10.2	0.7	29.5±8.4	29.5±10.6	0.97
Total MUFAs (g/d)	32.3±9.8	33.9±10.4	0.17	30.1±7.5	37.08±12.3	<0.001	35.3±10.6	31.4±9.5	<0.001
Total PUFAs (g/d)	23.6±9.3	21.3±9.3	0.01	18.9±5.8	26.9±11.7	<0.001	24.4±10.02	21.05±8.9	<0.001
Cholesterol (mg/d)	186.8±89.4	203.5±150.8	<0.001	252.2±137.5	226.7±128.6	0.06	228.2±100.4	243.9±137.9	0.25
Vitamin C (mg/d)	159.1±42.6	234.8±69.7	<0.001	180.9±62.8	201.4±61.9	0.001	168.4±53.7	221±67.8	<0.001
Vitamin E (mg/d)	13.8±5.1	14.3±5.9	0.5	12.1±3.7	16.7±7.1	<0.001	15.7±6.3	12.8±4.8	<0.001
Vitamin A (mcg/d)	401.6±205.4	782.5±370	<0.001	639.6±815.9	562.06±331.7	0.22	581.1±291.5	632.5±833.1	0.33
†obtained from one-way ANOVA									

Table 5. Multivariate adjusted odds ratios (95% CIs) for elevated serum level of hs-CRP across tertiles of dietary pattern scores

	Crude	Model I*	Model II┼	Model III╫
Healthy pattern				
Tertile 1	1	1	1	1
Tertile 2	1.29 (0.85-1.97)	1.22 (0.79-1.8)	1.25 (0.8-1.95)	1.31 (0.82-2.08)
Tertile 3	1.31 (0.86-2.01)	1.11 (0.7-1.7)	1.18 (0.73-1.89)	1.09 (0.66-1.79)
P trend	0.2	0.61	0.47	0.7
Traditional pattern				
Tertile 1	1	1	1	1
Tertile 2	0.97 (0.63-1.5)	0.96 (0.61-1.5)	1.06 (0.67-1.69)	1.32 (0.81-2.1)
Tertile 3	1.17 (0.77-1.78)	1.06 (0.68-1.67)	1.12 (0.71-1.78)	1.3 (0.8-2.1)
P trend	0.43	0.76	0.61	0.29
Western pattern				
Tertile 1	1	1	1	1
Tertile 2	1.57 (1.02-2.42)	1.51 (0.97-2.33)	1.54 (0.98-2.43)	1.69 (1.05-2.71)
Tertile 3	1.58 (1.03-2.42)	1.58 (1.02-2.44)	1.58 (1.01-2.46)	1.68 (1.05-2.69)
P trend	0.03	0.03	0.04	0.03

* Adjusted for age and energy intake

┼ Additionally adjusted for passive smoking, physical activity and menstruation

╫ Additionally adjusted for BMI