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Dietary Patterns Are Associated with Body Mass Index in a Korean Population

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ABSTRACT

Changes in dietary habits may be associated with the increased prevalence of obesity in South Korea. Therefore, we aimed to identify major dietary patterns and to evaluate the association between these patterns and body mass index (calculated as kg/m^2) in a Korean population. Typical dietary intake was assessed using a food frequency questionnaire in a cross-sectional study of 1,118 subjects aged 30 to 70 years who underwent health screening examinations. Dietary patterns were derived from 39 predefined food groups using factor analysis. A body mass index >27.5 was used as an indicator of obesity. Logistic regression was used to evaluate the association between obesity and dietary patterns. Three dietary patterns (vegetable-seafood, meat-fat, and snack) were identified and seem to be closely associated with lifestyle factors, including physical activity, smoking, and alcohol consumption. In the multivariate logistic regression model, the meat-fat dietary pattern was positively associated with obesity (odds ratio for high tertile vs low tertile intake=2.78 [95% confidence interval: 1.43 to 5.42]; P for trend=0.008), whereas the vegetable-seafood and snack dietary patterns showed no association with obesity. Results suggest that diets high in meat, oil, and sugar may be associated with obesity status in Korean adults.

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Obesity is a major risk factor for many chronic diseases, including cardiovascular diseases, and is becoming a major health problem throughout the world (1). The prevalence of obesity has been increasing rapidly in parallel with rapid socioeconomic progress in South Korea (2). The proportion of Korean adults (older than 30 years) whose body mass index (BMI; calculated as kg/m^2) is >25 increased from 29.0% in 1998 to 33.1% in 2008 (3). It is known that Asian populations have a higher risk of type 2 diabetes and cardiovascular disease than the white population at the same BMI levels because they have proportionally more body fat and abdominal fat (2,4). Dietary factors are one of the most important environmental factors in the development of obesity (5,6). Numerous studies have been conducted to elucidate the role of diet in obesity etiology, but dietary factors contributing to weight gain and the development of obesity remain unclear and controversial, especially in relation to macronutrient composition (7-9). Traditional, single nutrient–based diets and disease analyses have many shortcomings (eg, biological interactions and colinearity among nutrients and the inability to detect small effects from single nutrients), and dietary pattern analysis has emerged as a comprehensive approach to disease prevention and treatment (10,11). Several previous epidemiological studies have reported that dietary patterns high in fruits, vegetables, and fiber, and low in high-fat dairy products, sweets, and processed meat might be associated with a reduced risk of obesity (12-15). However, evidence is still limited, and most studies have been conducted using Western populations.

Koreans have experienced a rapid nutritional transition in the past several decades, and the prevalence of obesity has increased (6). Therefore, we aimed to identify major dietary patterns among Koreans and to evaluate the association of these patterns with other lifestyle factors and BMI.

METHODS

Study Sample

The source population consisted of 1,131 subjects aged 30 to 70 years old who underwent health screening examinations at the Center for Cancer Prevention and Detection at the National Cancer Center in South Korea between March 2007 and December 2008. Subjects with missing food frequency questionnaire (FFQ) information (n=13) were excluded. After these exclusions, 1,118 subjects (men=403, women=715) were included in the final analysis. Written informed consent was obtained from all subjects and the study protocol was approved by the Institutional Review Board of the National Cancer Center (IRB protocol number NCCNCS-07-077).

Data Collection

All participants were asked to complete a self-administered questionnaire about their sociodemographic char-

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acteristics (eg, age, education, occupation, and household income), cigarette smoking habits, alcohol intake, and physical activity. Physical activity level was categorized into two groups (yes/no) and subjects who had any moderate or vigorous physical activity were considered to be physically active. At the time of screening, body weight was measured to the nearest 0.1 kg, with subjects wearing only light indoor clothes. Height was measured to the nearest 1 cm, with subjects standing without shoes on. BMI was calculated as the patients' weight divided by height (kg/m^2).

Usual dietary intake was assessed with a validated self-administered FFQ (16). The FFQ consisted of 103 food items containing 410 kinds of food that were commonly consumed by study subjects. All subjects were interviewed regarding the average frequency of intake and the portion size of specific foods they had consumed during the previous year. Nine categories of frequency (never or rarely, once a month, two or three times a month, once or twice a week, three or four times a week, five or six times a week, once a day, twice a day, and three times a day) and three portion sizes (small, medium, and large) were included in the FFQ. Food photographs showing the usual intake portions were used to help participants estimate and record the amounts of food consumed. The validation study of this FFQ reported that the deattenuated, age, sex, and energy intake adjusted correlation coefficients between the FFQ and the 12-day dietary records among Koreans ranged between 0.23 (vitamin A) and 0.64 (carbohydrate) (median for all nutrients was 0.39) and that this FFQ is an acceptable tool for assessing nutrient intake in this population (16).

Statistical Analyses

The 103 FFQ items were grouped into 39 food groups based on the nutrient profiles and culinary usage of each food item (17). Thirty-nine food groups were as follows: condiments, light-colored vegetables, green/yellow vegetables, shellfish, tubers, seaweeds, mushrooms, tofu/soymilk, lean fish, fruits, fatty fish, bonefish, other seafood, kimchi, pickled vegetables, salted fermented seafood, legumes, nuts, red meat, high-fat red meat, red meat byproducts, oil, poultry, noodles, processed meats, sweets, carbonated beverages, seafood products, bread, cakes/pizza, cracker/cookie, fruit products, cheese/ice cream, milk, eggs, yogurt, rice cakes, coffee/tea, and grains. We used principal component analysis to identify distinct dietary patterns using predefined food groups. The extraction of principle components was followed by orthogonal rotation to achieve a structure with independent factors and a greater potential for interpretability (17). We determined which factors to retain based on a minimum eigenvalue of 1.0, the Scree test, and the interpretability of the factors. Three factors were considered to be indicators of the major dietary patterns of the Korean population and were labeled based on our interpretation of the data, which were then used in further analysis. For each dietary pattern, a factor score was calculated for each individual by summing the intakes of the food groups weighted by their factor loadings.

Dietary pattern scores were divided into tertiles based on the factor scores for each dietary pattern. The distribution of socioeconomic and behavioral characteristics of the study population across tertiles of dietary pattern scores was calculated, and P values for trends were calculated from a generalized linear model for continuous variables and a Mantel-Haenszel χ^2 test for categorical variables. In the present study, a BMI $\geq$27.5 was used as an indicator of obesity (4). Logistic regression analysis was used to evaluate the association between obesity and the tertiles of each dietary factor score, taking the lowest tertile group as the reference group. Multivariate models were adjusted for age (continuous), sex (men/women), education (middle school or less, high school, and college or more), smoking status (nonsmoker, former smoker, and current smoker), alcohol consumption (nondrinker, former drinker, and current drinker), physical activity (yes/no), and total calorie intake (continuous). The median value of each tertile category of the dietary pattern score was used as a continuous variable to test for trends. SAS software (version 9.1.3 Service Pack 3, 2002-2003, SAS Institute, Cary, NC) was used to perform the calculations, and two-sided P values <0.05 were considered to be statistically significant.

RESULTS AND DISCUSSION

In the present study, we identified the three major dietary patterns based on a factor loading matrix. Pattern 1 was labeled vegetable-seafood because it was characterized by high factor loadings for vegetables, shellfish, seaweeds, soy foods, fish, and fruits. Pattern 2 was labeled meat-fat because it was characterized by high factor loadings of red meat, oil, poultry, noodles, and processed meats. Pattern 3 was labeled snack because it was characterized by higher intakes of bread, cakes, pizza, cracker, cookie, and fruit products. These patterns explained 18%, 9%, and 5% of the variation in food intake, respectively.

Characteristics according to the tertiles of factor scores for each dietary pattern are shown in Table 1. Each dietary pattern appeared to be closely associated with lifestyle factors when comparing the high-intake group with the low-intake group. Subjects in the high-intake group of the vegetable-seafood dietary pattern were older, were less likely to drink alcoholic beverages, and were more likely to be physically active. Subjects in the high-intake group of the meat-fat dietary pattern were younger, included more men, had higher BMIs, were better educated, were more likely to smoke cigarettes and drink alcoholic beverages, and were physically active. Subjects in the high-intake group of the snack dietary pattern tended to be younger, included more women, had lower BMIs, were better educated, and were less likely to smoke cigarettes and drink alcoholic beverages. The high-intake group of all three dietary patterns showed higher total energy intake and a higher percentage of energy intake from fat. A higher percentage of energy intake from protein was also observed among the high-intake groups of the vegetable-seafood and meat-fat dietary patterns.

Table 2 represents the odds ratio (OR) of the prevalence of obesity in relation to dietary pattern scores in both the crude and the multivariate-adjusted model. In the multivariate logistic regression model, the meat-fat pattern was positively associated with obesity (high tertile vs low tertile intake, OR=2.78; 95% confidence interval: 1.43 to