ELSEVIER

Moderating Effects of Interactions Between Dietary Intake and Socioeconomic Status on the Prevalence of Metabolic Syndrome

KYUNG-WON PAEK, PhD, AND KI-HONG CHUN, MD, PhD

PURPOSE: The purpose of this study is to examine how nutrients can affect the relationship between the development of metabolic syndrome (MS) and socioeconomic factors.
METHODS: This study was based on data obtained from the 2005 Korea National Health and Nutrition Examination Survey was conducted as a health survey of nationally representative samples of non-institutionalized Korean. The final sample was composed of 3146 people over 40 years of age.
RESULTS: The relationship between the prevalence of MS and socioeconomic factors was associated with the consumption of nutrients. The slope of the graphs increased sequentially from the 1st quintile to 5th quintile of nutrient consumption. However, the directions of the 4th and 5th quintile were reversed from that of the 1st, 2nd, and 3rd quintile in reference to the horizontal axis. That is, the 1st, 2nd, and 3rd quintiles indicate that higher household income was associated with lower prevalence of MS. However, the plots for the 4th and 5th quintile indicate that higher the household income was associated with higher the prevalence of MS. This tendency was shown in all the models that yielded statistically significant confirmation of moderating effects.
CONCLUSIONS: The association between the prevalence of MS and different socioeconomic status varies according to the level of nutrient consumption.
Ann Epidemiol 2011;21:877–883.

KEY WORDS: Moderator Effect, Dietary Intake, Socioeconomic Factor, Metabolic Syndrome.

INTRODUCTION

Metabolic syndrome (MS) occurs through the influence of genetic factors and many environmental factors, but the mechanism remains vague due to the wide range of genetic and environmental factors that can contribute (1, 2). The prevalence of MS in the population is influenced by psychosocial factors and health-related behaviors. These modifiers cause an increase in the prevalence of MS through synergy with individual predisposing factors.

According to research on the connection between socioeconomic factors and health outcomes, as the individual's socioeconomic level decreases, the risk of cardiovascular disease (CVD) and abdominal obesity increases (3). Moreover, research has demonstrated that a lower education level is correlated with a lower carotid resilience (4). Changes such as the increased risk of CVD, abdominal obesity, and carotid atherosclerosis can be explained by biological factors such as hyperglycemia, elevated serum triglycerides, low serum high density lipoprotein (HDL) cholesterol, and hypertension. These components are standard elements of the diagnosis of MS. Thus, MS, a significant biological risk factor for CVD, is closely related to socioeconomic inequality (5).

A close relationship exists between nutrition and the risk of MS/CVD. Consumption of fat, especially saturated fatty acids, increases the risk of type 2 diabetes by raising blood sugar levels even during periods of fasting. It also increases the risk of CVD by elevating blood lipid concentrations (6). However, consumption of protein, such as in high-protein diets, is effective for losing weight (7–12). It has even been reported that high-protein/low-carbohydrate diets are more effective than low-fat/high-carbohydrate diets for losing weight quickly (13, 14). This is because high-protein diets raise satiety, thereby decreasing total energy intake (15). High-protein diets also improve blood lipid concentrations and have a role in reducing blood pressure (16–18). A thermal effect of high-protein diets distinguishes them from high-carbohydrate or high-fat diets, as the body does have a significant capacity to store protein and instead directly metabolizes excess protein. At the other end of the nutrition scale, a high-glycemic and refined carbohydrate diet decreases satiety and increases energy consumption at the same time (19).

Although previous studies showed that socioeconomic factors affected the prevalence of MS were limited to simply verifying common risk factors such as demographic characteristics, socioeconomic status, health-related behaviors, and nutrition, the interactions among these risk factors and their relationship to the prevalence of MS was largely neglected. We hypothesize that when these interactions are present, associations between these risk factors and MS

From the Division of Social Welfare, Baekseok University (K.-W.P.); and Department of Preventive Medicine and Public Health, Ajou University School of Medicine (K.-H.C.).
Address correspondence to: Ki-Hong Chun, MD, PhD, Department of Preventive Medicine and Public Health, Ajou University School of Medicine, San 5, Wonchon-dong, Yeongtong-gu, Suwon, 443-721, Korea. Tel.: +82-31-219-5082; Fax: +82-31-219-5084. E-mail: ajoujkh@ajou.ac.kr.
Received March 14, 2011. Accepted July 19, 2011. Published online September 1, 2011.

360 Park Avenue South, New York, NY 10010
1047-2797/$ - see front matter
doi:10.1016/j.annepidem.2011.07.006

AEP Vol. 21, No. 12
December 2011: 877–883

Selected Abbreviations and Acronyms

MS = metabolic syndrome
KNHANES = Korea National Health and Nutrition Examination Survey
CVD = cardiovascular disease
HDL = high density lipoprotein
LDL = low density lipoprotein

will modify the influences of these risk factors. Because of the possible interactions among variables, it is necessary to analyze whether the association between socioeconomic factors and MS is similar for different degrees of the other risk factors.

The purpose of this study was to examine how nutrients can affect the relationship between the development of MS and socioeconomic factors. To achieve this, we analyzed whether nutrient factors have a moderating effect on the relationship between the prevalence of MS and educational/income levels.

METHODS

Study Subjects

This study was based on data obtained from the Third Korea National Health and Nutrition Examination Survey (KNHANES III). KNHANES III was conducted as a cross-sectional health survey of nationally representative samples of non-institutionalized Korean civilians by the Korean Ministry of Health and Welfare in 2005. The survey applied a stratified multistage probability sampling design to the South Korean population using a two-stage stratified systematic sampling method. Six hundred sampling units (including 13,345 households) were randomly selected for the health interview survey, and 200 sampling units were randomly selected from among the 600 sampling units for the health-related behaviors survey, a health examination, and nutrition surveys. Clusters of households were selected from each sampling unit and included an average of 20–26 households. The Health Interview Survey sample consisted of 42,780 people, who came from 13,345 households of in the 600 sampling units. The final sample was composed of 3146 people over 40 years old and who had completed the necessary health examination, health-related behaviors survey, and nutrition survey. Subjects who were diagnosed with chronic diseases such as diabetes, CVD, and cancer were excluded due to possible changes in health-related habits.

Definition of Measures

Using the guidelines presented in the ATP III report, participants having three or more of the following criteria were defined as having MS: abdominal obesity (waist circumference >90 cm in men and >80 cm in women [Asia Pacific Criteria]), hypertriglyceridemia ($\geq$150 mg dL-1), low HDL-cholesterol (<40 mg dL-1 in men and <50 mg dL-1 in women), high blood pressure ($\geq$130/85 mm Hg), and high fasting glucose ($\geq$110 mg dL-1).

Risk factors of MS identified in previous studies were used and divided into five categories: genetic–demographic factors, socioeconomic factors, psychosocial factors, health-related behavior factors, and dietary factors. Among these factors, the genetic–demographic factors were the predisposing factors inherent to individuals that cannot be modified, and the remaining risk factors were modifying factors that could be modified by external influences. The genetic–demographic factors were sex, age, and family history. Among these factors, family history was measured by the presence of hypertension, CVD, or diabetes in parents, siblings, and paternal and maternal grandmothers. If a relative had at least one of these conditions, family history was considered to exist for that disorder. Psychosocial factors were based on stress levels and concern for health, and the study sample was divided into groups (stress level: severe, moderate, never; concern for health: always, sometimes, never) based on the levels of these factors.

Education and household income levels were used to measure socioeconomic status. The number of years of education and household income were recorded as actual numbers and treated as continuous variables. Also, if necessary, they were analyzed and categorized into three divisions (education: $\leq$6 years, 7–12 years, $\geq$12 years; monthly household income: $\leq$\$1000, \$1001–\$3000, $\geq$\$3001). For health-related behaviors, factors such as smoking, alcohol abuse, exercise, physical activity, and hours of sleep were determined. For smoking status, "yes" referred to subjects who were currently smoking; "no" indicated individuals who had not smoked before or were ex-smokers. For exercise, we focused on the daily rate of exercise within the last few days. A "yes" in exercise meant doing exercises at least once in a week, and "no" included people who did not exercise at least once a week. Hours of sleep were recorded with actual numbers and analyzed by categorizing the results into three levels: less than or equal to 5 hours, 6–7 hours, and greater than or equal to 8 hours. The amount of activity in a typical day was categorized according to three levels: heavy, moderate, minor.

Anthropometric and Biochemical Indices

Trained examiners took anthropometric measurements of individuals wearing light clothing or underwear but no shoes. A portable stadiometer was used to measure height to the nearest 0.1 cm, and a calibrated balance beam scale was used in the upright position to measure weight to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight divided by height squared (kg/cm^2). Waist circumference was measured at the end of normal expiration to the nearest