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Original article

Major dietary patterns and their associations with diet quality indices in Iranian adults

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Summary. *Background:* Limited data on the association of dietary patterns with nutrient intakes and diet quality indices are available. *Objective:* We examined the relation of dietary patterns and diet quality indices and nutrient intakes among Iranian. *Methods:* This cross-sectional study was conducted among 389 Isfahani adults. Dietary intakes were estimated using a validated semi-quantitative food frequency questionnaire. Dietary patterns were identified using factor analysis method. Diet quality indices [nutrient adequacy ratio (NAR), Mediterranean (MED) score, healthy eating index (HEI), dietary diversity score (DDS) and dietary energy density (DED)] were calculated according to standard methods. *Results:* We identified four dietary patterns: healthy, high animal fat and protein, traditional and Western patterns. Participants in the top tertile of healthy dietary pattern, in comparison with those in the first tertile, had greater NARs for all nutrients of concern, HEI (73.5±6.8 vs.67.7±6.3; P<0.0001) and MED score (5.5±1.2 vs. 3.5±1.5; P<0.0001). Higher scores of high animal fat and protein dietary pattern were more nutrient-dense, while greater adherence to the traditional dietary pattern was associated with greater MED score (4.8±1.5 vs. 4.2±1.7; P=0.004), but lower NARs. Individuals in the top tertile of Western dietary pattern had more energy-dense diet than those in the first (0.9±0.2 vs. 0.8±0.1; P=0.002) *Conclusion:* Dietary patterns are differently related to nutrient intakes and diet quality indices. Further studies are needed to determine the quality of dietary patterns to determine the best pattern.

Key words: diet quality, dietary patterns, nutrients, nutritional status

Introduction

Given the increasing prevalence of various chronic diseases, dietary intakes have been considered as a pivotal factor in the etiology of various non-communicable diseases. Although many investigations assessed the role of individual foods and nutrients, dietary pattern, as a holistic approach, has been emerged to consider the potential interactions between foods and their components. Therefore, it seems that dietary patterns provide more reliable association between diet and diseases.

Two approaches, posterior and priori, have been suggested to identify dietary patterns. To date, the relevance of both approaches in health has been widely investigated. There is much evidence from epidemiological studies that showing posterior dietary patterns are related to various cardiometabolic risk factors (e.g. insulin resistance, obesity, inflammation, dyslipidemia and impaired glucose tolerance) (1-6) as well as priori dietary patterns. Mediterranean dietary pattern (MED) (7-9) and healthy eating index (HEI) (10-13), as two priori dietary patterns, are inversely correlated with the risk of chronic diseases, whilst dietary energy density (DED) is positively related (14-17). Hitherto, we are aware of no study which assessed the associations of posterior dietary patterns with priori dietary patterns.

This issue could be important because of unique characteristics of dietary patterns in each population. For example, it is probable that loaded factors in a specific dietary pattern (e.g. healthy pattern) to be different from one population to another one. Therefore, the interactions, diet quality indices and thereby the effects of dietary patterns on health status might be different in each population. It is clear that healthy dietary pattern is a nutrient-dense and high quality pattern whilst Western pattern is a nutrient-poor and low quality; however, there might be some other patterns that their quality is not easily discernible. Additionally, it is clinically useful to know which nutrient deficiencies are more probable with specific dietary patterns. Despite a nutrition transition in our country, like other developing countries, a recent systematic assessment indicated no changes in diet quality of Iranians from 1999 to 2010, because of an increment in consumption of both healthy and unhealthy foods (18). However, it is not clear what were the impacts of these changes on nutritional status of Iranians. In this cross-sectional study, we aimed to find major dietary patterns in a sample of Isfahani adults and evaluate their associations with diet quality indices as well as nutrient adequacy ratios (NAR).

Subjects and Methods

Participants

This cross-sectional study was performed in a sample of Isfahani adults aged 24-71 y and working in Esfahan Steel Company (n=400). To provide a random sampling, after considering all parts of company (n=14), we randomly selected some phone numbers using multistage cluster random sampling method. All subjects declared their willingness to participate in the research by providing written informed consent. The present study was approved by the research council and ethical committee of Isfahan University of Medical Sciences, Isfahan, Iran. We excluded participants if their energy intake was out of range 800-4200 kcal/d (n=7), and all statistical analysis was performed on 393 individuals.

Dietary intake assessments

Usual dietary intake was assessed by using a valid semi-quantitative food frequency questionnaire (FFQ). FFQ consisted of 168 food items with standard serving sizes commonly used by Iranians. Participants were asked to report the frequency of each food item according to their consumption during the last year. All FFQs were administered by a qualified dietitian. Daily intake of each food item were estimated based on the frequency of consumption, and then were converted to gram by using household measures (19). Daily energy and nutrient intakes were estimated by using NUTRIONIST IV which modified for Iranian's food. We assigned each food item into one of 38 described food groups, because of large numbers of the food items relative to the numbers of subjects (Table 1). We allocated a food item in a specific food group based on the similarity of nutrients content. Some food items were individually allocated in a food group either because of their unique nutrient contents or their contribution in a specific dietary pattern.

Dietary Diversity Score (DDS)

In order to calculate DDS, we used the method of Kant et al. (20). According to U.S. Department of Agriculture's Food Guide Pyramid, all food items were categorized in five main food groups (bread–grains, vegetables, fruit, meats, and dairy) (21). These main groups also divided to 23 subgroups to assess the diversity score of diets (22). Seven subgroups were considered for the bread-grain group (refined bread, biscuits, macaroni, whole bread, corn flakes, rice, and refined flour). Fruit and vegetables comprised two (fruit and fruit juice, berries and citrus) and seven subgroups (vegetables, potato, tomato, other starchy vegetables, legumes, yellow vegetables, and green vegetables), respectively. Four (red meat, poultry, fish, and eggs) and three (milk, yogurt, cheese) subgroups for meat and dairies were considered. According to the Food Guide Pyramid quantity, participants who consumed each group per day were defined as the consumers of that group. Maximum and minimum scores of each main group were 2 and 0. Total diversity score was calculated by the summation of the scores of the five main groups. Therefore, total dietary diversity score was ranged between 0-10. We used the same method for calculating each food group diversity score. For example, if a person consumed potato, yellow and green vegetables in each day, his vegetables' diversity score would be $(3 \div 7) * 2= 0.85$.

Table 1. Food groups used in the factor analysis

Food groups	Food items
Refined grains	White breads (lavash, baguettes), noodles, pasta, rice, toasted bread, milled barley, sweet bread, white flour, starch, biscuits
Whole grains	Dark breads (Iranian), barley bread, popcorn, cornflakes, wheat germ, bulgur
Potatoes	Potatoes
Tomatoes	Tomatoes, tomato sauce, tomato pasta
Yellow vegetables	Carrots
Green leafy vegetables	Spinach, lettuce
Cruciferous vegetables	Cabbage, cauliflower, Brussels sprouts, kale
Other vegetables	Cucumber, mixed vegetables, eggplant, celery, green peas, green beans, green pepper, turnip, corn, squash, mushrooms, onions
Garlic	Garlic
Olive	Olive, olive oil
Legumes	Beans, peas, lima beans, broad beans, lentils, soy
Nuts	Peanuts, almonds, pistachios, hazelnuts, roasted seeds, walnuts
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 and dates dried figs, dried dates, dried mulberries, other dried fruit
Fruit juices	Apple juice, orange juice, grapefruit juice, other fruit juices
Fish	Canned tuna fish, other fish
Poultry	Chicken with or without skin
Red meats	Beef, lamb
Processed meats	Sausages, hamburger
Organ meats and animal fats	Beef liver, animal fats
Eggs	Eggs
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
Yogurt drink	Doogh
Vegetable oils	Vegetable oils (except for olive oil)
Hydrogenated fats	Hydrogenated fats, margarine
Butter	Butter
Mayonnaises	Mayonnaises
Broth	Broth
Pizza	Pizza
Salt and pickles	Salt and pickles
Snacks and French fries	Potato chips, corn puffs, crackers, popcorn, French fries
Condiments, sweets and deserts	Jam, jelly, honey, chocolates, cookies, cakes, confections
Soft drinks	Soft drinks
Sugars	Sugars, candies, gaz (an Iranian confectionery made of sugar, nuts, and tamarisk)
Tea	Tea
Coffee	Coffee
Pickle	Pickle
Curd	Curd

Dietary energy density (DED)

To calculate DED, we divided each subject's self-report of total daily energy intake (kcal/day) into the total weight of foods consumed (g/day), excluding beverages (23). The weight of foods (excluding beverages) estimated by summing the weight of food items. We did not include the weight of drinks, since earlier studies have shown that changing in weight of drinks could not alter effects of DED on body weight (24).

Healthy Eating Index (HEI)

We used Kennedy et al' method to calculate HEI (25). According to this method, HEI contains 10 various components. Components 1 to 5, including grains, vegetables, fruit, milk, and meat, were scored based on the consumed proportion of each food group compared with recommended amounts (26). Thereby, after removing outlier values, participants who consumed at or above the recommended amounts received a score of 10. In contrast, individuals with no serving consumption would be scored 0. Other consumers were scored proportionally between 0-10. Components 5 to 10 contain percentages of total fat and saturated fatty acids consumption, the amounts of cholesterol intake, dietary diversity score, and the amounts of sodium intake, respectively. A diet containing less than 30% of total energy from fat, less than 10% of total energy from saturated fat, less than 300 mg cholesterol and no added table salt according to the FFQ, were awarded a full score of 10 points.

Mean adequacy ratio and nutrient adequacy ratios (MAR & NAR)

Nutrient adequacy ratio (NAR) was defined as the ratio of daily nutrient intakes to standard recommended amounts according to age and gender categories for each person (27). The values of NAR for 15 main nutrients including zinc, iron, calcium, magnesium, vitamin B_1, vitamin B_2, vitamin B_3, vitamin B_5, vitamin B_6, vitamin B_9, vitamin B_{12}, biotin, vitamin A, vitamin C, and vitamin D, were calculated. We divided the summation of NARs by the number of nutrients (n= 15) to calculated mean adequacy ratio (MAR) (28).

Creation of MED scores: For the calculation of MED dietary score, we considered a maximum of 9 points, counting 1 point if: the daily serving of fruits, fish, vegetables, whole grains, legumes, nuts and ratio of the gram of MUFA to saturated fatty acids (SFA) were equal or more than the median intake of study population and also the daily serving of meats (red meat, poultry and processed meats) and dairy products were less than median intake of the study population. Energy adjustment, using the residual method, was done for all food groups before the score ranking. Finally, we categorized participants according to the tertiles of their scores (29).

Assessment of anthropometric measures: Weight was measured by using digital scales while participants were minimally clothed and not wearing shoes. Weight was recorded to the nearest 100 grams. Height was measured by using a fixed-wall tape while the participants were standing, without shoes and shoulders were in normal position. Body mass index was calculated as weight (kg) divided by height (m^2). Waist circumference (WC) was measured at the narrowest level between the lowest rib and iliac crest over light clothing by using an unstretched tape measure and recorded to the nearest 0.5 cm. All measurements were taken by the same dietitian to reduce measurement error.

Assessment of biomarkers: To assess biochemical markers, 10 ml venous blood samples were drawn after an overnight (12 h) fast. Plasma concentrations of glucose and serum lipid profiles were measured by using commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran) adapted to a Selectra-2 autoanalyzer (Vital Scientific, Spankeren, The Netherlands. Fasting blood sugar (FBS) was measured on the day of blood collection via enzymatic colorimetric method. Serum triglyceride levels were determined using enzymatic colorimetric tests with glycerol phosphate. Serum levels of HDL-C were assessed with phosphotungstic acid after precipitation of the apolipoprotein B-containing lipoproteins.

Assessment of other variables: Blood pressure was measure after a 15-min rest by using a standard mercury sphygmomanometer 2 times while participants were sitting. The mean of two measurements was recorded as subject's blood pressure. Demographic characteristics including age, sex, smoking habits, socioeconomic status, medical history, current use of medications was obtain with questionnaires.

Definition of terms: Obesity was defined as BMI more than 30 kg/m^2 (30). Abdominal obesity was considered as WC ≥88 cm for women and ≥102 cm for men (31).

Statistical analysis

Major dietary patterns were identified using principle component analysis and the factors were rotated by orthogonal transformation. Eigenvalues>1.6 and the Scree test were considered to retain important factors (32). After the fourth factor, the eigenvalues of the factors fell considerably and changed slightly after the fifth factor. Based on our interpretation of the data and available evidence, we labeled the derived factors (dietary patterns). The scores of the dietary patterns were computed by summing intakes of food groups weighted by their factor loadings, and a factor score was given to each participant for each recognized pattern (32).
Participants were categorized based on the tertile of dietary pattern scores. To detect the significant differences in quantitative variables (e.g. age, BMI, WC, NARs of different nutrients and diet quality scores), one-way analysis of variance was done. Chi-square tests were performed to compare the distribution of qualitative variables. We used SPSS software (version 9.05; SPSS Inc, Chicago IL) for all statistical analyses.

Results

Four dietary patterns were recognized by using factor analysis: the healthy dietary pattern (loaded by various kinds of vegetables, low fat dairy products and nuts), the traditional dietary pattern (loaded by refined grains, high-fat dairy products, sugars, legumes, tea, salt and pickles, eggs, vegetable oils and hydrogenated oils, but low in whole grains), the high animal fat and protein dietary pattern (loaded by organ meats and animal fats, red meats, broth, potatoes and processed meats) and the Western dietary pattern (loaded by soft drinks, pizza, processed meats, mayonnaises, snacks and French fries, butter, condiments, sweets and deserts). Table 2 shows the factor-loading matrixes for identified dietary patterns are shown in. Other identified but minor dietary patterns were not included in the subsequent analysis, because they explained only small variances.

General characteristics and dietary intakes of participants are shown in Table 3. Participants in the highest tertile of Western dietary pattern were younger (P=0.06), less likely to be married and low socio-economic status. Participants in the highest tertile of traditional dietary pattern were more likely to be smoker or ex-smoker. Compared with individuals in the highest tertile of high animal fat and protein dietary pattern, those in the lowest tertile were more likely to be married. Weight was not significantly different across the tertiles of different dietary patterns.

Age- and sex-adjusted energy intake was less in the first tertile of all dietary patterns compared with the top tertile. Individuals in the third tertile of healthy dietary pattern had lower carbohydrate and cholesterol but greater protein and fiber intake. Individuals in the first tertile of traditional dietary pattern had higher protein, fat, saturated fatty acids (SFA) and fiber intake, but carbohydrate was not significantly different across the tertiles. Conversely, protein, fat, cholesterol and SFA consumed in greater amounts by individuals in the third tertile of high animal fat and protein dietary pattern, whilst carbohydrate was consumed in less amounts. Compared with individuals in the first tertile of Western dietary pattern, those in the highest tertile consumed greater protein and SFA.

The NAR values of different nutrients across tertiles of dietary pattern scores are presented in Table 4. Higher healthy dietary pattern scores were associated with greater NARs for all nutrients. Traditional dietary pattern scores were inversely related to NARs of all nutrients except for B12. Participants in the first tertile of high animal fat and protein consumed less amounts of Zn, Fe, B1, B2, B3, B6, b12 and vitamin A. other nutrients were not significantly correlated with this pattern. Higher adherence to Western dietary pattern was associated with lower consumption of B2, Ca and Zn. Other nutrients were significantly different across tertiles of Western pattern. MAR was greater in the top tertile of high animal fat and protein, but no significant difference was found across tertiles of Western and healthy patterns.

Table 5 indicates the associations of priori diet quality indices and identified dietary pattern scores. Individuals with higher scores of healthy dietary pattern had greater HEI, DDS and MED scores. HEI was inversely related to other dietary pattern scores. Higher scores of both Western and high animal fat and protein dietary patterns were more energy-dense in comparison with lower scores. However, ED was

Table 2. Factor-loading matrix for major dietary patterns[1]

	Dietary patterns			
Food groups	**Healthy**	**Traditional**	**High animal fat and protein**	**Western**
Green leafy vegetables	0.61			
Other vegetables	0.61			
Tomatoes	0.59			
Olive	0.55			
Yellow vegetables	0.53			
Cruciferous vegetables	0.52			
Fish	0.42			0.2
Pickle	0.36			
Curd	0.35		0.28	0.22
Garlic	0.34			
Yogurt drink	0.33			
Low-fat dairy products	0.31			-0.21
Nuts	0.24			
Coffee	0.21			
Sugars		0.65		0.21
Legumes		0.58		
Tea		0.51		
Refined grains		0.42		
Salt and pickles		0.40		
Poultry		0.33		
Whole grains		-0.30		
Eggs		0.296		
High-fat dairy products		0.28	0.22	0.21
Vegetable oils		0.27		
Hydrogenated fats		0.27		
Organ meats and animal fats			0.91	
Red meats			0.89	
Broth		0.26	0.32	-0.22
Potatoes			0.23	
Soft drinks				0.57
Pizza				0.51
Processed meats			0.33	0.49
Mayonnaises				0.38
Snacks and French fries				0.37
Butter				0.34
Condiments, sweets and deserts				0.32
Fruit juices				0.25
Fruit				0.20
Percentage of variance explained (%)	*0.083*	*0.072*	*0.53*	*0.045 1*

Values<0.20 were excluded for simplicity.

Table 3. Characteristics and dietary intakes of study participants across the tertile of dietary pattern scores.

	Healthy				Traditional				High animal fat and protein				Western			
	Tertile 1	Tertile 2	Tertile 3	P[1]	Tertile 1	Tertile 2	Tertile 3	P	Tertile 1	Tertile 2	Tertile 3	P	Tertile 1	Tertile 2	Tertile 3	P
n	129	130	130		129	130	130		129	130	130		129	130	130	
Age (y)	37.77± 0.74	38.06± 0.69	38.92± 0.42	0.5	37.95± 0.81	38.72± 0.63	38.08± 8.22	0.7	37.79± 0.75	38.75± 8.0	38.22± 0.42	0.6	39.13± 0.71	38.77± 0.81	36.87± 0.62	0.06
Weight (kg)	78.69± 1.21	79.10± 1.15	81.06± 1.17	0.3	77.59± 1.20	80.58± 1.19	80.69± 1.12	0.1	81.40± 1.25	79.04± 1.18	78.44± 1.09	0.2	79.64± 1.04	80.76± 1.20	79.62± 1.27	0.4
Married (%)	90.7	90.8	93.8	0.6	89.1	94.6	91.5	0.3	93.0	95.4	86.9	0.04	92.2	96.2	86.9	0.02
Low-socioeconomic status (%)	16.1	16.3	13.1	0.5	12.7	18.1	14.6	0.7	10.2	14.8	20.5	0.2	19.2	15.5	10.9	0.04
Smoker or ex-smoker (%)	27.1	30.0	28.4	0.7	13.9	31.6	40.0	<0.0001	31.8	21.5	32.3	0.2	24.0	30.7	30.8	0.6
Dietary intakes																
Energy (kcal/d)	1970.27± 45.26	2320.09± 53.13	2642.44± 32.73	<0.0001	1969.77± 54.64	2280.28± 45.12	2682.74 ±51.87	<0.0001	2249.62 ±55.82	2123.94± 47.97	2561.38± 59.03	<0.0001	2105.04± 48.42	2190.23± 52.87	2638.56± 57.14	<0.0001
Carbohydrate (% of total energy)	64.48± 0.58	64.78± 0.55	62.50± 0.58	0.01	62.83±0.59	64.39± 0.55	64.52± 0.59	0.096	66.20± 0.52	64.39± 0.53	61.19± 0.54	<0.0001	63.37± 0.57	64.34± 0.56	64.04± 0.59	0.5
Fat (% of total energy)	24.58± 0.54	24.45± 0.51	25.78± 0.54	0.2	26.11± 0.54	24.59± 0.51	24.12± 0.54	0.04	23.61± 0.50	24.30± 0.05	26.89± 0.51	<0.0001	24.59± 0.52	24.34± 0.51	25.88± 0.54	0.1
Protein (% of total energy)	13.17± 0.28	14.10± 0.26	16.40± 0.28	<0.0001	15.57± 0.30	14.05± 0.28	14.07± 0.30	<0.0001	13.54± 0.28	14.73± 0.28	15.40± 0.28	<0.0001	15.26± 0.29	14.71± 0.28	13.72± 0.29	0.002
Cholesterol (mg/d)	212.01± 10.27	195.17± 9.68	175.19± 10.22	0.05	197.29± 10.48	186.20± 9.78	198.77± 10.44	0.6	136.34± 8.13	161.19± 8.18	284.25± 8.28	<0.0001	194.03± 10.06	192.80± 9.83	195.40± 10.32	0.98
SFA (% of total energy)	7.06± 0.20	7.10± 0.19	6.84± 0.20	0.6	7.70± 0.20	6.94± 0.18	6.36± 0.20	<0.0001	6.50± 0.19	7.04± 0.19	7.45± 0.19	0.002	6.47± 0.19	6.74± 0.18	7.78± 0.19	<0.0001
Dietary fiber (g/d)	15.0± 0.42	18.16± 0.40	21.23± 0.42	<0.0001	19.69± 0.47	17.93± 0.44	16.81± 0.47	<0.0001	17.94± 0.45	18.05± 0.45	18.43± 0.46	0.7	18.64± 0.46	18.20± 0.45	17.60± 0.47	0.3

[1] *ANOVA for quantitative variables and chi-square test for qualitative variables.*

[2] *Mean±SE (all such values), unless indicated.*

Table 4. The mean ± SE of diet mean adequacy ratio (MAR) and nutrients adequacy ratio (NAR) across the tertiles of dietary patterns.

	Healthy				Traditional				High animal fat and protein				Western			
	Tertile 1	Tertile 2	Tertile 3	P [1]	Tertile 1	Tertile 2	Tertile 3	P	Tertile 1	Tertile 2	Tertile 3	P trend	Tertile 1	Tertile 2	Tertile 3	P
MAR	1.4±0.07	1.4±0.06	1.5±0.07	0.4	1.4±1.0	1.3±0.7	1.5±0.7	<0.0001	1.1±0.05	1.1±0.05	2.0±0.05	<0.0001	1.4±0.06	1.4±0.06	1.4±1.06	0.9
NARs of nutrients																
Zn	0.7±0.02	0.7±0.02	0.9±0.03	<0.0001	0.9±0.02	0.7±0.02	0.7±0.02	<0.0001	0.74±0. 02	0.76±0. 02	0.85±0.02	<0.0001	0.84±0.02	0.78±0.02	0.73±0.02	0.005
Ca	1.1±0.04	1.2±0.04	1.5±0.04	<0.0001	1.4±0.04	1.3±0.04	1.2±0.04	0.01	1.3±0. 04	1.3±0. 04	1.3±0. 04	0.5	1.4±0. 04	1.3±0. 04	1.1±0. 04	<0.0001
Fe	1.5±0.04	1.6±0.04	1.8±0.04	<0.0001	1.7±0.04	1.6±0.04	1.5±0.04	0.04	1.4±0. 04	1.6±0. 04	1.8±0. 04	<0.0001	1.6±0. 04	1.7±0. 04	1.6±0. 04	0.4
Mg	0.6±0.02	0.7±0.02	0.9±0.02	<0.0001	0.88±0.02	0.73±0.02	0.68±0.02	<0.0001	0.8±0. 02	0.8±0. 02	0.5±0. 02	0.6	0.8±0.02	0.8±0.02	0.7±0.02	0.3
B1	1.1±0.03	1.2±0.02	1.4±0.03	<0.0001	1.4±0.03	1.3±0.03	1.2±0.03	<0.0001	1.2±0. 03	1.28±0. 03	1.33±0. 03	0.001	1.3±0. 03	1.3±0. 03	1.2±0. 03	0.4
B2	1.7±0.05	1.8±0.04	2.2±0.05	<0.0001	2.1±0.05	1.9±0.05	1.8±0.05	<0.0001	1.8±0. 05	1.9±0. 05	2.0±0. 05	0.04	2.0±0. 05	1.9±0. 05	1.8±0. 05	0.001
B3	1.0±0.02	1.1±0.02	1.2±0.02	0.003	1.15±0.02	1.09±0.02	1.05±0.02	0.02	1.0±0.02	1.1±0.02	1.2±0.02	0.001	1.0±0.02	1.1±0.02	1.1±0.02	0.09
B5	0.6±0.01	0.7±0.01	0.8±0.01	<0.0001	0.74±0.3	0.68±0.2	0.65±0.2	<0.0001	0.7±0.01	0.7±0.01	0.7±0.01	0.3	0.7±0.01	0.7±0.01	0.7±0.01	0.9
B6	1.2±0.04	1.4±0.04	1.6±0.04	<0.0001	1.6±0.04	1.3±0.04	1.2±0.04	<0.0001	1.29±0. 04	1.32±0. 04	1.6±0. 04	<0.0001	1.4±0. 04	1.4±0. 04	1.4±0. 04	0.9
B9	0.8±0.04	0.9±0.04	1.1±0.04	<0.0001	1.1±0.04	0.92±0.04	0.88±0.04	0.003	1.0±0. 04	0.9±0. 04	1.0±0. 04	0.2	1.0±0. 04	0.9±0. 04	1.0±0. 04	0.9
B12	7.0±0.9	5.1±0.8	3.4±0.9	0.02	6.8±0.9	4.5±0.8	4.2±0.9	0.08	1.0±0.7	1.3±0.7	13.1±0.7	<0.0001	5.2±0.8	4.8±0.8	5.5±0.8	0.9
Biotin	0.26±0.02	0.33±0.02	0.39±0.02	<0.0001	0.4±0.02	0.3±0.02	0.2±0.02	<0.0001	0.3±0.02	0.3±0. 02	0.3±0. 02	0.1	0.3±0.02	0.3±0. 02	0.3±0. 02	0.8
Vitamin C	1.7±0.1	2.2±0.1	3.0±0.1	<0.0001	2.9±0.1	2.1±0.1	1.8±0.1	<0.0001	2.5±0.1	2.2±0.1	2.1±0.1	0.08	2.1±0.1	2.2±0.1	2.5±0.2	0.2
Vitamin A	1.2±0.05	1.5±0.05	2.0±0.05	<0.0001	1.8±0.6	1.5±0.6	1.3±0.6	<0.0001	1.45±0.06	1.55±0.06	1.7±0.06	0.01	1.6±0.06	1.6±0.06	1.6±0.06	0.9
Vitamin D	0.16±0.01	0.20±0.01	0.23±0.01	0.003	0.25±0.01	0.20±0.01	0.15±0.01	<0.0001	0.2±0. 01	0.2±0.01	0.2±0. 01	0.06	0.2±0. 01	0.2±0. 01	0.2±0. 01	0.5 [1]

Resulted from ANCOVA. Adjusted for age, sex and energy intake.

Table 5. The mean ± SD of diet quality indices across the tertiles of dietary patterns.

	Healthy				Traditional				High animal fat and protein				Western			
	Tertile 1	Tertile 2	Tertile 3	P [1]	Tertile 1	Tertile 2	Tertile 3	P	Tertile 1	Tertile 2	Tertile 3	P trend	Tertile 1	Tertile 2	Tertile 3	P
HEI	67.7±6.3	69.3±6.4	73.5±6.8	<0.0001	72.6±7.7	68.9±6.4	69.1±6.0	<0.0001	70.5±7.2	71.4±7.1	68.6±6.2	0.004	71.5±6.9	71.0±6.4	68.1±7.0	<0.0001
DDS	5.6±0.8	5.6±0.7	5.9±0.8	0.002	5.8±0.6	5.5±0.8	5.8±0.8	0.004	5.5±0.8	5.8±0.7	5.9±0.7	0.001	5.7±0.8	5.8±0.8	5.6±0.7	0.4
DED	0.8±0.2	0.8±0.1	0.8±0.1	0.5	0.8±0.2	0.8±0.1	0.8±0.1	0.7	0.8±0.1	0.8±0.2	0.9±0.1	<0.0001	0.8±0.1	0.8±0.2	0.9±0.2	0.002
Mediterranean score	3.5±1.5	4.3±1.5	5.5±1.2	<0.0001	4.2±1.7	4.3±1.6	4.8±1.5	0.004	4.4±1.5	4.3±1.6	4.5±1.6	0.5	4.4±1.6	4.3±1.5	4.5±1.7	0.5 [1]

Resulted from one-way ANCOVA. Adjusted for age, sex and energy intake.

not significantly related to traditional and healthy dietary patterns. Individuals in the higher tertile of traditional pattern had greater MED scores. Subjects in the higher tertile of high animal fat and protein were more probably to have higher diversity scores.

We did not find any differences in the prevalence of general and abdominal obesity as well as lipid profile abnormalities across the tertiles of different dietary patterns (Figure 1).

Discussion

The results of the current study illustrated that healthy dietary pattern was a high quality pattern whilst Western and traditional dietary patterns were associated with lower diet quality indices. Higher scores of healthy pattern were more nutrient-dense in comparison with higher scores of traditional and Western dietary patterns.

Dietary patterns have attracted much attention during last decade; however, to the best of our knowledge, no study has assessed their associations with diet quality indices. Due to differences in dietary patterns in each region, it is relevant to determine their associations with diet quality indices to choose the best one separately in each population. On the other hand, it is probably that loaded factors in healthy dietary patterns differ from one population to another and thereby affect diet quality indices as well as health outcomes (6, 33, 34). Although it is expected that healthy dietary pattern to be high quality diet and Western dietary pattern to be low-quality diet, it is of interest to know which nutrients are less likely to be met by specific dietary pattern. Additionally, other identified dietary patterns in different populations might be differently related to diet quality indices. It would be clinically useful to know which nutrients are deficient in each dietary pattern.

In the present study, high animal fat and protein dietary pattern was loaded by some unhealthy foods like potatoes, high fat dairy products and animal protein and fats, but higher scores of this pattern were associated with greater NARs of different nutrients

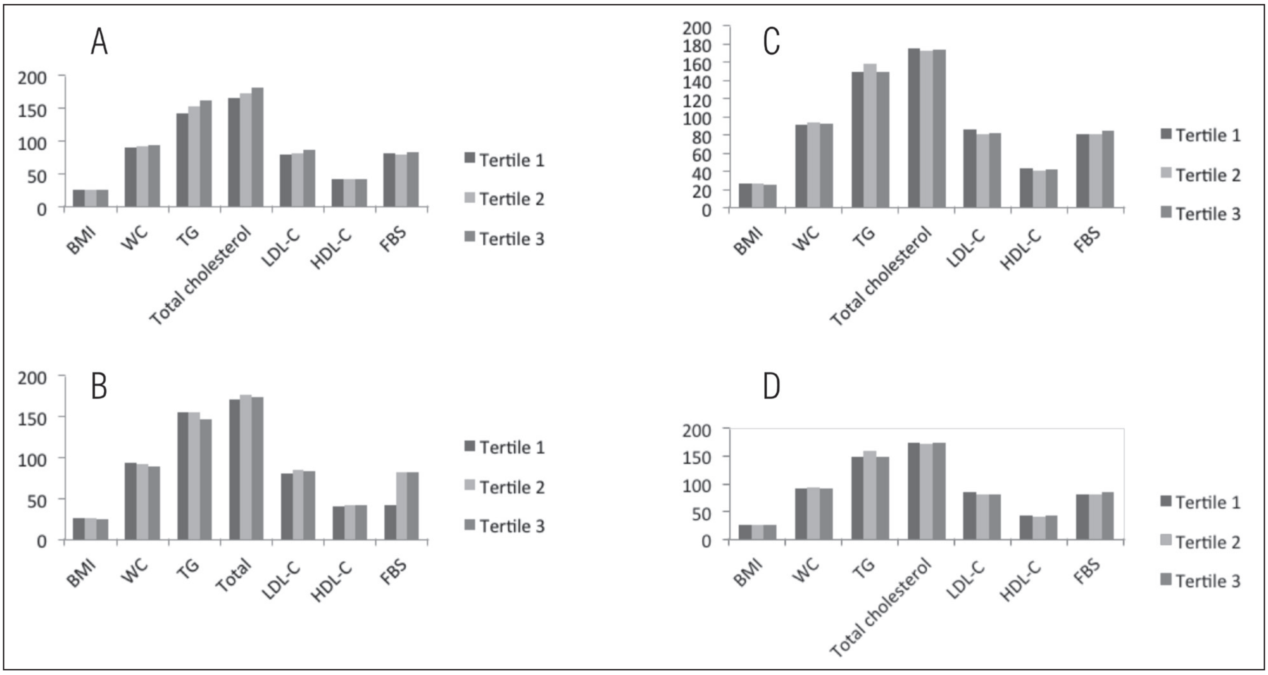

Figure 1. Mean of anthropometric measures, lipid profile and fasting blood sugar across tertiles of dietary patterns (A-healthy dietary pattern, B- Traditional dietary pattern, C- High animal fat and protein dietary pattern, D- Western dietary pattern). BMI: body mass index, WC: waist circumference, TG: triglyceride, LDL-C: low density lipoprotein, HDL-C: high density lipoprotein, FBS: fasting blood sugar.

including Zn, Fe, B1, B2, B3, B12 and vitamin A, in comparison with traditional and Western dietary patterns. This result is in line with the results of a current analysis on individuals participating in NHANES. They showed that the consumption of animal-based protein sources contributes to greater intakes of several nutrients of concern (e.g. Zn, Fe and B12) (8, 9). On the other side, we observed that traditional dietary pattern was mainly loaded by refined carbohydrates and inversely related to all NARs. Therefore, this might be concluded that high animal fat and protein are preferred to the traditional pattern to provide adequate intakes of different micronutrients. However, with considering their associations with SFA and cholesterol intake, it seems that traditional dietary pattern is healthier than high animal fat and protein.

Moreover, we found that higher adherence to the high animal fat and protein dietary pattern was associated with lower HEI scores and no significant difference in MED score, whilst traditional dietary pattern was positively related to MED score and negatively to HEI score. Therefore, it is difficult to determine the superior pattern between two dietary patterns, since higher scores of high animal fat and protein are more nutrient-dense whilst traditional dietary pattern contained lower amounts of SFA and cholesterol besides higher scores of MED pattern.

Other relevant findings of this study are related to determining nutrients of concern, including Mg, Zn, vitamin D, biotin and B5. Additionally, Ca and B2 deficiencies are two prevalent nutrient deficiencies among Iranian persons (35, 36). Our results suggested that their adequacy ratios significantly decreased according to each increased tertile of Western dietary pattern score.

In contrast with earlier publications, we did not observe any significant differences in cardiometabolic risk factors (1, 3, 4, 6, 37, 38). This discrepancy between our study and others might be attributable to differences in study population. Our participants were younger than the participants of Esmaillzadeh et al.'s study (6). Additionally, it was conducted among female teachers and controlled for the role of physical activity, whilst we did not. However, a new cohort study indicated that dietary patterns in older persons could not predict the risk of related-deaths to CVDs events and cancer (34). This study was not a representative sample and most of our participants were men. Therefore, the external validity of our findings might be limited, but its internal validity is acceptable, because of random sampling method.

In conclusion, healthy dietary pattern is favorably associated with NARs and different priori diet quality indices, but Western is not significantly related to these indices. Traditional and high animal fat and protein dietary patterns are differently related to the diet quality indices. Whilst higher scores of high animal fat and protein dietary pattern were more nutrient-dense, greater adherence to the traditional dietary pattern was associated with greater Med score. Further studies are needed to determine the quality of dietary patterns to determine the best pattern.

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L.A. conceptualized and designed the study. F.H. performed statistical analyses and drafted the manuscript, and interpreted data. N.R.P.F. participated in data collection and entry. M.K. and M.H.B. participated in data collection and took measurements. All authors approved the final manuscript for submission.

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