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A fruit and dairy dietary pattern is associated with a reduced risk of metabolic syndrome

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ABSTRACT

This study examines the relationship between adherence to different dietary patterns and the presence of metabolic syndrome and its components among Korean adults. The sample consisted of 406 Korean adults aged 22 to 78 years recruited from hospitals. Metabolic syndrome was defined according to the criteria issued by the Adult Treatment Panel III, with the exception of central obesity, which was defined according to the Asian-Pacific criteria. Dietary information was obtained by means of a 24-hour recall and a 3-day food record, and factor analysis was used to define dietary patterns. Factor analysis identified 4 major dietary patterns, which explained 28.8% of the total variance, based on the percentage of total daily energy intake from each food group: Korean traditional, alcohol and meats, sweets and fast foods, and fruit and dairy. After controlling for all potential confounders, we found that the Korean traditional dietary pattern was not associated with individual components of the metabolic syndrome but was significantly associated with increased odds of having metabolic syndrome. The fruit and dairy pattern was significantly associated with decreased odds of impaired blood glucose, hypertriglyceridemia, and metabolic syndrome. Our findings suggest that the fruit and dairy pattern is associated with reduced risk of having metabolic syndrome.

Author contributions: SH analyzed data and wrote the draft; YS wrote and reviewed/edited the manuscript; KHL, HSL, ML, and SHJ analyzed the data and reviewed/edited the manuscript; and HJ designed the study and supervised all procedures.

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1. Introduction

Metabolic syndrome has been proposed to be a cluster of diseases, which not only increase the risk factors of cardiovascular disease and type 2 diabetes mellitus but also reportedly increase the morbidity and mortality of these diseases [1,2]; however, its limited practical utility as a diagnostic or management tool has recently been suggested [3]. The metabolic abnormalities associated with metabolic syndrome include impaired blood glucose, elevated blood pressure, dyslipidemia, and abdominal obesity; and its etiological factors are complex and incompletely understood [4]. The interaction between a sedentary lifestyle, certain dietary patterns, and genetic factors is generally considered to contribute to its pathogenesis [4].

The prevalence of metabolic syndrome has been increasing throughout the world. According to the National Health and Nutritional Examination Survey (NHANES) [5], the prevalence of metabolic syndrome among adults in the United States was approximately 23% from 1988 to 1994, but increased to almost 34% from 2003 to 2006 even though the criterion for fasting blood glucose was updated to 100 mg/dL [6]. A trend toward an increased prevalence of metabolic syndrome has also been evident in Asia. According to the Korean NHANES, the prevalence of metabolic syndrome in Korea was approximately 23.6% in 1998; but the prevalence had increased to 28.0% in 2001 [7]. This increase in Asia has occurred only during the last few decades, and it has been attributed to the adoption of Western lifestyles and the reduction in physical activity accompanying rapid economic growth [8].

Data on the association of dietary factors with the risk of metabolic syndrome have been accumulating. High intake of dietary fiber, calcium, vitamin D, whole grains, fruits, and vegetables was reported to have independent favorable effects on metabolic syndrome [9-11]. Recently, dietary pattern analysis has been suggested as a useful measure for understanding the relationship between the overall quality of diets and health outcomes [12]. Although issues related to the subjectivity of analytical methods and to differences among ethnic populations have been raised [13], healthy dietary patterns, such as the Mediterranean diet or prudent diets characterized by high intakes of whole grains or fish, vegetables, and fruits, have shown favorable effects on metabolic abnormalities [9,11,14].

Few studies on the association between dietary patterns and metabolic syndrome have been conducted in Asian countries. The Asian diet is high in carbohydrates and low in saturated fat. Steamed rice is the central element in the Korean diet; and typical side dishes include raw, pickled, and steamed vegetables, as well as protein-rich foods such as tofu, fish, and meat [15].

Several studies have reported that the high intake of carbohydrates among Asian populations was associated with the risk of type 2 diabetes mellitus [16], cardiovascular disease [17], and metabolic syndrome among those who were metabolically obese with normal body weight [18]. However, the adoption of Western patterns involving the high consumption of animal products such as meat, processed meat, and eggs in Asian countries has also been reported to have increased the risk of diabetes [19], hypertriglyceridemia [20], cardiovascular disease [21], and obesity in young people [22] because of the high intake of saturated fat associated with this diet. These data have raised concurrent concerns regarding high carbohydrate intake and the high consumption of animal products in Asian countries. Thus, an approach that examines the dietary patterns and their overall quality in Asian populations at risk for metabolic syndrome would be useful for developing disease prevention strategies.

In this study, the association between adherence to several dietary patterns and the presence of metabolic syndrome was explored in Korean adults.

2. Subjects and methods

2.1. *Study population*

We recruited participants through the Health Examination Center or the internal medicine department of 2 general hospitals in Seoul, South Korea, from July 2006 to August 2007. Subjects who had all the information of impaired fasting blood glucose levels, elevated blood pressure, low high-density lipoprotein (HDL) cholesterol, hypertriglyceridemia, and abdominal obesity were invited to participate in the study. Because of the high percentage of patients taking medication to decrease blood glucose [23] or blood pressure [24], participants taking these medications were included; but those taking other medications or following other treatment regimens were excluded from this study.

Of the 503 potential participants, 477 (94.8%) agreed to participate in this study. We also excluded subjects reporting extremely low or high energy intakes (<500 or >5000 kcal/d) [25]. The final sample consisted of 406 subjects for whom complete data were available. The study protocol was reviewed and approved by the Institutional Review Board at the Seoul Medical Center. Written informed consent was obtained from each participant.

2.2. *Metabolic syndrome*

Metabolic syndrome was defined according to the diagnostic criteria from the Adult Treatment Panel III of the National Cholesterol Education Program [26] with the exception of the criteria for abdominal obesity, which were taken from the guidelines for Asian populations developed by the International Diabetes Federation [27,28]. Subjects with metabolic syndrome were defined as those who had 3 or more of the following metabolic abnormalities: triglycerides of at least 150 mg/dL, HDL cholesterol less than 40 mg/dL in men or less than 50 mg/dL in women, high blood pressure of at least 130 mm Hg (systolic) or at least 85 mm Hg (diastolic), fasting glucose of at least 110 mg/dL, and a waist circumference of at least 90 cm in men or at least 80 cm in women.

2.3. *Clinical measurements*

While participants wore light clothing but no shoes, weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively; and body mass index (BMI) was calculated as weight (in kilograms) divided by height squared (in square meters). Waist circumference was measured midway between the lower rib margin and the iliac crest. Blood pressure was measured with a standardized sphygmomanometer after 10 minutes of rest in the sitting position. Blood samples were obtained in the morning after 12 hours of fasting; and levels of fasting glucose, triglycerides, and HDL cholesterol were assessed with an automatic blood analyzer (COBAS Integra, Roche, Switzerland). The intraassay coefficients of variation for fasting glucose, triglycerides, and HDL were 1.24% to 2.98%, and the interassay coefficients were 0.04% to 0.10%.

2.4. *Assessment of other variables*

Data on sociodemographic variables such as age, sex, education, and income and on health behaviors such as physical activities and smoking status were collected by a questionnaire. The level of education was divided into 4 groups: elementary school or less, elementary through high school, university, and graduate school. The data on income were divided into 6 categories according to average monthly household income, and these were then regrouped into 3 categories: low, medium, and high. Although participants were asked to provide detailed information about the type, frequency, and duration of exercise, this study used dichotomized variables. Subjects who performed sweat-inducing regular exercise at least once per week were regarded as being physically active. Smoking habits were divided into 3 categories: current smokers, former smokers, and those who had never smoked.

2.5. *Dietary assessment*

Multiple days of food intake, including alcohol consumption, were evaluated to assess actual individual intakes. We used a combination of methods: one 24-hour recall and 3 days of food records. When subjects visited the hospital for the first time, trained dietitians interviewed them regarding what they had eaten during the previous 24-hour period and then taught them how to record food intake. Subjects were asked to record their food consumption on 2 weekdays and 1 weekend day. During the interview, food models and household measures including bowls, cups, and spoons were used to assist subjects in estimating their portion sizes.

Individual nutrient intakes were calculated from 4 days of food intake using the Korean Nutrition Database [29] and the software CAN-Pro (CAN-Pro 3.0; Korean Nutrition Society, Korea).

2.6. *Dietary pattern analysis*

For dietary pattern analysis, food input variables were generated first because we used quantitative data such as the 4 days of food intake. The classification of foods into groups was necessary because the food items consumed daily were very diverse. The total number of foods that appeared in this study was 1050, and they were merged into 33 foods or food groups based on similarity and food-group classification in the Korean Nutrition Database [29]. For example, kimchi (fermented cabbage) was classified as a single food item, which differed from vegetables because it is a regular side dish for Koreans.

The average daily intake of the 33 foods or food groups was calculated for each participant, and the percentage of energy from each food or food group was calculated. Finally, the 33 food variables were used as input variables for each participant in the next dietary pattern analysis.

To identify dietary patterns, we used principal component analysis, a type of factor analysis in which input variables are aggregated into factors (distinct patterns) by the degree to which they are correlated with one another. The number of factors was determined based on eigenvalues (eigenvalue >1.5), the scree plot, and the interpretability of the derived factors [12]. Each individual had a factor score for identified patterns and was categorized by his or her factor scores into groups using quartiles [12]. The derived patterns were named according to both the foods that loaded most positively on the factor and how the factors correlated with nutrients [30].

2.7. *Statistical analysis*

Data were analyzed using the Statistical Analysis System (SAS 9.1; SAS Institute, Cary, NC). Distributions of general characteristics are presented as means ± standard deviations for continuous variables and as frequencies for categorical variables. The distribution of general characteristics by sex was tested using a χ^2 test.

To identify dietary patterns by factor analysis, the PROC FACTOR procedure in SAS using a principal component analysis and orthogonal rotation (varimax option in SAS) was used. A factor score was calculated for each subject for each dietary pattern (4 factors), and subjects were categorized according to quartiles of factor scores in each pattern.

General characteristics and nutrient intake were compared by quartiles of pattern scores using generalized linear models. All models controlled for age, sex, medications, smoking status, physical activity, and BMI. The first quartile in each dietary pattern was considered a reference in all models.

Multivariate logistic regression models were used to assess the overall trend of the odds ratios for metabolic abnormalities across quartiles of each dietary pattern. A *P* value less than .05 was considered to be statistically significant.

3. Results

Table 1 shows the characteristics and distributions of all subjects according to sex. The mean age was 50.6 years, 65.3% of the sample was male, 65.8% exercised regularly, 22.9% currently smoked, and 64% consumed alcohol. In addition, 58.6% of the subjects had elevated blood pressure; and 60.1% met the criteria for abdominal obesity. These conditions affected a greater proportion of the sample than did impaired blood glucose levels, low HDL cholesterol, and hypertriglyceridemia. The prevalence of metabolic syndrome in this population was 47.3%. Overall prevalence of metabolic syndrome did not differ according to sex, although significant differences by sex were noted in individual components.

Table 1 – General characteristics of study subjects by sex

	Total		Male		Female		P [b]
	n	%	n	%	n	%	
Age (y) (mean ± SD)	50.6	11.6	53.1	11.2	49.4	11.6	.003
Education							
Elementary	67	16.6	22	8.4	45	32.1	<.001
Secondary	132	32.8	81	30.8	51	36.4	
University	156	38.7	121	46.0	35	25.0	
Graduate school	48	11.9	39	14.8	9	6.4	
Income							
Low	127	31.7	61	23.3	66	47.5	<.001
Medium	133	33.2	97	37.0	36	25.9	
High	141	35.2	104	39.7	37	26.6	
BMI (kg/m^2) (mean ± SD)	25.4	3.1	25.7	7.7	24.9	3.5	.012
Physical activity							
Regular	267	65.8	177	66.8	90	63.8	.311
Smoking status							
Never	195	48.0	64	24.2	131	92.9	<.001
Current	93	22.9	88	33.2	5	3.5	
Former	118	29.1	113	42.6	5	3.5	
Supplement use	37	9.1	17	6.4	20	14.2	.009
Medication use							
Diabetes	51	12.6	31	11.7	20	14.2	.284
Hypertension	130	32.0	78	29.4	52	36.9	.078
Both or any	156	38.4	97	36.6	59	41.8	.177
Component [a]							
Impaired blood glucose	130	32.0	92	34.7	38	27.0	.068
Elevated blood pressure	238	58.6	164	61.9	74	52.2	.042
Low HDL cholesterol	160	39.4	85	32.1	75	53.2	<.001
Hypertriglyceridemia	198	48.8	144	54.3	54	38.3	.001
Abdominal obesity	244	60.1	151	57.0	93	66.0	.049
Metabolic syndrome	192	47.3	124	46.8	68	48.2	.432
No. of components							
0	38	9.4	25	9.4	13	9.2	.748
1	75	18.5	50	18.9	25	17.7	
2	101	24.9	66	24.9	35	24.8	
3	98	24.1	58	21.9	40	28.4	
4	71	17.5	50	18.9	21	14.9	
5	23	5.7	16	6.0	7	5.0	
Total	406	100	265	65.3	141	34.7	

[a] Components of metabolic syndrome were defined as abdominal adiposity (waist circumference ≥80 cm for women or ≥90 cm for men); low serum HDL cholesterol <50 mg/dL for women or <40 mg/dL for men; hypertriglyceridemia ≥150 mg/dL; elevated blood pressure (≥130/85 mm Hg); and abnormal glucose homeostasis: fasting blood glucose ≥110 mg/dL.

[b] P from χ^2 test.

Table 2 – Factor-loading matrix for the 4 major dietary patterns according to the percentage of energy derived from food or food groups

Food or food groups [a]	Dietary patterns			
	Korean traditional	Alcohol and meat	Sweets and fast foods	Fruit and dairy
Soy sauce	0.697	–	–	
Refined grains	0.594	–	–	–0.331
Onion and garlic	0.582	0.400	–	–
Vegetable oil	0.552	0.363	–	–
Soy products	0.516	–0.424	–	–
Red pepper and soybean paste	0.453	–	–	–
Starch syrup and sugar	0.452	–	–	–
Kimchi	0.440	–	–	–0.315
Seaweed	0.433	–	–	–
Fish	0.393	0.261	–	–
Whole grains	0.320	–	–	–
Vegetables	0.284	–	–	–
Alcohol	–	0.651	–	–
Processed meat	–	0.503	–	–
Poultry and eggs	–	0.460	–	–
Beef	–	0.418	–	0.255
Boiled fish paste	–	0.400	–	–
Animal fat	–	0.336	–	–
Organ meat	–	0.306	–	–
Coffee	–	0.270	–	–
Fruits juice and canned fruits	–	–	0.619	–
Chocolate and ice cream	–	–	0.557	–
Pizza and hamburgers	–	–	0.533	–
Spaghetti	–	–	0.489	–
Carbonated beverages	–	–	0.438	–
Sauce	–	0.268	0.414	–
Fruits	–	–	–	0.496
Pork	0.267	–	–	–0.493
Ramen (instant noodles)	–	–	0.273	–0.487
Dairy products	–	–	0.274	0.477
Rice cakes	–	–	–	0.432
Nuts	–	–	–	0.327
Cereal		–	–	–
Variance of intake explained (%)	9.341	7.197	6.598	5.656

[a] Factor loadings that were –0.20 and +0.20 are not shown.

Elevated blood pressure and hypertriglyceridemia were less frequent in women than men, and the opposite was true for low HDL cholesterol and abdominal obesity.

As shown in Table 2, the Korean traditional dietary pattern was characterized by high factor loadings from refined and whole grains, Korean seasonings, onions and garlic, vegetable oil, soy products, starch syrup, and sugar. The alcohol and meat pattern was characterized by high loadings for processed meats, eggs, fish paste, animal fat, and alcohol. The sweets and fast foods pattern was characterized by high loadings for fruit juices, chocolate, ice cream, pizza, and hamburgers. The fruit and dairy pattern was characterized by the highest factor loadings for fruits and dairy products; however, it was also characterized by high loadings for rice cakes and nuts and negative loadings for refined grains, kimchi, pork, and instant noodles.

The general characteristics and nutrient intakes according to the quartile of each dietary pattern are presented in Table 3. Age, sex, and BMI were not associated with a quartile among those subjects following the Korean traditional pattern. The daily intake of energy and carbohydrates significantly increased across quartiles, but the percentages of carbohydrates and fats did not differ according to quartile among those following the Korean traditional pattern. Age and sex differed significantly across quartiles, but BMI was not a significant factor among those following

Table 3 – General characteristics and nutrient intake by quartile of scores on dietary patterns

	Q1	Q2	Q3	Q4	P
Korean traditional					
Age (y) [a]	49.4 (12.0)	51.1 (12.0)	51.6 (11.6)	50.5 (10.8)	.549
No. of women	42 (41.2)	41 (40.6)	31 (30.4)	27 (26.7)	.069
BMI (kg/m^2)	25.7 (3.2)	25.2 (3.4)	25.2 (3.1)	25.6 (2.8)	.536
No. taking medication [a]	34 (33.3)	38 (37.6)	63 (61.8)	56 (55.4)	.432
Total energy (kcal/d)	1615.4 (575.9)	1659.6 (321.1)	1885.0 (382.4)	2200.1 (633.3)	<.001 [b]
Carbohydrates (g/d)	227.8 (73.3)	245.6 (45.3)	277.1 (49.0)	309.7 (74.7)	<.001 [c]
From carbohydrates (%)	58.0 (10.5)	59.9 (8.3)	59.5 (7.6)	57.3 (8.3)	.082 [b]
Protein (g/d)	64.3 (28.3)	67.0 (17.6)	77.2 (18.0)	96.4 (28.6)	<.001 [c]
From proteins (%)	15.0 (2.9)	16 (12.3)	16.4 (2.3)	17.6 (2.3)	<.001 [b]
Fat (g/d)	42.6 (23.8)	42.6 (16.2)	47.6 (19.3)	57.2 (22.5)	.029 [c]
From fat (%)	23.2 (6.9)	22.7 (5.9)	22.3 (5.7)	23.2 (4.9)	.813 [b]
Crude fiber (g/d)	17.1 (8.5)	19.0 (4.4)	22.2 (5.1)	29.2 (9.0)	<.001 [c]
Alcohol and meat					
Age (y) [a]	56.5 (10.6)	51.5 (10.3)	49.3 (11.3)	45.3 (11.4)	<.001
No. of women	51 (50.5)	43 (42.2)	30 (29.4)	17 (16.8)	<.001
BMI (kg/m^2)	25.2 (3.0)	25.5 (3.6)	25.4 (3.0)	25.6 (2.8)	.818
No. taking medication [a]	49 (48.5)	36 (35.3)	40 (39.2)	31 (30.7)	.062
Total energy (kcal/d)	1691.6 (475.5)	1722.4 (451.2)	1810.4 (477.3)	2135.3 (645.8)	<.001 [b]
Carbohydrates (g/d)	271.2 (68.8)	263.7 (69.6)	258.3 (64.4)	266.8 (74.4)	<.001 [c]
From carbohydrates (%)	64.7 (6.6)	61.6 (6.2)	57.5 (6.7)	50.7 (8.6)	<.001 [b]
Protein (g/d)	67.1 (23.4)	69.8 (20.7)	76.8 (24.8)	91.0 (31.0)	.001 [c]
From proteins (%)	15.8 (2.6)	16.2 (2.3)	16.9 (2.3)	17.1 (2.8)	<.001 [b]
Fat (g/d)	38.5 (18.2)	42.7 (15.5)	47.4 (19.9)	61.3 (24.3)	<.001 [c]
From fat (%)	20.0 (5.6)	22.2 (5.0)	23.3 (5.2)	25.8 (6.1)	<.001 [b]
Crude fiber (g/d)	25.2 (8.8)	21.0 (7.1)	21.3 (8.7)	20.0 (8.0)	<.001 [c]
Sweets and fast foods					
Age (y) [a]	53.8 (10.3)	52.7 (10.7)	50.9 (11.4)	45.2 (12.1)	<.001
No. of women	23 (22.8)	40 (39.2)	43 (42.2)	35 (34.7)	.021
BMI (kg/m^2)	25.6 (3.2)	25.3 (2.7)	25.4 (3.0)	25.5 (3.5)	.852
No. taking medications [a]	49 (48.5)	51 (50.0)	30 (29.4)	26 (25.7)	<.001
Total energy (kcal/d)	1867.5 (516.4)	1710.0 (499.1)	1768.5 (438.1)	2014.3 (662.0)	.050 [b]
Carbohydrates (g/d)	259.5 (63.9)	255.2 (68.0)	262.8 (63.8)	282.5 (78.3)	.012 [c]
From carbohydrates (%)	57.2 (11.2)	60.4 (7.5)	60.0 (7.1)	56.9 (8.3)	.365 [b]
Protein(g/d)	78.3 (26.5)	73.2 (25.4)	73.0 (21.9)	80.3 (32.0)	.003 [c]
From protein (%)	16.7 (2.7)	17.0 (2.3)	16.4 (2.1)	15.9 (2.9)	.003 [b]
Fat(g/d)	42.8 (18.1)	41.5 (19.6)	46.9 (16.2)	59.7 (25.7)	<.001 [c]
From fat (%)	19.7 (5.6)	21.6 (4.9)	23.7 (4.9)	26.4 (5.9)	<.001 [b]
Crude fiber (g/d)	22.0 (7.7)	22.3 (8.7)	22.2 (7.5)	21.0 (9.5)	.136 [c]
Fruit and dairy					
Age (y) [a]	45.8 (10.2)	51.0 (10.3)	52.0 (11.9)	53.8 (12.4)	<.001
No. of women	12 (11.9)	37 (36.3)	43 (42.2)	49 (48.5)	<.001
BMI (kg/m^2)	25.9 (3.1)	25.5 (3.0)	25.6 (3.4)	24.7 (2.8)	.027
No. taking medications [a]	40 (39.6)	33 (32.4)	43 (42.2)	40 (39.6)	.511
Total energy (kcal/d)	2034.5 (705.4)*	1670.3 (455.3)	1758.5 (431.6)	1897.4 (481.1)	.217 [b]
Carbohydrates (g/d)	266.9 (72.4)	252.7 (72.6)	257.8 (61.3)	282.7 (67.4)	.001 [c]
From carbohydrates (%)	54.0 (9.7)	60.8 (7.3)	59.4 (8.4)	60.3 (8.1)	.054 [b]
Protein (g/d)	83.6 (35.0)	68.8 (20.4)	73.7 (22.7)	78.6 (25.0)	.251 [c]
From protein (%)	16.3 (2.6)	16.5 (2.4)	16.7 (2.4)	16.5 (2.8)	.160 [b]
Fat (g/d)	54.3 (26.2)	40.2 (18.0)	45.2 (16.8)	50.2 (21.2)	.040 [c]
From fat (%)	23.6 (5.5)	21.5 (5.9)	22.8 (5.4)	23.5 (6.5)	.013 [b]
Crude fiber (g/d)	21.5 (10.2)	20.8 (7.3)	21.4 (7.70)	23.8 (7.7)	.121 [c]

[a] Number (percentage); χ^2 test; mean ± SD for other variables.
[b] Adjusted for age, sex, taking medications, and BMI.
[c] Adjusted for age, sex, taking medications, BMI, and energy intake.

the alcohol and meat pattern and the sweets and fast foods pattern. The daily consumption of energy (or energy from fat) and fat intake increased significantly in both patterns. Age, sex, and BMI were significantly related to quartile among those following the fruit and dairy pattern. The daily intake of energy was not associated with a quartile, but the daily intake of carbohydrates increased significantly according to quartile.

The odds ratios for metabolic syndrome across quartiles are presented in Table 4. The Korean traditional pattern was not associated with individual components of metabolic syndrome but was significantly associated with a 2-fold increase in the likelihood of having metabolic syndrome in the highest quartile compared with that in the lowest quartile after adjusting for age, sex, medication use, smoking, drinking, physical activity, and BMI.

The alcohol and meat pattern was significantly associated with a decreased odd of impaired blood glucose, and the sweets and fast foods pattern tended to be associated with decreased odds of hypertriglyceridemia. However, neither pattern was associated with the odds of having metabolic syndrome after adjusting for confounding factors.

The fruit and dairy pattern was significantly associated with decreased odds of having impaired blood glucose levels, hypertriglyceridemia, and metabolic syndrome. Subjects in the highest quartile of those following the fruit and dairy pattern showed a 58% decreased likelihood of having impaired fasting glucose levels, a 61% decreased likelihood of hypertriglyceridemia, and a 54% decreased risk for metabolic syndrome compared with those in the lowest quartile.

4. Discussion

In this study, we identified 4 major dietary patterns among Korean adults. The Korean traditional pattern was not associated with individual components of metabolic syndrome, but was significantly associated with an increased likelihood of having metabolic syndrome. On the other hand, the fruit and dairy pattern was strongly associated with a decreased likelihood of having metabolic syndrome, impaired fasting glucose, and hypertriglyceridemia.

The protective association of the fruit and dairy pattern with metabolic syndrome is similar to the findings of healthy patterns in other studies. Healthy dietary patterns, including fruit consumption, were associated with a decreased risk for metabolic syndrome and its components among women in Tehran [31], adults in Greece [32], women in Japan [22], and adults in Korea [33].

To examine the effect of a single item, we analyzed fruits and dairy products separately. Fruit consumption per se showed a similar strong association with the risk for metabolic syndrome abnormalities; however, consumption of dairy products per se showed no association with metabolic syndrome (data not shown). Given that this pattern also has high loadings in the rice cakes and nuts, these findings suggest that the effects of an overall dietary pattern rather than single food items may more effectively mediate health variables, although fruit consumption is an important component in a healthy dietary pattern in Korea.

We found that the Korean traditional pattern was associated with increased odds of having metabolic syndrome. We could not identify the underlying mechanism because associations with individual components were not detected, but a

Table 4 – Odds ratios for metabolic syndrome and its components by quartile based on scores for dietary patterns

	Q1	Q2	Q3	Q4	P [b] for trend
Korean traditional					
Impaired fasting glucose	1	0.97 (0.51-1.84)	1.40 (0.75-2.59)	1.46 (0.79-2.70)	.146
Elevated blood pressure	1	1.42 (0.76-2.65)	1.88 (1.00-3.51)	1.17 (0.63-2.18)	.342
Low HDL cholesterol	1	1.41 (0.77-2.57)	1.53 (0.84-2.80)	1.75 (0.96-3.20)	.075
Hypertriglyceridemia	1	1.59 (0.87-2.89)	1.37 (0.76-2.49)	1.30 (0.72-2.37)	.493
Abdominal obesity	1	1.59 (0.76-3.29)	1.07 (0.53-2.18)	0.94 (0.47-1.88)	.650
Metabolic syndrome [a]	1	2.09 (1.07-4.07)	2.02 (1.06-3.88)	**2.03 (1.05-3.92)**	**.047**
Alcohol and meat					
Impaired fasting glucose	1	0.80 (0.43-1.47)	0.71 (0.38-1.33)	**0.46 (0.23-0.92)**	.030
Elevated blood pressure	1	0.68 (0.36-1.28)	0.72 (0.38-1.39)	0.95 (0.47-1.90)	.924
Low HDL cholesterol	1	1.56 (0.86-2.81)	1.13 (0.61-2.09)	1.09 (0.56-2.09)	.950
Hypertriglyceridemia	1	1.05 (0.57-1.92)	1.22 (0.66-2.26)	1.51 (0.79-2.91)	.194
Abdominal obesity	1	1.46 (0.70-3.05)	0.91 (0.45-1.88)	1.13 (0.53-2.41)	.955
Metabolic syndrome	1	1.21 (0.63-2.33)	0.90 (0.46-1.74)	1.16 (0.58-2.34)	.945
Sweets and fast foods					
Impaired fasting glucose	1	1.42 (0.80-2.65)	1.02 (0.55-1.90)	0.70 (0.36-1.36)	.223
Elevated blood pressure	1	0.76 (0.40-1.46)	0.67 (0.35-1.26)	0.98 (0.50-1.90)	.829
Low HDL cholesterol	1	1.01 (0.56-1.84)	1.37 (0.75-2.50)	0.72 (0.38-1.37)	.571
Hypertriglyceridemia	1	0.65 (0.36-1.19)	0.61 (0.33-1.12)	0.57 (0.30-1.06)	.087
Abdominal obesity	1	0.93 (0.47-1.88)	1.43 (0.69-2.93)	1.16 (0.55-2.44)	.543
Metabolic syndrome	1	1.08 (0.56-2.08)	1.07 (0.56-2.07)	0.81 (0.41-1.61)	.687
Fruit and dairy					
Impaired fasting glucose	1	0.90 (0.49-1.66)	0.64 (0.34-1.20)	0.42 (0.20-0.84)	.010
Elevated blood pressure	1	1.01 (0.53-1.93)	0.67 (0.34-1.30)	0.72 (0.36-1.43)	.180
Low HDL cholesterol	1	1.07 (0.58-1.96)	0.94 (0.50-1.77)	0.97 (0.50-1.87)	.844
Hypertriglyceridemia	1	0.55 (0.30-1.02)	0.58 (0.31-1.10)	0.39 (0.20-0.76)	.009
Abdominal obesity	1	1.19 (0.58-2.43)	1.13 (0.54-2.37)	1.68 (0.78-3.59)	.233
Metabolic syndrome	1	0.74 (0.38-1.42)	0.55 (0.28-1.10)	0.46 (0.22-0.95)	.025

[a] Components of metabolic syndrome were defined as abdominal adiposity (waist circumference ≥80 cm for women or ≥ 90 cm for men); low serum HDL cholesterol <50 mg/dL for women or <40 mg/dL for men; hypertriglyceridemia ≥150 mg/dL; elevated blood pressure (≥130/85 mm Hg); and abnormal glucose homeostasis: fasting blood glucose ≥110 mg/dL.

[b] All models were adjusted for age, sex, taking medications, smoking, physical activity, and BMI.

possible explanation could be the high carbohydrate content from refined grains in this pattern.

In Korea, a major staple food is grain; and several studies reported that dietary patterns high in staple foods were associated with a greater risk for type 2 diabetes mellitus in Chinese women [34] and that high-carbohydrate diets were associated with insulin resistance and dyslipidemia in South Asia [35]. In addition, white rice was reported to be associated with an increased risk for diabetes in Japanese [36] and American individuals [37] and for ischemic stroke in Chinese individuals [38]. Future studies are necessary to explore the effect of carbohydrate quality in staple foods or the effect of fiber contents in grain foods on the risk of metabolic syndrome.

Another possible explanation is the limitation in the practical utility of the definition of metabolic syndrome. A recent report claimed that metabolic syndrome might be considered useful as an educational concept with limited clinical utility because no accepted central underlying mechanisms have been suggested [3].

Recently, Asian countries have been experiencing a transition in their nutritional habits as a result of the adoption of Western foods [39]. The Western patterns in Asian countries are characterized by the consumption of considerable quantities of meat, processed meat, and eggs and have been associated with increased risks for obesity, glucose intolerance, and mortality related to cardiovascular disease [19-22]. In this study, 2 patterns (ie, the alcohol and meat pattern and the sweets and fast food pattern) could be regarded as Western patterns; but neither pattern was associated with risk for metabolic syndrome. Although the meat and alcohol pattern tended to be related to hypertriglyceridemia and abdominal obesity, these tendencies did not reach significance. Considering that the fat intake of the highest quartile of participants following the alcohol and meat pattern was 61 g (25.8% of energy), this dietary pattern could not be classified as a high-fat diet.

The Western pattern in Asian countries is not exactly the same as that followed by Western populations [31,40]. Even Asians who consume substantial quantities of meat or animal-based foods still adhere to a rice-based diet, which contributes to the maintenance of a low-fat diet compared with Western countries. We assume that Westernized patterns will not become associated with metabolic syndrome abnormalities unless the staple foods change. However, these patterns should be monitored.

The present study had several strengths. First, in contrast to other studies that relied on only a single day of recalled food intake or on a food-frequency questionnaire, we obtained data for 4 days of food intake, which enabled our estimates to more closely reflect usual food intakes. Second, we recruited subjects who visited hospitals for metabolic syndrome, which allowed us to closely examine the association between dietary patterns and abnormalities related to metabolic syndrome.

Several limitations also need to be considered in the interpretation of our findings. First, our study population was conveniently recruited from hospitals. According to a Korean NHANES report, the prevalence of metabolic syndrome is 23% to 28% in the Korean adult population. Considering that our study population showed a prevalence of 47.3%, generalization of our findings to the entire adult population of Korea is not advised; and our findings should be interpreted with caution. Further studies, including random sampling, are necessary. Second, because we recruited subjects from hospitals, we dealt with issues related to taking medications. We included subjects taking medications for lowering blood pressure or blood glucose because of the large population that visited the center, and we excluded subjects taking other medications and/or undergoing other treatments. To control for the effects of taking medications, we used the variable of taking medications as a covariate in all models. Because detailed information regarding type, duration, and adherence to taking medication should have been obtained to thoroughly address these effects, future studies are necessary to confirm our findings. Third, the cross-sectional design of this study limits the interpretation of our findings in terms of its temporality. Finally, the dietary pattern approach can be subjective and creates difficulties in replicating results in other populations. Nevertheless, this approach is useful for enhancing our understanding of the complex dietary variables implicated in chronic diseases [41].

In summary, the fruit and dairy pattern was associated with a reduced risk of having metabolic syndrome. This pattern can be considered a healthy dietary pattern for Koreans. Further interventional or longitudinal studies are necessary to confirm our findings.

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Conflict of Interest

No potential conflicts of interest relevant to this article were reported.

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