Original Article

Dietary patterns and the metabolic syndrome in middle aged women, Babol, Iran

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It is important to elucidate the dietary factors contributing to the development of metabolic syndrome among middle-aged women to better prevent and manage the syndrome. The objective was to determine the relationship between dietary intake and metabolic syndrome in urban Babolian middle-aged women. Systematic random sampling was used to select 984 women 30-50 years of age from urban area of Babol, Mazandaran, Iran. Dietary patterns were evaluated using a food frequency questionnaire. The ATP III criteria were used to classify study participants as having the metabolic syndrome. Correlations of component foods with indices of the metabolic syndrome were assessed using Spearman's rank correlation coefficient (rho). The adjusted odds ratios (OR) and their 95% confidence intervals were obtained for the nutrient groups. Mean total kilocalories consumed per day were 2965. The study suggests that a good dietary pattern that is rich in fruits, legumes, vegetables, cereals, and fish (component 1), as well as high intake of dairy products and eggs (components 4) decrease the likelihood of having metabolic syndrome. The adjusted OR for the metabolic syndrome in women with low fat intake was higher than in women with high and moderate fat (OR= 2.92; 95% CI= 1.36, 6.28). It is necessary to emphasize the benefits of lifestyle modification, including losing weight, and consumption of more fruits, legumes, vegetables, cereals, fish, dairy products in reducing the risk of the metabolic syndrome in middle aged women.

Key Words: dietary patterns, metabolic syndrome, FFQ, women's health, Iran

INTRODUCTION

Metabolic syndrome is becoming highly prevalent in many populations worldwide.[1] It is more common in women than in men.[2] In women with metabolic syndrome, cardiovascular mortality has significantly increased.[3] Many studies show a clear relationship between diet and risk factors of metabolic syndrome.[4,5] Liu and Manson[6] reported diets that promote a low fat intake as well as increased carbohydrates, especially complex carbohydrates, often result in an increased glycemic load. This may increase the risk of coronary heart disease by aggravating glucose intolerance, increasing triglyceride, and decreasing HDL cholesterol. Evidence indicates that the prevalence of obesity, overweight, and hypertension and the metabolic syndrome in Mazandaran is higher than the other areas. [6] There are many rice paddies around Babol city. Consequently, Babolian women have access to a diet that is rich in carbohydrate (rice).

If the metabolic syndrome is left untreated, problems such as diabetes and atherosclerosis may result,[7] and eventually, diabetes and atherosclerosis can lead to other complications such as kidney failure, blindness, and heart disease.[8] It is postulated that the modification of a lifestyle which is associated with risk factors, is essential for preventing and managing the metabolic syndrome. It is common knowledge now that metabolic syndrome and its complications are an increasing threat to the Iranian population: hence it is critical to identify factors which are associated with increased risk of metabolic syndrome. Although there are many reports that discuss the association between dietary intake and metabolic syndrome, the role of dietary components in the development of the metabolic syndrome is poorly understood.[9,10] Therefore, in the present study, we investigated the following hypothesis: diet (components of various food groups, carbohydrate, fat) is associated with the metabolic syndrome in middle aged women.

MATERIALS AND METHODS

During a period of 6 months, systemic random sampling

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was used to select 984 women, 30 to 50 years of age from the urban Babol, Mazandaran, Iran. There are fourteen active urban primary healthcare centers (PHC), the official agencies responsible for vaccination programmes and collection of health-related statistics in urban Babol. A total of 5782 households listed in the operational areas of these PHCs were used as the sampling frame.

The households were randomly selected, and stratified according to the number of households covered by each healthcare center, to achieve a distribution proportionate to the original population. In each household, all women between 30 and 50 years of age were selected. The Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia and that of Babol University approved the study. Informed written consent was obtained from all subjects in the study. Inclusion criteria for the study were Babolian women 30 to 50 years of age who were not pregnant. In order to accurately determine the prevalence of the metabolic syndrome, exclusion criteria included individuals with a history of antilipidemic medication intake or any other drugs which interfere with lipid metabolism, renal or thyroid dysfunction, acute or chronic hepatic inflammatory diseases, immobilization, recent surgical operations, myocardial infarction, individuals who had cerebrovascular accidents within the previous three months and pregnant women.

To determine accurately the associated dietary factors, women with a history of cardiovascular problems, diabetes, or stroke were excluded because of potential changes in diet. Also excluded were those suffering from hypertension, those on pharmacological treatment for diabetes mellitus and women who were breast-feeding.

The Metabolic Syndrome Assessment

The ATP III criteria were used. A woman has metabolic syndrome if she has any three or more of the following criteria: 1) waist circumference > 88 cm, 2) serum triglycerides ≥ 150mg/dL, 3) blood pressure ≥ 130/85 mmHg, 4) HDL cholesterol < 50 mg/dL and 5) serum glucose ≥ 110 mg/dL.[11]

Laboratory Studies and Biochemical Measurement

Fasting blood samples for the measurement of glucose and lipid concentrations were drawn from the right arm of each subject, in the resting position. Plasma glucose was measured on the day of blood collection by using the enzymatic colorimetric method with glucose oxidase.[12] Total cholesterol and triglycerides were determined by using commercially available enzymatic reagents adapted to the Selectra autoanalyzer (Parsazmon). Low-density lipoprotein cholesterol (LDL) was estimated by the Friedewald equation. It was not calculated when the serum concentration of triglycerides was greater than 400 mg/dL.[13] All samples were analyzed to ensure that internal quality control met the acceptable criteria. Inter-assay and intra-assay coefficients of variation were 8.61% and 2.53% for total cholesterol and 7.92% and 1.60% for triglyceride, respectively.

Dietary Assessment

In this study a food frequency questionnaire (FFQ) was used; its validity and reliability have been assessed by Malekshah et al.[14] The FFQ was based on the distinct cultural practices of northern Iran, the eastern part of Mazandaran province (new Golestan Province). Malekshah et al.[14] has shown that this FFQ is both reliable and valid in middle-aged subjects in a developing country when compared with multiple 24-hr recalls or biomarkers of nutrient intake. They reported that the FFQ provides valid and reliable measurements of habitual intake for energy and most of the nutrients studied.

The questionnaire was used in assessing an individual's habitual intake of 150 single foods and nutrients. The foods were grouped into eleven categories namely bread/grains, meat products, dairy products, cereals, oil/butters, vegetables, fruits, dried nuts, sugar, drinks, and condiments/spices. In addition, it consists of a list of foods with a standard serving size. Participants reported habitual frequency of consumption of each food item during the previous year and the frequency of food intake is recorded as the number of times per day, week, month and year or as never. A set of household measurement tools (glass, cup, Chinese bowl, plate, teaspoon, table spoon and serving spoon) were used to help subjects to estimate portions consumed.[14] Portion sizes of consumed foods are converted from household measures to grams based on a manual for household measures by Ghaffarpour M et al.[15] The Iranian food composition table was also used to calculate daily energy and nutrient intake.[16] A new software program was designed based on the Iranian food composition table and the FFQ to facilitate computation of nutrient data. The data provided information regarding total calories consumed per day, protein, calcium, carbohydrate, fat as well as percent of carbohydrates and fats.

Statistical Analysis

All analyses were performed using SPSS (version 15.0). All variables were tested for normality. Descriptive statistics were used to describe baseline demographic, anthropometric measures, physical activity, lipoprotein subclass levels, and nutritional data in the entire cross-sectional study. For data that were not normally distributed, measures of central tendency were reported as medians together with 25th and 75th percentiles and the interquartile range (IQR). For data that were not normally distributed, measures of central tendency were reported as medians. Differences between two groups were identified by non-parametric tests such as the Mann-Whitney U and the chi-square tests. Correlations of component foods with indices of the metabolic syndrome were assessed by using Spearman's rank correlation coefficient (rho). The adjusted odds ratios (OR) and their 95% CI were calculated for different levels of carbohydrate and fat intake. All analyses were two-tailed and a p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 984 people were selected with a mean age of 40.1 years (range 30 to 50 years). Forty women (4.1%) did not fast adequately prior to the blood test and were excluded. Data were obtained for the remaining 944 participants (95.9%).

The median age of 944 participants was 40.0 years. The participants had a median education of 5.0 years. More than 75% (n=713) of subjects had an educational level of elementary school or lower. Overall, 887 women (94%) were married and 854 women (90.5%) had no income for themselves (housewives). The mean monthly household income of the study population was 243,000 ± 6.10 Tomans (1 Toman=0.01 USD) and median household income was 220,000 Tomans. In addition, 44.5% of women reported having debts.

The mean weight of the women was 72.0 ± 12.4 kg and the mean height was 156.0 ± 7.4 cm. The mean BMI was 29.7 ± 5.5 kg/m², and the mean and median waist circumference was 96.9 ± 11.7 cm and 98.0 cm respectively. Abdominal obesity was observed in about 76.6% of subjects (n=273). The overall prevalence of the metabolic syndrome among Babolian urban women 30-50 years of age was 31.0% by the ATP III definition.

Table 1 shows the distribution of various variables such as age, BMI and abdominal obesity by the number of components of the metabolic syndrome; *p*-values obtained were from chi-square tests.

In order to explore the relationship between intake of food groups and presence of the metabolic syndrome, the subjects were divided into two groups: women with metabolic syndrome (n=284) and those without (n=632). Between-group differences were analyzed with Mann-Whitney U Test. Overall, women with metabolic syndrome had significantly higher consumption of bread/grain ($p<0.05$) and drinks ($p<0.001$) than those without metabolic syndrome. Total energy intake, meat products, dairy products, cereals, oil/butters, vegetables, fruits, dried nuts and condiments/spice were significantly lower in women with the metabolic syndrome than women without metabolic syndrome ($p<0.0001$) (Table 2).

The frequency of metabolic syndrome was analyzed according to consumption of carbohydrate and fat as a percentage of total energy intake. Women with metabolic

Table 1. Characteristics of Women by the Number of Components of the Metabolic Syndrome

Variables	The number of the components of the metabolic syndrome*						*p*-value
	0 (n=85)	1(n=283)	2 (n=265)	3 (n=207)	4 (n=70)	5 (n=7)	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	
Age>40 years	23 (27.1)	111 (39.4)	115 (43.4)	108 (52.2)	50 (71.4)	5 (71.4)	<0.001
Overweight≥25 kg/m2	45 (52.9)	223 (79.1)	231 (87.2)	187 (24.6)	67 (95.7)	7 (100)	<0.001
Abdominal obesity>88 cm	0 (0.0)	196 (69.5)	237 (89.4)	193 (93.2)	69 (98.6)	7 (100)	<0.001
Education <6 years	35 (41.2)	123 (43.6)	124 (46.8)	128 (61.8)	49 (70.0)	4 (57.1)	<0.001
Low income <200000 Toman†	31 (36.5)	119 (42.2)	116 (43.8)	95 (45.9)	31 (44.3)	4 (57.1)	0.712
Menopause	6 (7.1)	35 (12.4)	45 (17.0)	30 (14.5)	19 (27.1)	3 (42.9)	0.002
Systolic BP≥130 (mm Hg)²	0 (0.0)	15 (5.3)	36 (13.6)	52 (25.1)	44 (62.9)	7 (100)	<0.001
Diastolic BP≥85 (mm Hg)³	0 (0.0)	23 (8.2)	42 (15.8)	47 (22.7)	43 (61.4)	7 (100)	<0.001
Fasting glucose≥110 (mg/dL)	0 (0.0)	8 (2.8)	13 (4.9)	41 (19.8)	42 (60.0)	7 (100)	<0.001
Total cholesterol≥200 (mg/dL)	28 (32.9)	98 (34.8)	95 (35.8)	96 (46.4)	30 (42.9)	6 (85.7)	0.006
LDL cholesterol≥130 (mg/dL)	17 (20.0)	65 (23.0)	66 (24.9)	50 (24.2)	20 (29.0)	3 (42.9)	0.656
HDL cholesterol<50 (mg/dL)	0 (0.0)	54 (19.1)	152 (57.4)	169 (81.6)	63 (90.0)	7 (100)	<0.001
Triglyceride≥150 (mg/dL)	0 (0.0)	22 (7.8)	104 (39.2)	181 (87.4)	66 (94.3)	7 (100)	<0.001
Exposed to cigarettes at home	24 (29.6)	74 (28.7)	92 (36.7)	62 (33.0)	26 (40.0)	3 (42.9)	0.321
Exposed to cigarettes at work	1 (8.3)	6 (13.3)	7 (14.9)	6 (14.0)	1 (8.3)	0 (0.00)	0.978
Low/moderate activity	23 (27.1)	80 (28.4)	67 (25.3)	49 (23.7)	12 (17.1)	2 (28.6)	0.505

†Toman; 10 Rials = 1 Toman= 0.01 USD; ² Systolic BP=systolic blood pressure; ³ Diastolic BP=diastolic blood pressure
*****0= without component of metabolic syndrome, 1= Having one component of the metabolic syndrome, 2= Having two components of the metabolic syndrome, 3= Having three components of the metabolic syndrome, 4= Having four components of the metabolic syndrome, 5= Having 5 components of the metabolic syndrome

Table 2. Subject Daily Intake of foods from the different Food Groups (gram/day) According to Occurrence of Metabolic Syndrome (N=800)

Variables	Without metabolic syndrome (n=588)		With metabolic syndrome (n=212)		*p*-value
	Median	25th, 75th percentiles	Median	25th , 75th percentiles	
Bread & Grains	428.2	391.4, 476.5	465.5	351.3, 495.4	0.044
Meat products	77.8	37.9, 88.1	55.2	31.1, 83.3	0.1
Dairy products	345.4	299.0, 604.9	317.3	235.8, 487.4	<0.001
Cereals	25.2	16.1, 59.3	17.4	11.2, 31.0	<0.001
Oil and Butters	33.2	22.1, 42.9	22.1	18.8, 36.1	<0.001
Vegetables	523.1	378.4, 662.9	378.4	318.1, 516.3	<0.001
Fruits	482	347.5, 1018.6	425.21	275.2, 496.5	0.001
Dried nuts	8.7	3.2, 20.6	3.51	1.0, 8.7	<0.001
Sugar	35.5	29.3, 64.3	38.4	27.0, 64.3	0.97
Drinks	1688.6	1251.4, 1748.6	1718.6	1237.7, 2168.5	<0.001
Condiments/Spice	67.5	51.1, 106.2	64.28	46.5, 84.2	<0.001
Total energy (kcal/d)	2472.2	2389.5, 4197.1	2389.5	2107.2, 2538.9	<0.001

Table 3. Adjusted odds ratios (OR)† for association between consumption of carbohydrates and fat, and metabolic syndrome in Babolian women

Variables	Adjusted OR	95%CI	*p*-value
Carbohydrates			
Low (<40%)	1.12	0.48-2.64	0.785
Moderate (40-60%)	1.15	0.60-2.19	0.673
High (>60%)	1		
Fat			
Low (<30%)	2.92	1.36-6.28	0.006
Moderate (30-40%)	1.13	0.59-2.17	0.71
High (>40%)	1		

†Adjusted for total physical activity, total energy intake, years of school, income and BMI.

syndrome had a significantly higher consumption of carbohydrates but a lower consumption of fat as total energy intake ($p<0.002$).

Table 3 shows the adjusted odds ratios (with 95% CI) for different levels of carbohydrate and fat intake. The adjusted OR for metabolic syndrome in women with low fat intake was significantly higher than in women with high and moderate fat intake (OR= 2.923; 95% CI =1.36, 6.28). No significant association was found between metabolic syndrome and carbohydrate intake.

In order to further explore the relationship between the diet and metabolic syndrome in middle-aged women, five food components were obtained from the food frequency questionnaire. These are: component 1) a healthful food pattern, which is heavily loaded on low-fat products such as fish, vegetables, legumes, cereals, and fruits; component 2) a high glycemic index and high-fat pattern, which included red or white meat and meat products, and potatoes; component 3) a dietary pattern that included the consumption of pasta; component 4) a pattern that is characterized by the intake of dairy products and eggs; and component 5) a pattern that is mainly characterized by the consumption of sweets. These food components, identified by Panagiotakos et al,[17] were strongly correlated to each other (Table 4).

The food component measurements were compared with the indices of the metabolic syndrome. Spearman rank correlation coefficients revealed that food component 1 was inversely associated with waist circumference, total cholesterol, fasting blood glucose, LDL-cholesterol and triglycerides and positively associated with HDL-cholesterol levels. Food component 3 was positively cor-

Table 4. Correlations between Food Component Measures†

Food component groups	Component 1	Component 2	Component 3	Component 4	Component 5
	Rho *p-value*	Rho *p-value*	Rho *p-value*	Rho *p-value*	Rho *p-value*
Component 1		0.690** *p*<0.001	-0.358** *p*<0.001	0.103** *p*=0.005	0.080* *p*=0.028
Component 2	0.690** *p*< 0.001		0.063 *p*=0.083	0.075* *p*=0.040	0.373** *P*<0.01
Component 3	-0.358** *p*<0.001	0.063 *p*=0.083		-0.072* *p*=0.048	-0.094** *p*=0.01
Component 4	0.103** *p*=0.005	0.075* *p*=0.040	-0.072** *p*=0.048		0.647** *p*= <0.01
Component 5	0.080* *p*=0.028	0.373** *p*<0.001	-0.094** *p*=0.01	0.647** *p*<0.001	

**Spearman's rank correlation coefficient is significant at the 0.01 level (2-tailed).
*Spearman's rank correlation coefficient is significant at the 0.05 level (2-tailed).
†component 1= fish, vegetables, legumes, cereals, and fruits; component 2= red or white meat and meat products, and potatoes ; component 3= pasta; component 4= dairy products and eggs; component 5= sweets

Table 5. Correlations Between Food Component Measures† and Indices of the Metabolic Syndrome

Variable	Waist-C	Systolic BP	Cholesterol	Triglyceride	HDL-C	FBS	LDL-C
	Rho *p-value*	Rho *p-value*	Rho *p-value*	Rho *p-value*	Rho *p-value*	Rho *p-value*	Rho *p-value*
Component 1	-0.086* *p*=0.019	-0.062 *p*=0.090	-0.106** *p*=0.004	-0.183** *p* <0.001	0.141** *p*= 0.001	-0.096** *p*= 0.008	-0.081* *p*= 0.027
Component 2	-0.053 *p*= 0.147	-0.042 *p*= 0.252	-0.043 *p*= 0.239	-0.054 *p*= 0.140	0.053 *p*= 0.147	-0.043 *p*= 0.244	-0.024 *p*= 0.517
Component 3	0.03 *p*= 0.415	-0.026 *p*=0.475	0.073* *p*=0.047	0.080* *p*= 0.029	-0.026 *p*= 0.476	0.007 *p*= 0.850	0.076* *p*= 0.037
Component 4	-0.129** *p*=0.001	-0.099** *p*= 0.006	-0.011 *p*= 0.757	-0.171** *p* <0.001	0.142** *p* <0.001	-0.028 *p*= 0.445	0.025 *p*= 0.493
Component 5	-0.089 *p*= 0.015	-0.022 *p*= 0.556	-0.002 *p*= 0.959	0.002 *p*= 0.962	0.006 *p*= 0.870	0.057 *p*=0.118	0.001 *p*= 0.970

**Spearman's rank correlation coefficient is significant at the 0.01 level (2-tailed).
*Spearman's rank correlation coefficient is significant at the 0.05 level (2-tailed).
†component 1= fish, vegetables, legumes, cereals, and fruits; component 2= red or white meat and meat products, and potatoes ; component 3= pasta; component 4= dairy products and eggs; component 5= sweets

related with total cholesterol, triglyceride, LDL-cholesterol. Finally, component 4 was inversely correlated with waist circumference, systolic blood pressure, and triglyceride and positively correlated with HDL-cholesterol levels. Food components 2 and 5 were not associated with indices of the metabolic syndrome (except for waist circumference and component 5) as illustrated in Table 5.

DISCUSSION

In this investigation, the mean total kilocalories consumed per day was 2965. This is similar to the value reported in the Iranian Islamic Report of Food Balance Sheet, where the mean total kilocalories for Iranian people was reported as 3,095.[18] Also, Mirmiran et al.[19] showed that daily energy requirements for women aged 20-50 years were 2900 kilocalories. We found that women with the metabolic syndrome had lower mean total kilocalories consumed per day, compared with those without the metabolic syndrome. Our findings are in agreement with a prospective study of histological severity in patients with non-alcoholic fatty liver disease that showed the total amount of calories consumed tended to be lower in the group of patients with metabolic syndrome.[20] Many studies showed that acute energy restriction and subsequent weight loss have beneficial effects on glucose metabolism in insulin-resistant and type 2 diabetes mellitus.[21,22] Further research on the role of total energy intake and pathogenesis of the metabolic syndrome is necessary.

It could not be discounted that subjects may have misreported their energy intake. Dietary information was obtained through self-reported questionnaires, which may be subject to under-reporting and recall bias. Azizi et al [23] showed under-reporting and over-reporting of energy intake are problems in dietary intake assessment and there is a high prevalence of misreporting of energy intake in Tehran. Under-reporting of energy intake may be more frequent in women than in men (34.0% vs. 15.4% respectively), for the 25 to 50 year-old group.[19]

In this study, food groups consumed were compared in accordance with the presence or absence of the metabolic syndrome. Also the database on eleven food groups were grouped into the five food components according to the classification by Panagiotakos et al.[17] The first component is similar to the prudent pattern, which is high in fish, vegetables, legumes, cereals, and fruits.[24]

In the present study, women with metabolic syndrome had a lower consumption of cereal products than those without metabolic syndrome. Also, statistical significance of lower soy protein consumption is observed in women with the metabolic syndrome. These findings are also consistent with evidence from a cohort study of Japanese ancestry.[25] A meta-analysis of thirty eight controlled human clinical trials indicated that significant decreases of: 9% for total cholesterol, 13% for LDL cholesterol, and 11% triglyceride can be obtained from an average daily intake of around 47 gram of soy protein.[26] However in our study the average intake of soy protein was low.

Our findings showed that women with metabolic syndrome had a lower consumption of vegetables and fruits than those without the metabolic syndrome. This finding is consistent with many studies that reported dietary patterns high in fruit and vegetable content which were generally associated with a lower prevalence of the metabolic syndrome.[27,29] Intake of fruit and vegetables reduce the risk of metabolic syndrome through the beneficial combination of phytochemicals such as antioxidants, potassium, magnesium, fiber[30,31] and reduced plasma concentrations of inflammatory markers such as c-reactive protein.[29]

Component 1 was inversely associated with waist circumference, total cholesterol, LDL-cholesterol, fasting glucose and triglyceride level, and positively associated with HDL-cholesterol levels in this study. Since food component 1 was inversely related to indices of the metabolic syndrome, this could be described as a healthful pattern. These findings are in agreement with many studies that reported a prudent dietary pattern which was characterized by higher intakes of fruits, vegetables, legumes, fish, and whole grains.[32, 33, 17]

Component 2 foods include potatoes, red or white meat, and meat products. Lean meats such as beef, mutton and fish contain a highly absorbable iron (Fe++), and are a good source of zinc and vitamin B12. In the present study women with metabolic syndrome had a lower consumption of meat products than those without metabolic syndrome. Also this difference was detected with red meat, chicken, organs of chicken and fish. These findings are in contrast with evidence from a study in which a higher consumption of red meat especially total processed meat was associated with an increased risk of developing type 2 diabetes mellitus independent of known diabetes risk factors in middle-aged and older US women.[34] Nonetheless, our findings showed that component 2 foods were not associated with indices of the metabolic syndrome. These findings are also in contrast with evidence from a study which reported that component 2 was positively correlated with waist circumference and HDL-cholesterol levels.[17]

Component 3 foods included consumption of bread and grain (pasta). Bread/grain foods are high in complex carbohydrates and fibre, and are also generally low in saturated fats. In the present study, component 3 positively correlated with triglyceride and LDL-cholesterol levels. The comparison of intake between women with and without the metabolic syndrome showed that women with the metabolic syndrome had a higher consumption of foods in the bread/grain food group as well as drinks than those without the metabolic syndrome. These findings are consistent with evidence from a cohort study of Japanese ancestry.[25] However a study from France reported that bread intake was inversely related to the frequency of occurrence of the metabolic syndrome in men, but not in women.[35]

Component 4 is a pattern that included intake of dairy products and eggs. Dairy products are important sources of protein, calcium, phosphorus, and vitamin D.[36] In this study, component 4 was inversely associated with waist circumference, systolic blood pressure, and triglyceride level, and positively associated with HDL-cholesterol levels.

Skimmed milk and other fat-free or low-fat dairy products provide as much or more calcium and protein than whole milk dairy products, with little or no saturated fats.[36] There are some observational studies which showed dairy products and particularly milk to be positively associated with indexes of the metabolic syndrome[8,35] and risk factors of cardiovascular disease because they are sources of saturated fatty acids and cholesterol.[38] However, our findings showed that women with metabolic syndrome had significantly lower dairy product consumption than those without the metabolic syndrome.

Component 5 was mainly characterized by the consumption of sweets. Our findings showed a weak inverse correlation between component 5 and waist circumference. In contrast Panagiotakos et al.[17] reported that components 3, 4, and 5 were not associated with indices of the metabolic syndrome.

The relationship between dietary carbohydrates and the metabolic syndrome is a matter of controversy. Zhu et al.[29] showed that consumption of low or moderate carbohydrate diet leads to a relatively low risk of the metabolic syndrome in men. In this study, metabolic syndrome in women with high carbohydrate intake was more prevalent than in women with low or moderate intake. However the association between the metabolic syndrome and carbohydrate was not significant in our study.

For many years, public health groups have recommended low intake of total fat for decreasing obesity and to decrease the risk of some forms of cancer.[40] The Dietary Guidelines for Americans reported that lower total fat intake (less than 30 percent of energy) may have led to an over consumption of carbohydrates as well as may increase prevalence of obesity. Very high intake of carbohydrates in overweight/ obese persons can aggravate some of the risk factors of the metabolic syndrome.[41,42] In the present study, we have also found an inverse association between fat intake and metabolic syndrome. However, our analysis did not discriminate between saturated, polyunsaturated and monounsaturated fatty acid and therefore it is not known whether the inverse association between fats and risk of having the metabolic syndrome is due to high intake of saturated fat. A high-fat diet has been shown to reduce insulin receptors in both skeletal muscle and adipose tissues, thus reducing insulin-stimulated glucose transport and intracellular glucose metabolism.[43]

In conclusion, this study suggests that a dietary pattern rich in fruits, legumes, vegetables, cereals, and fish (component 1), as well as high intake of dairy products and eggs (component 4) decrease the likelihood of having the metabolic syndrome. There are also indications that a relatively higher intake of fat and as well as calcium is associated with a lower risk of the metabolic syndrome. Further studies are needed to explain this controversy. A large prospective study is proposed to elucidate associations between diet, lifestyle and metabolic risk factors in middle-aged women in Iran.

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AUTHOR DISCLOSURES

We certify that all financial resources and materials for this work are clearly identified in the manuscript.

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Original Article

Dietary patterns and the metabolic syndrome in middle aged women, Babol, Iran

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伊朗 Babol 中年婦女的飲食模式及代謝症候群

闡明飲食因子對於中年婦女代謝症候群發生的影響，有助於預防及管理代謝症候群。此研究目的為評估在 Babol 市的中年婦女，其飲食攝取與代謝症候群之相關性。使用系統性隨機抽樣，從伊朗 Mazandaran 省的 Babol 市區選取 984 名女性，年齡在 30-50 歲。使用飲食頻率問卷(FFQ)評估飲食模式。使用 ATP III 的標準來分類受試者是否有代謝症候群。食物組成與代謝症候群指數的相關性，是用斯皮爾曼等級相關係數(rho)評估。取得營養素組別的校正危險對比值(OR)及其 95%信賴區間。受試者平均每天攝取的熱量為 2965 kcal。此研究結果顯示，良好的飲食模式為富含水果、豆類、蔬菜、穀類及魚類(組成 1)，以及攝取高量的乳製品及蛋(組成 4)可降低罹患代謝症候群之可能性。攝取低脂肪的婦女比起攝取高脂或中脂的婦女，有較高的代謝症候群校正危險對比值(OR= 2.92; 95% CI= 1.36, 6.28)。有必要去強調生活型態改變的益處，包含減重及攝取較多的水果、豆類、蔬菜、穀類、魚與乳製品，以降低中年婦女罹患代謝症候群之危險性。

關鍵字：飲食模式、代謝症候群、飲食頻率問卷、女性健康、伊朗