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Dietary Patterns and Risk for Metabolic Syndrome in Korean Women

A Cross-Sectional Study

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Abstract: Dietary patterns are a risk factor for metabolic syndrome (MetS). The prevalence of MetS has increased in Korea, and this condition has become a public health issue. Therefore, the present cross-sectional study aimed to identify the associations between dietary patterns and the risk of MetS among Korean women.

The data of 5189 participants were analyzed to determine dietary intake and lifestyle. A principal components analysis was employed to determine participant dietary patterns with regard to 106 food items. MetS was diagnosed using the National Cholesterol Education Program, Adult Treatment Panel III. Logistic regression analyses were applied to evaluate the associations between dietary pattern quintiles and MetS and to generate odds ratios (ORs) and 95% confidence intervals (CIs) after adjusting for potential confounders.

Three dietary patterns were identified: ''traditional,'' ''western,'' and ''prudent.'' The ''prudent'' dietary pattern consisted of a high intake of fruits and fruit products as well as nuts, dairy, and a low consumption of grains; this pattern was negatively associated with the risk of MetS. The highest quintile of the ''prudent'' dietary pattern was significantly less likely to develop MetS (OR: 0.5, 95% CI: 0.36–0.68, P for trend <0.001) compared with the lowest quintile. This pattern was also negatively associated with all of the MetS diagnostic criteria: abdominal obesity (OR: 0.52, 95% CI: 0.41–0.65), blood pressure (OR: 0.72, 95% CI: 0.59–0.87), triglycerides (OR: 0.67, 95% CI: 0.52–0.85), fasting glucose (OR: 0.64, 95% CI: 0.43–0.95), and high-density lipoprotein cholesterol (OR: 0.53, 95% CI: 0.42–0.68). However, the ''traditional'' and ''western'' dietary patterns were not associated with the risk of MetS.

The ''prudent'' dietary pattern was negatively associated with the risk of developing MetS among Korean women.

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Abbreviations: BMI = body mass index, CI = confidence interval, DASH = Dietary Approaches to Stop Hypertension, DBP = diastolic blood pressure, FFQ = food frequency questionnaire, HDL = high-density lipoprotein, MetS = metabolic syndrome, OR = odds ratio, PCA = principal components analysis, SBP = systolic blood pressure, TG = triglyceride.

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INTRODUCTION

Dietary patterns and nutritional intake influence the development and progress of diseases such as metabolic syndrome (MetS).[1–3] MetS is a typical degenerative disorder characterized by the combination of abdominal obesity, dyslipidemia, hypertension, and insulin resistance.[4] MetS is therefore associated with an increased risk for cardiovascular disease and diabetes mellitus as well as with general morbidity and mortality.[5]

The increasing prevalence of MetS is especially evident in Asia.[3,6] According to the Chinese National Nutrition and Health Survey, the prevalence of MetS was 13.8% in 2002.[7] However, this prevalence increased to 27.4% in 2010, although that was at a regional level.[8] A rapid increase in the incidence of MetS from 24.9% to 37% was observed from 1998 to 2012 in Korea, causing MetS to become a public health issue.[9,10] Although multiple risk factors (eg, metabolic and genetic components) must be considered to account for this emerging health problem,[11,12] the increasing prevalence of MetS might stem from changes in dietary patterns and nutritional intake.[1] Over the past several decades, dietary patterns and levels of nutritional intake have changed with the development of food industries and westernization. Trends toward the increased consumption of red meat, fat, and sodium and the insufficient intake of vegetables and fruits[13] have occurred, and these trends might be associated with the increased prevalence of MetS.

The traditional Korean diet is likely protective against MetS because it consists of a large portion of vegetables and is lower in fat than the western diet.[14,15] Recent studies are not consistent with this notion, however, noting that the traditional dietary pattern did not significantly lower the prevalence of MetS; rather, it increased the risk.[16–18] In addition, noble dietary patterns that consist of a variety of food items have been recently observed, and their association with MetS has been investigated.[16,18,19] These findings suggest that the association between dietary patterns and MetS in Korea remains unclear, and additional studies are needed to clarify this area of research. Therefore, the present study aimed to determine the association between dietary patterns and the risk of MetS among Korean women.

METHODS

Study Subjects

This research was designed as a cross-sectional study. A total of 5931 female participants were recruited from a health screening examination (a benefit program of the National Health Insurance) at the National Cancer Center in the Republic of Korea between September 2007 and December 2014. All of the participants volunteered for the study and agreed to provide data for the survey questions, including their medical histories, clinical test results, and dietary habits. Participants whose medical records were not available (n = 659) or who reported implausible energy intakes (<500 or ≥4000 kcal, n = 83) were excluded from this study. However, no one was excluded because of other medical issues, including diabetes, stroke, coronary disease, or cancer. The remaining 5189 participants were aged between 31 and 70, and their data were analyzed (Figure 1). The institutional review board provided ethical approval before the commencement of the research (No. NCCNCS-07-077), and all of the participants provided informed consent before participating in the study.

Data Collection

The participants completed a self-administered questionnaire designed to evaluate each participant's demographics (eg, age, education, household income, and marital status), lifestyle (eg, cigarette smoking, alcohol consumption, and regular physical activity), medical history and diet on the day of the examination. A validated food frequency questionnaire (FFQ) was applied to determine dietary intake. The FFQ classifies 106 food items into 37 groups based on their nutrient profiles and culinary uses. To examine the average consumption of each food item over the last year, 3 portion sizes (eg, small, medium, and large) and 9 degrees of frequency (eg, never or rarely, once a month, 2 or 3 times a month, once or twice a week, 3 or 4 times a week, 5 or 6 times a week, once a day, twice a day, and 3 times a day) were presented. Height and weight of each subject were determined using the InBody 370 (Biospace, Seoul, Korea). Body mass index (BMI) was computed as weight (kg) divided by the square of the height (m). Waist circumference was measured at the umbilical level using a measuring tape (Tech-Med model 4414; Moore Medical Corp., New Britain, CT). Blood pressure was measured using an automatic blood pressure monitor (FT-200S, Jawon Medical, Kyungsan, Korea).

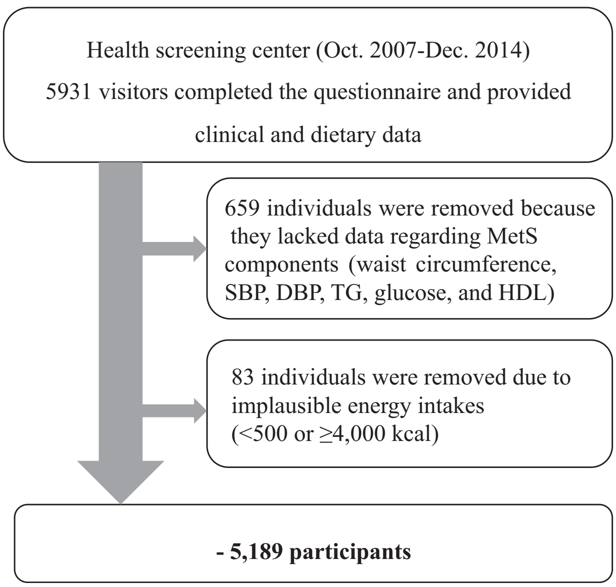

FIGURE 1. Flow chart of the participant selection process. DBP = diastolic blood pressure, HDL = high-density lipoprotein, SBP = systolic blood pressure, TG = triglyceride.

Blood samples for biochemical analyses were collected from participants by venipuncture following 8 hours of fasting. Levels for triglyceride (TG) and high-density lipoprotein (HDL) cholesterol (Kyowa Medex, Tokyo, Japan), and fasting glucose (Denka Seiken, Tokyo, Japan) were determined using a Chemistry Analyzer (TBA-200FR, Toshiba, Tokyo, Japan).

Metabolic Syndrome Diagnosis

MetS, with the exception of abdominal obesity, was defined using the National Cholesterol Education Program Adult Treatment Panel III.[20] Waist circumference was determined using Asian guidelines.[21] The participants were diagnosed with MetS if they had 3 or more of the following risk conditions: waist circumference of ≥80 cm; systolic blood pressure (SBP) of ≥130 mm Hg and a diastolic blood pressure (DBP) of ≥85 mm Hg; TG count of ≥150 mg/dL; fasting blood glucose level of ≥110 mg/dL or medicine therapy for glucose level; and HDL cholesterol level of <50 mg/dL.

Analyses of Dietary Patterns and Nutritional Intakes

To extract the participants' dietary patterns, a principal components analysis (PCA; PROC FACTOR) was conducted. The analyzed factors were adjusted using a varimax rotation to improve data interpretability. The eigenvalues, scree plot, and interpretability were taken into account to determine the number of retained factors with regard to dietary patterns. The factor score for individual dietary patterns was grouped by quintiles for further analysis. In addition, to understand the characteristics of the identified dietary patterns, analyses for nutritional intake based on the dietary patterns were performed using CAN-PRO 4.0 (Computer Aided Nutritional Analysis Program, The Korean Nutrition Society, Seoul, Korea). Vitamins B_1, B_2, B_6, C, E, and folate as well as sodium, potassium, iron, calcium, and fiber intakes were particular concerns, as were energy, carbohydrates, proteins, and lipids because previous studies have shown that these nutrients are associated with MetS risk, and they benefit human health.[3,22]

Statistical Analyses

Student *t* tests and Chi-square tests were performed to compare continuous and categorical variables, respectively. Binominal logistic regression models with a log scale for each dietary pattern score were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) across quintiles. The trend tests for the association between each of the dietary patterns and MetS and the comparison of nutritional intakes across quintiles were examined using a general linear model adjusted for confounding factors. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Inc., Cary, NC). All reported *P*-values were associated with 2-tailed hypotheses with 95% CIs.

RESULTS

Table 1 provides the general participant characteristics by MetS phenotype. The prevalence of MetS was 11.4% in the study population. The participants with MetS were older and had higher BMIs than the control subjects ($P < 0.001$). Significant differences were also observed between the MetS phenotypes with regard to socioeconomic variables. The patients with MetS were less likely to be married ($P < 0.01$) or educated ($P < 0.001$), and they had less income ($P < 0.001$) than the

TABLE 1. General Characteristics of Study Population and Comparison for Subjects With and Without Metabolic Syndrome

	Total	MetS (+)*	MetS (−)	P-Value†
Number of participants (%)	5189 (100)	592 (11.4)	4597 (88.6)	
Age (mean, year)	52.2 ± 8.3	56.3 ± 8.1	51.6 ± 8.2	<0.001
Body mass index (mean, kg/m^2)	23.2 ± 3.0	26.3 ± 3.0	22.8 ± 2.8	<0.001
Marital status				
Married	4212 (81.2)	454 (76.7)	3758 (81.8)	<0.01
Unmarried	313 (6.0)	30 (5.1)	283 (6.2)	
Divorced, widowed	574 (11.1)	91 (15.4)	483 (10.5)	
Missing	90 (1.7)	17 (2.9)	73 (1.6)	
Education level				
Less than middle school	792 (15.3)	142 (24.0)	650 (14.1)	<0.001
High school	2092 (40.3)	239 (40.4)	1853 (40.3)	
College or more	2068 (39.9)	173 (29.2)	1895 (41.2)	
Missing	237 (4.6)	38 (6.4)	199 (4.3)	
Household income (10,000 won/month)				
<200	1070 (20.6)	177 (29.9)	893 (19.4)	<0.001
200–400	1749 (33.7)	188 (31.8)	1561 (34.0)	
>400	1688 (32.5)	132 (22.3)	1556 (33.9)	
Missing	682 (13.1)	95 (16.1)	587 (12.8)	
Smoking status				
Nonsmoker	4850 (93.5)	551 (93.1)	4299 (93.5)	0.88
Ex-smoker	183 (3.5)	23 (3.9)	160 (3.5)	
Current smoker	142 (2.7)	16 (2.7)	126 (2.7)	
Missing	14 (0.3)	2 (0.3)	12 (0.3)	
Alcohol consumption				
Nondrinker	2901 (55.9)	384 (64.9)	2517 (54.8)	<0.001
Ex-drinker	282 (5.4)	40 (6.8)	242 (5.3)	
Current drinker	2003 (38.6)	168 (28.4)	1835 (39.9)	
Missing	3 (0.1)	0 (0.0)	3 (0.1)	
Regular exercise				
No	2223 (42.8)	281 (47.5)	1942 (42.2)	0.02
Yes	2818 (54.3)	297 (50.2)	2521 (54.8)	
Missing	148 (2.9)	14 (2.4)	134 (2.9)	
Waist circumference (cm)	74.2 ± 7.5	82.7 ± 6.5	73.1 ± 6.9	<0.001
Systolic blood pressure (mm Hg)	124.5 ± 14.8	138.2 ± 13.0	122.7 ± 14.1	<0.001
Diastolic blood pressure (mm Hg)	74.4 ± 10.2	81.9 ± 9.1	73.5 ± 10.0	<0.001
Triglyceride (mg/dL)	105.1 ± 64.1	194.7 ± 90.2	93.6 ± 49.2	<0.001
Fasting glucose (mg/dL)	91.3 ± 15.2	105.4 ± 26.6	89.4 ± 11.8	<0.001
High-density lipoprotein cholesterol (mg/dL)	62.5 ± 14.3	48.3 ± 9.0	64.4 ± 13.8	<0.001

Numbers are the mean ± standard deviation, unless otherwise stated.
* MetS (+) and MetS (−) mean the presence and the absence of metabolic syndrome, respectively.
† Chi-square test for categorical variables and Student *t* test for continuous variables.

healthy controls. The ratio of nondrinkers in MetS subjects was higher than controls ($P < 0.001$). However, participants without MetS were more engaged in regular physical activity ($P = 0.02$). These variables might be associated with the incidence of MetS; thus, they were considered as potential confounders in subsequent analyses. All biochemical indices for MetS significantly differed between the absence and presence of MetS (all $P < .001$).

The dietary patterns and factor loadings derived from the PCA are presented in Figure 2. Three dietary patterns were identified that explained 24.7% of the total variance. The ''traditional'' dietary pattern was characterized by a high intake of traditional food items regularly consumed in Korea, such as vegetables, condiments, shellfish, mushrooms, seaweed, fish, tubers, and kimchi. The ''western'' dietary pattern was characterized by high intake of general foods found in western diets, such as red meat, oil, cake/pizza, noodles, poultry, processed meats, bread, and sweets and by low intake of grain. The ''prudent'' dietary pattern was characterized by low consumption of grains and by high intake of fruits and fruit products as well as bread, dairy products, nuts, cake/pizza, and milk.

Table 2 shows the nutritional intakes of the participants according to quintiles of the factor scores for each dietary pattern. After controlling for potential confounders, the dietary levels of the examined vitamins, calcium, and iron were increased with factor scores in the ''traditional'' and ''prudent'' dietary patterns (data not shown). However, the average intakes of dietary sodium and potassium showed differential trends with regard to the factor scores depending on the dietary patterns. In the ''prudent'' dietary pattern, dietary sodium levels did not

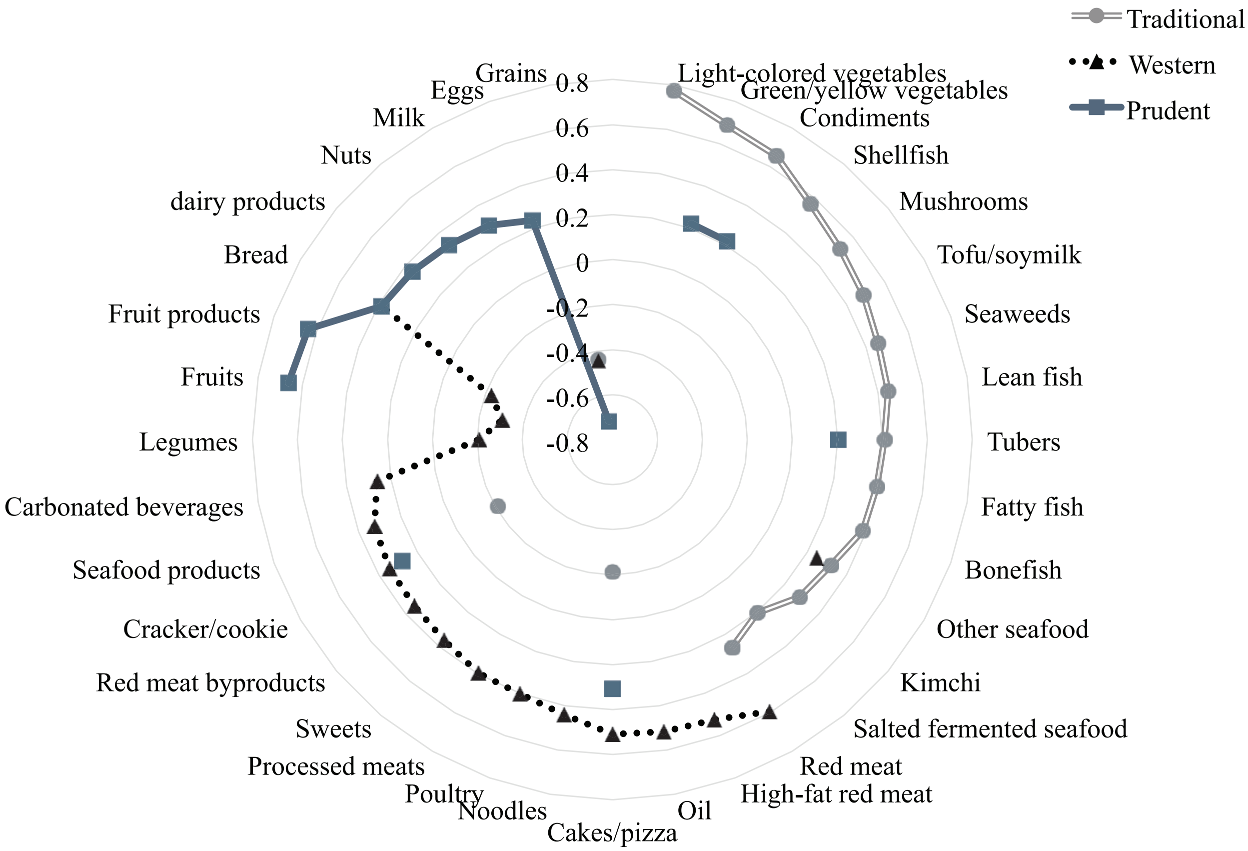

FIGURE 2. Factor loading diagram for the 3 major dietary patterns identified using a factor analysis. Factor loadings of <|0.20| were not listed for simplicity; the traditional, western, and prudent dietary patterns explained 11.5%, 7.8%, and 5.4% of the variance, respectively.

increase with factor scores ($P = 0.86$), whereas potassium was positively associated with the factor scores, resulting in decreased dietary sodium-to-potassium ratios across the quintiles (1.4 and 1.0 for the lowest and highest quintiles, respectively, $P < 0.001$). However, the ratios were elevated for both the ''traditional'' and ''western'' dietary patterns ($P < 0.001$). In the ''western'' dietary pattern, vitamin C, folate, fiber, and potassium intakes were negatively associated with the factor scores ($P < 0.001$). Carbohydrate intake decreased with the factor scores for all dietary patterns ($P < 0.001$).

Logistic regression analyses adjusting for potential confounders clearly showed that the dietary patterns were associated with the risk for MetS (Table 3). The highest quintile of the ''prudent'' dietary pattern was significantly associated with a reduced risk for of developing MetS (OR: 0.5, 95% CI: 0.36–0.68, P for trend <0.001) compared with the lowest quintile. This positive effect of the highest quintile of the ''prudent'' dietary pattern was also evident with regard to all of the diagnostic criteria for MetS (OR: 0.52, 95% CI: 0.41–0.65 for waist circumference; OR: 0.72, 95% CI: 0.59–0.87 for blood pressure; OR: 0.67, 95% CI: 0.52–0.85 for TG; OR: 0.64, 95% CI: 0.43–0.95 for fasting glucose; and OR: 0.53, 95% CI: 0.42–0.68 for HDL cholesterol). However, the ''traditional'' and ''western'' dietary patterns were not associated with the risk of developing MetS. A high intake of the ''traditional'' dietary pattern was only associated with an increased risk of abdominal obesity (OR: 1.27, 95% CI: 1.02–1.57).

DISCUSSION

Dietary pattern is a risk factor for MetS. This cross-sectional study examined various dietary patterns and their associations with MetS risk among Korean women. Three dietary patterns were identified. The ''prudent'' dietary pattern was negatively associated with the risk for MetS, whereas the ''traditional'' and ''western'' dietary patterns did not show any significant association with MetS.

The foods identified in the ''prudent'' dietary pattern (eg, fruits, dairy products, nuts, bread, and milk) might not be typical of either the traditional Korean or western diets. Since the 1970s, an increasing prevalence of typical features of the western diet (eg, reduced intakes of vegetables and grains but high intakes of fat, sugar, and red meat) has been observed in Korea.[13] However, a noble dietary pattern including a high intake of fruits and dairy products with low sugar consumption was also identified beginning in the late 1990s.[13,23] The prevalence of this new dietary pattern doubled between 1998–1999 and 2009–2010, whereas that of the western dietary pattern declined over the same period.[13] These recent changes in dietary patterns might reflect the public's concern for improved well-being. The association between degenerative chronic

TABLE 2. Nutrient Intake of the Study Participants According to the Quintile of Factor Scores for Each Dietary Pattern

	Quintile of Dietary Pattern Score				
	1st Quintile	3rd Quintile	5th Quintile	*t*	*P* for Trend*
Traditional					
Energy (kcal)	1615.4 ± 536.4	1720.8 ± 532.4	1762.6 ± 682.6	6.7	<0.001
Carbohydrate (g)	295.5 ± 94.9	300.0 ± 94.1	282.7 ± 112.5	−31.35	<0.001
Protein (g)	47.3 ± 18.0	60.1 ± 20.1	76.8 ± 33.2	63.76	<0.001
Lipid (g)	25.4 ± 16.7	30.5 ± 14.6	37.4 ± 19.1	22.23	<0.001
Dietary fiber (g)	13.8 ± 6.5	19.4 ± 7.5	28.0 ± 13.1	55.15	<0.001
Sodium (mg)	1972.3 ± 1078.9	2903.7 ± 1213.5	4199.8 ± 2012.1	47.41	<0.001
Potassium (mg)	1782.2 ± 826.9	2525.0 ± 962.6	3648.9 ± 1654.6	60.06	<0.001
Sodium/potassium	1.1 ± 0.4	1.2 ± 0.3	1.2 ± 0.3	4.58	<0.001
Western					
Energy (kcal)	1640.5 ± 548.1	1661.7 ± 526.0	1777.7 ± 686.3	5.85	<0.001
Carbohydrate (g)	307.4 ± 101.7	290.4 ± 92.9	275.0 ± 104.6	−46.28	<0.001
Protein (g)	53.8 ± 23.5	59.0 ± 22.4	69.9 ± 32.3	23.93	<0.001
Lipid (g)	21.7 ± 13.1	28.7 ± 12.8	44.1 ± 22.2	49.13	<0.001
Dietary fiber (g)	21.7 ± 11.7	19.5 ± 10.0	19.1 ± 9.7	−12.59	<0.001
Sodium (mg)	2732.0 ± 1610.3	2935.9 ± 1581.2	3314.4 ± 1763.4	8.51	<0.001
Potassium (mg)	2670.0 ± 1533.7	2518.2 ± 1222.0	2648.8 ± 1256.9	−5	<0.001
Sodium/potassium	1.1 ± 0.4	1.2 ± 0.3	1.3 ± 0.3	13.81	<0.001
Prudent					
Energy (kcal)	1528.9 ± 476.8	1717.9 ± 558.6	1780.5 ± 677.3	10.58	<0.001
Carbohydrate (g)	272.0 ± 77.6	294.3 ± 96.5	302.2 ± 120.5	−9.02	<0.001
Protein (g)	53.0 ± 24.7	62.3 ± 24.6	64.2 ± 27.5	4.09	<0.001
Lipid (g)	22.8 ± 16.1	31.6 ± 15.3	37.5 ± 19.0	21.73	<0.001
Dietary fiber (g)	16.2 ± 8.9	19.6 ± 9.0	23.8 ± 11.7	18.25	<0.001
Sodium (mg)	2723.6 ± 1671.6	3008.8 ± 1589.0	3100.7 ± 1613.8	−0.16	0.86
Potassium (mg)	1972.6 ± 1047.2	2573.5 ± 1105.9	3228.9 ± 1531.0	26.99	<0.001
Sodium/potassium	1.4 ± 0.4	1.2 ± 0.3	1.0 ± 0.3	−27.64	<0.001

Data signify mean ± standard deviation.
*Adjusted for age, marital status, education, household income, smoking status, alcohol consumption, regular exercise, and total energy.

diseases and the western diet has been well studied.[24] The western diet is known to be associated with elevated incidence of colorectal cancer,[25] atherosclerosis,[26] hypertension,[27] and MetS.[28,29] Compared to the western diet, the traditional Korean diet is highlighted as it consists of a variety of vegetables and is low in fat. However, problems with the traditional Korean diet, including high sodium and carbohydrate intakes, have also been reported.[16,18] National campaigns and information from the mass media with respect to maintaining a healthy diet may increase individuals' awareness of the issues with the western and Korean traditional diets as well as about the benefits of foods associated with the ''prudent'' dietary pattern. Thus, the prevalence of the ''prudent'' dietary pattern might increase; the present study showed that it achieved its primary goal of maintaining health and reducing disease risk. The ''prudent'' dietary pattern was significantly associated with a reduced risk for MetS. The protective effect of a high intake of the ''prudent'' dietary pattern was also evident with regard to each MetS criterion: abdominal obesity, hypertension, dyslipidemia, and fasting glucose level.

The protective effect of the foods in the ''prudent'' dietary pattern has been suggested previously. Diets high in fruits, vegetables, dairy, and nuts are negatively associated with the risk of MetS.[30,31] According to the ''Dietary Approaches to Stop Hypertension (DASH)'' trial, diets rich in fruits and fruit products as well as in vegetables, low-fat dairy, and nuts reduced DBP and SBP compared with a control diet by an average of 5.5 and 3.0 mm Hg, respectively.[32] Adherence to the DASH diet for 8 weeks also decreased weight, BMI, serum TG, and very-low-density lipoprotein cholesterol levels, whereas increased concentrations of plasma total antioxidant capacity and total glutathione were detected.[33] The precise mechanisms for the positive effects of these foods remain unclear.[22] However, the high consumption of fiber, vitamins, and minerals might lower the risk for high blood pressure and MetS. In addition, antioxidants and other undefined functional compounds may be involved in these mechanisms. The reduced intake of grains might also contribute to the protective effect of the ''prudent'' dietary pattern. Dietary carbohydrates possess differential effects on the risk of MetS depending on their source and type, and refined grains (including white rice) elevated the risk of MetS among Korean women compared with other carbohydrate sources.[34] In line with this research, reduced-grain carbohydrates in the ''prudent'' dietary pattern might decrease the risk for MetS.

The findings regarding dietary sodium and potassium as well as their decreased ratio support the beneficial effects of ''prudent'' dietary pattern against MetS. A high sodium intake has long been considered to be associated with increasing SBP and DBP as well as hypertension via the stiffening of the

TABLE 3. Odds Ratios and 95% Confidence Intervals for Metabolic Syndrome and Its Components According to Quintiles of Dietary Pattern Score

	Quintiles of Dietary Pattern Score			
	1st Quintile	3rd Quintile	5th Quintile	*P* for Trend*
Traditional				
Metabolic syndrome	1	1.06 (0.80–1.41)	1.09 (0.83–1.44)	0.44
Waist circumference (≥80 cm)	1	1.21 (0.97–1.51)	1.27 (1.02–1.57)	0.02
Blood pressure (≥130/85 mm Hg)	1	1.07 (0.89–1.29)	1.19 (0.99–1.43)	0.09
Triglycerides (≥150 mg/dL)	1	0.95 (0.75–1.19)	0.88 (0.70–1.11)	0.67
Fasting glucose (≥110 mg/dL)	1	0.90 (0.62–1.31)	1.07 (0.75–1.53)	0.23
HDL-cholesterol (<50 mg/dL)	1	0.99 (0.78–1.24)	1.13 (0.90–1.41)	0.24
Western				
Metabolic syndrome	1	0.90 (0.68–1.19)	0.98 (0.72–1.32)	0.95
Waist circumference (≥80 cm)	1	1.17 (0.95–1.45)	1.19 (0.94–1.49)	0.11
Blood pressure (≥130/85 mm Hg)	1	1.08 (0.90–1.30)	1.14 (0.94–1.39)	0.15
Triglycerides (≥150 mg/dL)	1	1.08 (0.86–1.35)	1.09 (0.85–1.40)	0.67
Fasting glucose (≥110 mg/dL)	1	1.09 (0.76–1.57)	1.17 (0.79–1.73)	0.48
HDL-cholesterol (<50 mg/dL)	1	0.97 (0.77–1.22)	1.00 (0.79–1.28)	0.75
Prudent				
Metabolic syndrome	1	0.84 (0.64–1.11)	0.50 (0.36–0.68)	<0.001
Waist circumference (≥80 cm)	1	0.72 (0.58–0.89)	0.52 (0.41–0.65)	<0.001
Blood pressure (≥130/85 mm Hg)	1	0.90 (0.75–1.08)	0.72 (0.59–0.87)	<0.01
Triglycerides (≥150 mg/dL)	1	0.93 (0.74–1.17)	0.67 (0.52–0.85)	<0.01
Fasting glucose (≥110 mg/dL)	1	0.82 (0.57–1.18)	0.64 (0.43–0.95)	0.08
HDL-cholesterol (<50 mg/dL)	1	0.77 (0.62–0.96)	0.53 (0.42–0.68)	<0.001

HDL = high-density lipoprotein.
* Adjusted for age, marital status, education, household income, smoking status, alcohol consumption, regular exercise, and total energy intake. *P* for trend was calculated using the median value of each quartile category as a continuous variable.

endothelial wall, a perturbation in resistance of the arteries and nitric oxide-releasing mechanisms.[35,36] Studies have also shown that a high sodium intake is associated with increased insulin resistance[37] and waist circumference in women[38]; furthermore, reduced dietary sodium improves lipid profiles.[39] A low intake of potassium is also a risk factor for elevated blood pressure and hypertension given contrasting effects of potassium and sodium in cellular mechanisms.[40] Therefore, reducing sodium, increasing potassium intake, or both are nutritional approaches recommended in preventing hypertension, cardiovascular disease, and MetS.

A growing number of studies suggest that the sodium-to-potassium ratio is strongly associated with blood pressure and cardiovascular disease mortality. A larger such ratio is associated with the risk of hypertension, and this effect is more significant than that of each nutrient alone.[41–43] Fruits and fruit products as well as nuts and dairy products (except for cheese), which largely comprise the ''prudent'' dietary pattern, have a low sodium-to-potassium ratio.[44] Furthermore, fruits and their products as well as nuts, dairy products, and milk are generally consumed without condiments (sources of added sodium) in Korean cuisine. Therefore, the decreased sodium-to-potassium ratio caused by the high intake of these foods might also contribute the positive effects of the ''prudent'' dietary pattern.

In the present study, neither the ''traditional'' nor the ''western'' dietary pattern was associated with MetS. As mentioned above, traditional Korean and western diets are generally accepted as having contrasting effects on the risk for MetS: The traditional diet might be protective, but the western diet might increase the risk for MetS.[28,29] However, recent studies have reported that neither dietary pattern showed associations with regard to MetS prevalence,[16,45] and the risk of the western diet was evident only among males.[1,24] Gender-specific effects, differential factor loadings, or both might have led to this discrepancy. In addition, because nutrients are consumed in combination and are highly interrelated, the interactions among nutrients might counter or modify the effect of the foods in the dietary patterns. For instance, the high consumption of condiments from the ''traditional'' dietary pattern increases sodium intake and the sodium-to-potassium ratio, thereby nullifying the benefits of the traditional pattern. This effect might lead to the lack of an association between that dietary pattern and MetS and show a negative effect with regard to abdominal obesity. Additional studies are required to verify this complex relationship in greater detail.

This study found an interesting association between dietary patterns and MetS risk among Korean women; however, certain limitations exist. Because this study was cross-sectional, temporality, and ambiguous causality between dietary intake and health status may exist. In addition, the participants volunteered for the health screening examination, which shows that these participants had concerns for a healthier lifestyle, which might have led to a lower prevalence of MetS in the present research compared with previous studies. Lastly, the 3 dietary patterns identified using PCA may not account for all dietary patterns in Korean because they explained approximately 24.7% of the total variation. Therefore, the associations identified in the present study should be interpreted with caution.

In summary, the present study identified 3 dietary patterns: ''traditional,'' ''western,'' and ''prudent.'' The ''prudent'' dietary pattern is characterized by high consumption of fruits, fruit products, dairy products, and nuts as well as low intake of grains; this pattern was negatively associated with the likelihood of having MetS among Korean women. However, the ''traditional'' and ''western'' dietary patterns did not significantly influence on the likelihood of developing MetS.

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