Letter to the Editor

Dietary Patterns Associated Metabolic Syndrome in Chinese Adults*

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Dietary pattern has been revealed to be associated with metabolic syndrome. However, the association was not well documented in Chinese due to the complexity of Chinese foods. We mainly assessed the dietary patterns and examined their effects on metabolic syndrome among Chinese adults. Four dietary patterns including 'Refined Grains & Vegetables' Pattern, 'Dairy & Eggs' Pattern, 'Organ Meat & Poultry' Pattern, and 'Coarse Grains & Beans' Pattern were extracted. 'Dairy & Eggs' Pattern was associated with a decreased odds of metabolic syndrome in women, and 'Coarse Grains & Beans' Pattern was associated with a decreased odds of hypertension in men. These results provided a scientific basis for future research and dietary guideline perfection.

Metabolic syndrome (MetS) is composed of a cluster of abnormal conditions, including abdominal obesity, hyperglycemia, hyperlipidemia and hypertension[1], and it can be diagnosed according to several indicators including waist circumference (WC), fasting blood glucose (FBG), serum triglyceride (TG), serum high density lipoprotein cholesterol (HDL-C), systolic blood pressure (SBP), and diastolic blood pressure (DBP). MetS has been identified to increase the risks of cardiovascular disease and diabetes mellitus, all-cause, and cause-specific mortality[2].

Lifestyle such as dietary habit or dietary pattern was one of the most important factors of MetS and its individual components[3], and there are various ways to prepare Chinese foods and Chinese foods are usually made of a variety of foods and ingredients. This study aimed to identify the dietary patterns of Chinese adults, and to examine the association between these dietary patterns and MetS as well as its components.

Data were collected from the fifth Chinese Nationwide Nutrition and Health Survey (CNNHS) in 2010 till 2012, and a stratified, multistage probability cluster sampling design was used to assure the representativeness of the samples. The questionnaire survey, physical examination, laboratory examination, and dietary survey (method of 24-h dietary recall for 3 d) were conducted. MetS was diagnosed according to the Adult Treatment Panel-III of the National Cholesterol Education Program (NCEP-ATPIII) criteria, and the criteria of WC was appropriate for Asian[4].

A total of 2196 subjects aged 18 years and over were enrolled in this study. Of them 617 subjects were diagnosed as MetS, and 1579 subjects were non-MetS. Distributions of categorical variables were presented as frequencies, *P*-values were tested for chi-square test; Distributions of continuous variables were presented as mean±standard deviation values, *P*-values were tested for independent-samples *t* test. Dietary Patterns were extracted using factor analysis, the number of principal components were determined by the precondition that the eigenvalues were greater than 1.0, scree plot test and varimax rotation of the factors was performed to enhance the interpretability, rotated factor loadings ≥0.500 were considered as the elements of the dietary pattern, and the dietary pattern scores were divided into quintiles (named Q1-Q5 from lowest quintile to highest quintile). Multivariable logistic regression

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models were applied to evaluate the odds of MetS and its components, for each quintile compared with the lowest quintile, *P*-value was tested for a linear trend of Q1-Q5 for MS and its five components in the logistic regression model. All statistical analyses were conducted using Statistical Package for the Social Sciences software version 17.0 (SPSS Inc. Chicago, Illinois, USA).

The general characteristics, biochemical characteristics and food intakes of the subjects were described in Table 1. The subjects with MetS were older, more females, and more likely to be unemployed, and from small-medium city, and they do less physical exercise and lower labour intensity comparing with non-MetS subjects. Table 2 showed four principal components exacted and explained 48.65% of the variance in dietary consumption, and we took them as four different dietary patterns, Pattern 1 mainly including refined grains, vegetables and livestock meat, pattern 2 mainly including milk, and dairy products, eggs, fruits and marine products, pattern 3 mainly including organ meat and poultry, pattern 4 mainly including coarse grains, soybean and bean products. These four dietary patterns were named as 'Refined Grains & Vegetables' Pattern, 'Dairy & Eggs' Pattern, 'Organ Meat & Poultry' Pattern and 'Coarse Grains & Beans' Pattern respectively.

Table 1. General Characteristics, Biochemical Characteristics and Food Intakes of MetS and Non-MetS Subjects

Variables	MS (*n*=617)	Non-MS (*n*=1579)	*P*-value
Age (y)	58.06±11.75	51.31±14.48	<0.001
Gender			<0.001
Male (%)	251 (40.68)	782 (49.53)	
Female (%)	366 (59.32)	797 (50.47)	
Occupation			<0.001
Unemployed (%)	333 (53.97)	534 (33.82)	
White-collar employee (%)	22 (3.57)	72 (4.56)	
Skilled worker (%)	40 (6.48)	135 (8.55)	
Agriculture, forestry, grassland, and fishery industry (%)	140 (22.69)	528 (33.44)	
Commercial service and others (%)	82 (13.29)	310 (19.63)	
Living areas			<0.001
Large city (%)	220 (35.66)	448 (28.37)	
Small-medium city (%)	270 (43.76)	572 (36.23)	
Rural area (%)	127 (20.58)	559 (35.40)	
Physical exercise			<0.001
No (%)	222 (35.98)	398 (25.21)	
Yes (%)	395 (64.02)	1181 (74.79)	
Labour intensity			<0.001
Mild (%)	475 (76.99)	1018 (64.47)	
Moderate (%)	130 (21.07)	490 (31.03)	
Severe (%)	12 (1.94)	71 (4.5)	
Biochemical characteristics			
BMI (kg/m^2)	25.71±3.09	22.42±2.92	<0.001
WC (cm)	89.25±8.62	78.72±8.74	<0.001
SBP (mmHg)	135.02±16.54	119.38±16.38	<0.001
DBP (mmHg)	82.31±8.75	75.35±9.09	<0.001
FBG (mmol/L)	6.23±1.64	5.10±1.10	<0.001
TG (mmol/L)	2.57±1.71	1.43±1.03	<0.001
HDL-C (mmol/L)	1.36±0.28	1.38±0.30	0.089
Food categories			
Refined grains (g)	276.58±123.00	282.08±140.45	0.394
Coarse grains (g)	24.70±50.25	25.12±78.18	0.901
Vegetables (g)	265.63±158.64	264.15±159.35	0.845
Soybean and bean products (g)	23.01±28.82	24.37±31.08	0.347
Fruits (g)	55.05±96.36	53.66±106.85	0.778
Livestock meats (g)	75.33±73.24	77.62±69.16	0.494
Poultry meats (g)	25.25±37.49	28.90±42.38	0.061
Eggs (g)	22.44±27.58	23.05±27.49	0.645
Organ meats (g)	2.56±11.97	3.49±13.90	0.119
Marine products (g)	59.80±66.29	51.47±59.20	0.007
Milk and dairy products (g)	23.41±69.24	22.27±69.05	0.728

Note. Metabolic syndrome was diagnosed according to NCEP-ATPIII criteria.

The odds ratios (ORs) and 95% confidence intervals (95% CIs) of MetS were presented in Table 3. In male subjects, 'Coarse Grains & Beans' Pattern was inversely associated with the OR of hypertension (*P* for trend <0.05), after adjusting age, occupation, living area and BMI, and there was a 50%

Table 2. Factor Loadings and Explained Variance for Main Factors of Dietary Nutrient Identified by Factor Analysis

Food Category	Pattern 1	Pattern 2	Pattern 3	Pattern 4
Refined grains	**0.672**	0.028	0.106	-0.051
Vegetables	**0.644**	0.206	-0.126	0.083
Livestock meat	**0.635**	0.087	0.299	0.041
Milk and dairy products	-0.127	**0.700**	0.245	-0.028
Eggs	0.167	**0.605**	-0.050	-0.030
Fruits	0.025	**0.549**	-0.405	0.307
Marine products	0.251	**0.545**	0.108	0.000
Organ meats	0.049	0.166	**0.687**	-0.063
Poultry	0.145	-0.039	**0.522**	0.257
Coarse food grains	-0.252	0.079	0.173	**0.692**
Soybean and bean products	0.337	-0.063	-0.065	**0.662**
Proportion of explained variance (%)	14.35	14.04	10.30	9.95
Cumulative explained variance (%)	14.35	28.39	38.69	48.65

Note. Estimates from factor analysis were done on 11 food categories. Rotated factor loadings≥0.500 were considered as the elements of the dietary pattern, and elements of loadings≥0.500 are highlighted in boldface.

Table 3. Association Between Dietary Patterns and MetS or Its Components

Patterns	Male				Female			
	Q1	Q3	Q5	*P* for Trend	Q1	Q3	Q5	*P* for Trend
'Refined Grains & Vegetables' Pattern								
MetS	1.00	0.55 (0.28, 1.09)	0.60 (0.32, 1.14)	0.496	1.00	0.90 (0.57, 1.40)	0.98 (0.55, 1.77)	0.021
Abdominal obesity	1.00	0.56 (0.23, 1.35)	0.90 (0.40, 2.02)	0.011	1.00	0.69 (0.43, 1.11)	0.69 (0.38, 1.27)	0.186
Hypertension	1.00	0.72 (0.40, 1.30)	0.86 (0.49, 1.52)	0.005	1.00	0.78 (0.52, 1.18)	0.93 (0.55, 1.58)	0.003
Hyperglycemia	1.00	1.08 (0.62, 1.88)	1.00 (0.59, 1.69)	0.692	1.00	0.83 (0.56, 1.25)	0.62 (0.35, 1.09)	0.001
Hypertriglycemia	1.00	0.59 (0.35, 1.00)	0.74 (0.44, 1.23)	0.089	1.00	0.93 (0.64, 1.36)	0.68 (0.38, 1.20)	0.192
Low HDL-C	1.00	0.54 (0.27, 1.10)	0.61 (0.33, 1.15)	0.962	1.00	0.92 (0.63, 1.35)	1.08 (0.68, 1.72)	0.306
'Dairy & Eggs' Pattern								
MetS	1.00	1.04 (0.59, 1.84)	1.54 (0.88, 2.68)	<0.001	1.00	0.84 (0.52, 1.36)	0.45 (0.26, 0.79)	0.008
Abdominal obesity	1.00	1.75 (0.88, 3.44)	1.42 (0.69, 2.90)	<0.001	1.00	0.80 (0.48, 1.33)	0.84 (0.47, 1.50)	0.611
Hypertension	1.00	0.89 (0.57, 1.40)	0.78 (0.47, 1.27)	0.114	1.00	0.89 (0.57, 1.41)	0.77 (0.46, 1.29)	0.110
Hyperglycemia	1.00	1.02 (0.65, 1.59)	1.07 (0.68, 1.69)	0.013	1.00	0.95 (0.61, 1.48)	0.63 (0.38, 1.05)	0.103
Hypertriglycemia	1.00	1.14 (0.73, 1.78)	1.28 (0.80, 2.05)	0.015	1.00	1.09 (0.71, 1.67)	0.81 (0.50, 1.31)	0.841
Low HDL-C	1.00	0.64 (0.36, 1.14)	0.98 (0.55, 1.74)	0.281	1.00	0.74 (0.49, 1.11)	0.93 (0.59, 1.48)	0.003
'Organ Meat & Poultry' Pattern								
MetS	1.00	0.95 (0.50, 1.81)	1.63 (0.93, 2.87)	0.087	1.00	0.60 (0.55, 1.48)	0.70 (0.41, 1.22)	0.002
Abdominal obesity	1.00	0.68 (0.30, 1.53)	1.32 (0.65, 2.68)	0.004	1.00	1.20 (0.71, 2.05)	1.03 (0.59, 1.81)	0.097
Hypertension	1.00	0.66 (0.40, 1.11)	0.78 (0.49, 1.26)	0.032	1.00	0.92 (0.57, 1.47)	0.98 (0.60, 1.60)	0.037
Hyperglycemia	1.00	1.24 (0.75, 2.04)	1.34 (0.86, 2.09)	0.589	1.00	1.11 (0.70, 1.74)	1.23 (0.76, 2.01)	0.195
Hypertriglycemia	1.00	1.43 (0.87, 2.35)	1.44 (0.91, 2.28)	0.006	1.00	0.82 (0.54, 1.25)	0.75 (0.47, 1.21)	0.014
Low HDL-C	1.00	0.65 (0.35, 1.21)	0.58 (0.34, 1.00)	0.007	1.00	0.82 (0.53, 1.27)	0.65 (0.42, 1.01)	0.001
'Coarse Grains & Beans' Pattern								
MetS	1.00	1.39 (0.80, 2.40)	0.75 (0.44, 1.29)	0.467	1.00	0.96 (0.59, 1.56)	1.35 (0.81, 2.22)	0.655
Abdominal obesity	1.00	1.15 (0.57, 2.32)	0.66 (0.33, 1.30)	0.992	1.00	0.72 (0.43, 1.20)	1.39 (0.82, 2.35)	0.778
Hypertension	1.00	0.88 (0.55, 1.41)	0.50 (0.32, 0.79)	0.021	1.00	1.03 (0.65, 1.61)	1.21 (0.76, 1.93)	0.378
Hyperglycemia	1.00	1.09 (0.69, 1.73)	0.94 (0.61, 1.45)	0.401	1.00	0.91 (0.59, 1.41)	0.71 (0.45, 1.13)	0.086
Hypertriglycemia	1.00	1.29 (0.83, 2.02)	1.23 (0.79, 1.92)	0.553	1.00	0.92 (0.61, 1.39)	1.22 (0.78, 1.91)	0.790
Low HDL-C	1.00	1.48 (0.83, 2.62)	1.50 (0.87, 2.61)	0.052	1.00	0.92 (0.62, 1.36)	1.09 (0.73, 1.65)	0.053

Note. Values are expressed as odds ratio (OR) and 95% confidence intervals (95% CI). Age, occupation, types of area, and BMI were adjusted.

decrease (OR=0.50, 95% CI: 0.32, 0.79) in likelihood of having hypertension (Q5 compared with the Q1). The result confirmed the findings from the previous studies, WANG et al. found that higher whole-grain intake was associated with a reduced risk of hypertension in middle-aged and older women[5], and a dietary pattern rich in soybeans, grains is associated with reduced metabolic factors such as TG, FBG, WC, coarse grains and beans are rich in dietary fiber which is good for health[6].

In female subjects, 'Dairy & Eggs' Pattern was negatively associated with the odds of MetS (*P* for trend <0.05), and a 55% reduction (OR=0.45, 95% CI: 0.26, 0.79) in likelihood of having MetS (Q5 compared with the Q1) were observed. Kim showed that increasing consumption of dairy products was associated with a lower risk of MetS[7], which was similar to the results in our study. Because milk and dairy, eggs or marine products are good source of essential amino acid (EAA) and unsaturated fatty acid (UFA), which might enhance insulin sensitivity, reduce blood pressure, promote weight loss and increase energy expenditure or fat oxidation[8].

In our study, 'Refined Grains & Vegetables' Pattern and 'Organ Meat & Poultry' Pattern were not associated with MetS or its components, but in Sun's study, moderate intake of 'traditional food' was associated with decreased blood pressure and cholesterol level[6]. This might be due to the habits or customs and population structures were different between Jiangsu province and Zhejiang province in China.

Based on findings from this study, we would suggest that health policy for control and prevention of MetS should be developed. Limitations existed in this study. Firstly, the study was a cross-sectional study. The causality between dietary patterns and MetS or its components were therefore difficult to be explored. In addition, the food intake was inquired more than weighed. Also, the present study was community-based with random sampling, and the method of 24-h dietary recall for 3 d (Thursday, Friday, and Saturday) was used in the study. Therefore, we believe that more studies are needed in the future to clarify and back up the associations between the dietary patterns and MetS or its components as found in our present study.

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