Dietary factors related to hypertension risk in Korean adults-data from the Korean national health and nutrition examination survey III

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Abstract
Regional differences between large cities and rural areas are observed in the Korean National Health and Nutrition Examination Survey (KNHANES). This present study was conducted to evaluate the effect of dietary factors on hypertension risk in Korean populations, especially residents of the Chungcheong province which was not in metropolitan area, using KNHANES III. A total of 544 adults aged ≥19 years were placed into either the normotensive or the hypertensive group. Subject characteristics, BMI, blood pressure, and nutrient intakes were compared between the two groups using a chi-square test and t-test. We estimated odds ratios (ORs) using multiple logistic regression, adjusted for energy intake and selected covariates. There were significant differences in age, education level, alcohol consumption, and BMI between the normotensive and hypertensive groups. We found decreased ORs for the medium versus lowest tertile of calcium intake (multivariate OR = 0.43, 95% CI: 0.21-0.88), for the highest versus lowest tertile of calcium intake (multivariate OR = 0.43, 95% CI: 0.20-0.90) with significant trends in risk (P = 0.040), and for the medium versus lowest tertile of potassium intake (multivariate OR = 0.43, 95% CI: 0.20-0.89). Subjects with the highest sodium/calcium ratio had a 2.10-fold greater risk of hypertension compared to the subject with the lowest, with significant trends in risk (P = 0.002). Adequate calcium and potassium intake should be encouraged and regional differences should be considered in making a healthy plan for hypertension management.

Key Words: Hypertension, sodium, potassium, calcium, Korean National Health and Nutrition Examination Survey

Introduction
Hypertension presents a significant public health burden due to increased cardiovascular disease, mortality, disability, and economic cost. It is becoming an increasingly common health problem worldwide because of increasing longevity and a higher prevalence of contributing factors, such as obesity, physical inactivity and an unhealthy diet [1,2]. Worldwide hypertension is estimated to cause 7.1 million premature deaths and 4.5% of the disease burden [3]. Mortality rate per 100,000 persons due to high blood pressure varies from country to country. It is reported that the mortality rate due to hypertension was 15.9 per 100,000 persons in the United States in 2000 and 4.5 in 2002 in Japan. The mortality rate due to high blood pressure in Korea increased slightly, from 10.6 to 11.0 per 100,000 persons, between 2002 and 2007 [4].

Currently, the prevalences of hypertension in many developing countries, particularly in urban areas, are as high as those seen in developed countries [5-8]. In contrast to previous studies in other developing countries, the prevalence of hypertension in Korean adults (≥30 yrs) decreased from 30% to 24.9% between 1998 and 2007 [9] and the trends of regional differences in prevalence of hypertension were observed in opposite direction; the prevalence of hypertension were 26.2% in metropolitan areas while 34.3% in small towns [10]. Indeed, hypertension rate in Chungcheong province, which is not in metropolitan area, increased from 22.1% in 2001 to 28.0% in 2005, while normotensive rate decreased from 47.7% in 2001 to 41.0% in 2005 [10]. Local traditional and seasonal variations in foods intake are common in Korea, due to environmental differences such as regional variations in climate and geographical characteristics. The prevalence of hypertension in rural areas may differ from metropolitan areas based on these variations. Based on the Korean Health and Nutrition Examination Survey (KNHANES) III report [10], healthy lifestyles, including healthy diet patterns, were observed more in urban areas than in rural areas. Sodium intake was relatively higher in rural areas than in urban areas (4,834 mg vs. 4,571 mg). Community nutritionists should consider these regional variations and characteristics when they plan hypertension management program for the community residents.

The target of this research area, Chungcheong province, is located in central area of South Korea, and includes the inland area, Chungcheongbuk-do and the west coast border, Chungcheongnam-do.
The characteristics of local food culture in Chungcheong province is a mix between that of the inland and the west coast area. Particularly, people in this province have traditionally used a wide variety of salted foods, including abundant sea foods, which leads to high sodium intake and might eventually relate to high blood pressure and a risk of hypertension. Therefore, this study was executed to reveal the relationship of blood pressure to intakes of sodium, potassium, and calcium and to the sodium/calcium ratio and the sodium/potassium ratio in residents of Chungcheong province using KNHANES III data. It is hoped that this study can contribute to the creation of a guideline for the prevention and treatment of hypertension attuned to regional differences.

Subjects and Methods

Study population

The data analyzed in the present study were obtained from KNHANES III, conducted by the Ministry for Health, Welfare and Family Affairs in Korea. KNHANES has been conducted every three years since 1998, and the raw data are released to the public for scientific use. KNHANES consists of a Health Interview Survey, a Health Behavior Survey, a Health Examination Survey, and a Nutrition Survey. The surveys are given to stratified multistage samples of the South Korean population from multiple geographic areas, ages, and sexes. Trained interviewers administered structured questionnaires in participants’ homes to obtain information on sociodemographic characteristics, lifestyle, health, nutritional status, and the use of dietary supplements. In total, 33,848 people responded to KNHANES III, but only 7,597 people participated in the Health Behavior Survey, the Health Examination Survey, and the Nutrition Survey. From this group, 544 adults aged 19 years or older in Chungcheong province were selected for the present study. Data from the Health Examination Survey were used to obtain information on smoking, alcohol intake, and physical activity. Intakes of energy, sodium, potassium, and calcium were obtained from the Nutrition Survey, while data on height, weight, body mass index (BMI), blood pressure [systolic blood pressure (SBP) and diastolic blood pressure (DBP)], and pulse rate were obtained from the Health Examination Survey.

Ascertainment of hypertension

Hypertension was identified in individuals who met at least 1 of 4 criteria from the KNHANES III data: self-reports of physician diagnosis of hypertension; self-reports of antihypertensive drug intake; SBP ≥ 140 mmHg; DBP ≥ 90 mmHg. Blood pressure measurements were taken three times in a stable state, and the average SBP and DBP measurements were used to determine hypertension.

Statistical analysis

As part of the standard KNHANES data collection protocol, 24-hour dietary recalls were elicited, and here were used to estimate intakes of energy, sodium, potassium, and calcium. General characteristics, nutrient intakes, and anthropometric data were compared across the normotensive and hypertensive group. In addition, sodium, potassium, and calcium intakes were calculated per 1,000 kcal of energy. Income groups were categorized according to average monthly income in 2005 in relation to the minimum cost of living. Low income was defined as an average monthly income that was, at most, 1.2 times the minimum cost of living; middle income was defined as an average monthly income that was 1.2 to 2.5 times the minimum cost of living; and high income was defined as an average monthly income that was more than 2.5 times the minimum cost of living. Subjects were also categorized based on their educational level, defined as middle school or less (9 years and below), high school (10-12 years), and college or more (13 years or more). Present smoking status was used to classify each subject as a “current smoker”, “ex-smoker”, or “non-smoker”. Metabolic Equivalent of Task values (METs) were used to classify physical activity as low, middle, or high. METs are multiples of the resting metabolic rates and were calculated using the short form (version 2.0, April 2004) of the International Physical Activity Questionnaire; that is, low activity was 600 ≥ MET-minutes/week, middle activity was 600 ≤ MET-minutes/week < 3,000, and high activity was 3,000 ≤ MET-minutes/week. Responses for the question regarding following the instructions of eating a healthy diet (reducing salt consumption) were classified as “take action”, “try to practice”, and “do not practice”.

All analyses used survey weighting to account for the complex survey design that consisted of multistage, stratified, and clustered sampling. Probability sampling weights were used with strata and primary sampling units in the data analysis. Subject characteristics were compared between the normotensive and the hypertensive groups using a chi-square test. Mean values and standard errors for nutrient intakes were calculated and t-test was used to verify significance for each normotensive and hypertensive group. To determine the impact of risk factors on high blood pressure, weight, waist circumference, sodium, potassium, and calcium intake were each classified by tertile. We estimated odds ratios (ORs) using multiple logistic regression, adjusted for age (19-29, 30-49, 50-64, ≥ 65), sex, education (middle school or lower, high school, college or higher), BMI, alcohol drinking (drinker, non-drinker), and energy intake. All statistical analyses were performed using SURVEY procedure of SAS software (version 9.12, Cary, NC, USA) and DESCRIPT procedure of SUDDAN software (release 9.0, Research Triangle Institute, Research Triangle Park, NC, USA) applying a significance level of P < 0.05.