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Grains, Vegetables, and Fish Dietary Pattern Is Inversely Associated with the Risk of Metabolic Syndrome in South Korean Adults

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ABSTRACT

Background Dietary patterns are critical in the prevention and management of chronic diseases.

Objective We examined the association between habitual dietary patterns and the risk of metabolic syndrome in South Korean adults.

Design The study sample was composed of 9,850 Korean adults (aged ≥19 years) who participated in the second and third Korean National Health and Nutrition Examination Survey. Dietary data were assessed by the 24-hour recall method. Metabolic syndrome was defined by the joint of interim statement of the International Diabetes Federation and the American Heart Association/National Heart, Lung, and Blood Institute.

Results Four dietary patterns were derived using factor analysis (white rice and kimchi pattern; meat and alcohol pattern; high fat, sweets, and coffee pattern; and grains, vegetables, and fish pattern). Each dietary pattern explained 8.6%, 6.7%, 5.7%, and 5.7% of the variation in food intakes, respectively. The meat and alcohol pattern was adversely associated with hypertriglyceridemia (*P* for trend 0.01) and elevated blood pressure (*P* for trend 0.01) after adjustments for potential risk factors of metabolic syndrome such as age, sex, body mass index, energy intake, alcohol intake, smoking status, and physical activity. In contrast, the grains, vegetables, and fish pattern was associated with lower risk of hypertriglyceridemia (*P* for trend 0.0002) and was also inversely associated with the risk of metabolic syndrome after adjusting for risk factors of the metabolic syndrome (*P* for trend 0.02).

Conclusions Our study suggests that a specific Korean dietary pattern that includes grains, vegetables, and fish may be associated with lower risk of metabolic syndrome in South Korean adults.

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Metabolic syndrome is a cluster of metabolic risk factors associated with increased risks of cardiovascular disease and type 2 diabetes (1,2). The components of metabolic syndrome include abdominal obesity, hyperglycemia, hypertension, and dyslipidemia. According to the Korean National Health Nutrition and Examination Survey (KNHANES) III data, 33.1% of Korean men and 26.1% of Korean women aged 30 years or older had metabolic syndrome based on the National Cholesterol Education Program Adult Treatment Panel III criteria (3).

The role of diet in metabolic syndrome is not well understood. Among several factors that influence the syndrome, epidemiologic studies have found that dietary patterns are associated with the risk of metabolic syndrome or its components. In the Atherosclerosis Risk in Communities study, a Western dietary pattern characterized by high intakes of refined grains, meat, and fried foods was inversely associated with incident metabolic syndrome among US adults (4). A Mediterranean-style dietary pattern rich in whole grains, fruits, vegetables, nuts, and fish was associated with a reduced risk of metabolic syndrome traits (ie, central obesity, hypertriglyceridemia, lower high-density lipoprotein cholesterol, and hyperglycemia) and incidence of metabolic syndrome (5). Dietary patterns vary according to age, sex, ethnicity, and culture even though similarities in food patterns are

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evident in several countries (6). Furthermore, the prevalence of metabolic syndrome is rapidly increasing in Korean adults (3) and even in Korean children and adolescents (7). It may be related to the shift of diet from traditional diet to more Western style diet in Koreans (8,9). Thus, it is of particular interest to identify the relationships between Korean habitual dietary patterns and metabolic syndrome due to the ethnic homogeneity inherent to the Korean population (7).

A recent Korean study showed that a Western dietary pattern was significantly associated with the risk of central obesity compared to a traditional dietary pattern (7). However, this study failed to find an association between the dietary patterns tested and metabolic syndrome. Furthermore, this previous study examined the relationship among a specific age (between 10 and 19 years) group of 4,347 Korean adolescents, not in Korean adults.

In this study, we examined associations between dietary patterns derived by factor analysis and metabolic syndrome or its components using survey data from the largest, nationally representative, general South Korean population.

MATERIALS AND METHODS

Study Population

This study was based on a combination of the second and third KNHANES, which were cross-sectional and nationally representative surveys carried out by the Korea Centers for Disease Control and Prevention in 2001 and 2005, respectively. The surveys used a stratified multistage probability sampling design and the samples for each year were independent of each other. Thus, the combination of data from two surveys increased the number of samples and statistical power for the analysis. Our study selected 13,618 adults aged 19 years or more among the Koreans who participated in the nutrition survey, health examination study, and health behavior survey. Ninety-nine adults were excluded because of implausible energy intakes (<2,092 or ≥33,472 kJ/day). Among the remaining participants, 3,669 adults were further excluded because they had insufficient information on anthropometric measurements or components of the metabolic syndrome. A total of 9,850 South Korean adults (5,104 from 2001 and 4,746 from 2005) were ultimately eligible for the analysis. Informed written consent for participation was obtained from each individual. The study was approved by the Korea Centers for Disease Control and Prevention Institutional Review Board.

Dietary Assessment

Dietary intake was assessed by 1-day 24-hour recall method (7). To identify the dietary patterns, food items were categorized into 23 food groups based on common food groups classified in the Korean Nutrient Database (10) (see the Figure). Because the grain and grain product intakes of Koreans are very high, this group was divided into five subgroups: white rice, other grains, noodles and dumplings, flour and bread, and cereals and snacks (11). Among those, white rice is frequently consumed in Korean population. Vegetable group was divided into two subgroups: vegetables and kimchi. Kimchi (traditional fermented cabbage) was separated into a single vegetable group because it is commonly eaten as a traditional side dish in Korea. Coffee and alcohol were also separated from the beverage group (12,13) because the consumption of coffee and alcohol is very common with meals or after meals among Korean adults. Nutrient intakes were estimated from the food composition table of the Rural Development Administration and complemented with the nutrient database of the Korea Health Industry Development Institute (3).

Definition of Metabolic Syndrome

Waist circumference was measured as part of the health examination study. Waist circumference was measured to the nearest 0.1 cm at the narrowest point between the lowest rib and the uppermost lateral border of the right iliac crest. Blood samples to measure fasting plasma glucose (FPG), triglycerides (TG), and high-density lipoprotein (HDL) cholesterol were collected after an overnight fast. All biochemical analyses were carried out within 2 hours of blood sampling. FPG, HDL cholesterol, and TG levels were measured by enzymatic methods with an ADVIA 1650 autoanalyzer (Bayer, Pittsburgh, PA). Blood pressure was measured with a Baumanometer mercury sphygmomanometer (WA Baum, Copiague, NY) after the subjects had rested for 5 minutes in a sitting position. Systolic (SBP) and diastolic blood pressures (DBP) were measured at phase I and V Korotkoff sound (14), respectively. Three readings of SBP and DBP were recorded, and the average of the last two readings was used for data analysis.

Metabolic syndrome was defined according to the joint interim statement of the International Diabetes Federation and the American Heart Association/National Heart, Lung, and Blood Institute as ≥3 of any of the following (15). The International Diabetes Federation cutpoint for Asian population was used to define abdominal obesity (16): abdominal obesity (waist circumference >90 cm in men or >80 cm in women); hyperglycemia (FPG ≥100 mg/dL [5.5 mmol/L]) or current use of insulin or oral hypoglycemia medication); hypertriglyceridemia ≥150 mg/dL (1.7 mmol/L); low HDL cholesterol <40 mg/dL (1.04 mmol/L) in men or <50 mg/dL (1.30 mmol/L) in women; elevated blood pressure (SBP/DBP ≥130/85 mm Hg) or regular use of antihypertensive medication.

Covariates

Height and body weight were measured as part of the health examination study (17). Body mass index (BMI) was calculated from the measured heights and weights (kg/m^2) of the participants. The cutoff points for obesity (BMI ≥25) were defined by the International Obesity Task Force for Asian adults in the Asian and Pacific regions (18). Smoking status was classified as three groups: nonsmoker, former smoker (for at least 1 year), or current smoker (17). Physical activity was examined as regular exercise during one's spare time. Alcohol intake was assessed by questionnaires on the frequency of alcohol use during the month and was then converted to the frequency per week. Alcohol intake was used to categorize the participants into three groups: nondrinker, light or

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