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Three distinct clustering patterns in metabolic syndrome abnormalities are differentially associated with dietary factors in Korean adults☆,☆☆

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ABSTRACT

Dietary factors are not consistently associated with metabolic syndrome abnormalities. In this cross-sectional study, we hypothesized that distinct clustering patterns exist in metabolic syndrome abnormalities and that those patterns are differentially associated with dietary factors. To test this hypothesis, we examined distinct clustering patterns of metabolic syndrome abnormalities and their association with dietary factors in Korean adults. A total of 141 subjects were recruited through the Family Medicine Division of the General Hospital in Seoul. Subjects who had complete data on waist circumference, blood pressure, blood glucose and lipid indicators, and no medication usage were included in this study. Dietary intake data were obtained by multiple 24-hour recalls (2-4 days) through on-site or telephone interviews. To identify clustering patterns of metabolic syndrome abnormalities, factor analysis was used for waist circumference, systolic and diastolic blood pressure, blood glucose, triglycerides, and high-density lipoprotein cholesterol. Three distinct clustering patterns were identified: (1) high blood pressure, (2) dyslipidemia, and (3) high blood glucose. The high blood pressure pattern was significantly associated with higher alcohol intake and lower carbohydrate intake. The dyslipidemia pattern was significantly associated with a diet of high glycemic index and glycemic load. The high blood glucose pattern was associated with lower carbohydrate intake. Metabolic syndrome abnormalities had 3 distinct clustering patterns independently associated with dietary factors. Diets with high glycemic index and glycemic load were strongly linked with the dyslipidemia pattern, and high alcohol intake was linked with the high blood pressure pattern in Korean adults.

Abbreviations: BMI, body mass index; DGI, dietary glycemic index; DGL, dietary glycemic load; GI, glycemic index; GL, glycemic load; HDL-cholesterol, high-density lipoprotein cholesterol.

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1. Introduction

Metabolic syndrome refers to a clustering of metabolic risk factors and is associated with increased risk of cardiovascular disease or type 2 diabetes [1]. The prevalence of metabolic syndrome is increasing worldwide, and an alarming increase has been observed in Asian countries [2]. The prevalence of metabolic syndrome in Korean adults increased from 24.9% in 1998 to 31.3% in 2007 [3], and these rates are comparable with the 34.2% prevalence reported in the United States [4].

The rapid increase in the prevalence of metabolic syndrome in Asian countries has been attributed to a Westernized diet and sedentary lifestyles. Several studies have examined the associations between a Western dietary pattern, characterized by high intake of animal-based foods and metabolic syndrome in Asian adult populations [5-8]. However, these studies have not shown a strong consistent association between Western dietary patterns and metabolic syndrome. Rather, some individual abnormalities of metabolic syndrome have shown a different association with diet. The Westernized pattern, including a high consumption of meat, was associated with an increased risk of glucose tolerance abnormalities in Korean [8] and Chinese adult populations [9], whereas the Westernized breakfast pattern or the Western dietary pattern was associated with a reduced risk of high blood pressure in the Japanese working population [5] and low high-density lipoprotein cholesterol (HDL-cholesterol) in Korean women [6], respectively. The role of diet in the development of metabolic syndrome remains unclear but may differentially influence individual risk factors of metabolic syndrome.

Recent studies have questioned whether a single metabolic risk factor underlies metabolic syndrome. Although the underlying pathophysiology is thought to be related to insulin resistance, several studies have modeled the structure of metabolic syndrome with various metabolic risk factors [10-12]. From these studies, some types of models, including 3- or 4-factor models, were proposed with good fit of data, and their major proposed factors included insulin resistance, obesity, dyslipidemia, or high blood pressure. However, studies on the association of these models with dietary factors have not been conducted.

To understand the role of diet in the development of metabolic syndrome, identifying the underlying risk factors of metabolic syndrome and exploring the association of dietary factors with these underlying risk factors is essential. In this cross-sectional study, we hypothesized that distinct clustering patterns exist in metabolic syndrome abnormalities and that those patterns are differentially associated with dietary factors. To test this hypothesis, we examined the distinct patterns of metabolic syndrome by clustering metabolic risk factors and the association between clustering patterns of metabolic syndrome abnormalities and dietary factors in the urban Korean adult population.

2. Methods and materials

2.1. Study subjects

Subjects in this study were recruited through the Health Examination Center or the Family Medicine Division of Seoul National University Hospital in the Seoul metropolitan area in South Korea, from September 2010 to December 2012. Individuals were considered eligible if they were age 20 years or older and were disease-free at the time of study enrollment. Among the 182 eligible subjects, subjects with incomplete data regarding general characteristics (n = 9) or biochemical variables (n = 17) were excluded. In addition, subjects who took medications to lower serum lipids, blood glucose, or blood pressure (n = 15) to avoid related disease treatment effects were excluded as they were considered to have made dietary changes. A total of 141 subjects (44 men and 97 women) were included in the present cross-sectional analyses. This study protocol was approved by the Institutional Review Board at the Seoul National University Hospital, and written informed consent was obtained from each subject.

Subjects were considered to have metabolic syndrome according to the National Cholesterol Education Program Adult Treatment Panel III criteria [1] with a modified waist circumference cutoff for Asian populations provided by the International Diabetes Federation [13]. Metabolic syndrome was defined as subjects presenting with 3 or more of the following components: (1) elevated waist circumference 90 cm or more in men and 80 cm or more in women, (2) elevated triglycerides 150 mg/dL or more, (3) reduced HDL-cholesterol less than 40 mg/dL in men and less than 50 mg/dL in women, (4) elevated blood glucose 100 mg/dL or more or a diagnosis of diabetes, and (5) elevated systolic blood pressure 130 mm Hg or more or diastolic blood pressure 85 mm Hg or more or a diagnosis of hypertension.

2.2. Assessment of dietary factors

Dietary intake data were obtained from multiple 24-hour recalls. All subjects in this study had 2 to 4 days of dietary data. Two days of dietary data were obtained through on-site interviews for all subjects, and an additional 1 to 2 days of dietary data were collected by telephone interviews with available subjects (average 2.8 days of dietary data: 55 subjects [39.0%] with 2 days, 58 subjects [41.1%] with 3 days, and 28 subjects [19.9%] with 4 days of dietary intake data). Trained dietitians interviewed the subjects when they visited the hospital after a multiple 3-step procedure [14] regarding their dietary intake during the previous 24-hour period. Briefly, in the first step, the subject quickly reported food items eaten during the previous day. Second, the subject was questioned in detail concerning the food reported in the first step. Lastly, a subject was asked about any forgotten food items. The telephone interview was conducted using the same protocol as the on-site interview within 2 weeks from the day of the on-site interview.

Mean daily energy and nutrient intake for each subject was calculated from the 2 to 4 days of dietary intake data using the Diet Evaluation System (Human Nutrition Lab, Seoul National University, Seoul, South Korea), which is a web-based computer program for dietary assessment [15]. Mean daily alcohol intake was estimated in grams per day for each subject based on their dietary intake data. We evaluated the specific alcohol content of each type of alcoholic beverage according to the Korean food composition table [16].