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Association between Fruit and Vegetable Consumption and Risk of Hypertension in Middle-Aged and Older Korean Adults

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ABSTRACT

Background High fruit and vegetable (F/V) intake may be beneficial for hypertension prevention. However, a prospective association has not been investigated in a Korean population, and differences exist between typical diets in Korea and those of Western populations.

Objective The aim of this prospective study was to investigate the association between F/V intake and risk of incident hypertension in middle-aged and older Korean adults using the data from the Korean Genome and Epidemiology Study (KoGES).

Design The KoGES is a large community-based cohort study of Korean adults aged 40 to 69 years, which began in May 2001. Questionnaires on demographic information and lifestyle factors were completed at baseline. Anthropometrics and biochemical measurements were conducted biennially. Fruit and vegetable consumption was assessed with a semiquantitative food frequency questionnaire. Hypertension was defined as a systolic blood pressure≥140 mm Hg or diastolic blood pressure ≥90 mm Hg.

Participants and setting A total of 4,257 participants (2,085 men, 2,172 women) without hypertension at baseline were evaluated.

Main outcome measures The primary outcome was incident hypertension.

Statistical analysis performed Multivariate Cox proportional hazard models were used to examine hazard ratios (HRs) and 95% CIs for incident hypertension according to F/V consumption.

Results During the 8-year follow-up, 1,158 participants (606 men and 552 women) developed hypertension. Among men, frequent fruit consumers (≥4 servings/day) had a 56% lower risk of incident hypertension than did infrequent consumers (<1 serving/day) (HR=0.44, 95% CI=0.32 to 0.60, *P* for trend <0.0001). Among women, frequent fruit consumers had a 67% lower risk of incident hypertension than did infrequent consumers (HR=0.33, 95% CI=0.24 to 0.45, *P* for trend <0.0001), after adjustment for potential confounders. However, there was no association between vegetable consumption and risk of incident hypertension in either men or women.

Conclusion A higher intake of fruit was prospectively associated with a lower risk of incident hypertension in middle-aged and older Korean adults, regardless of sex.
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HYPERTENSION IS A MAJOR PUBLIC HEALTH ISSUE and a major risk factor for cardiovascular disease, kidney disease, and other morbidities in many populations.[1-3] According to the Korean National Health and Examination Survey VI, the prevalence of hypertension in Korean adults aged 30 or over was 35% for men and 29% for women.[4]

Among many risk factors, diet plays an important role in the development of hypertension. The Dietary Approaches to Stop Hypertension diet (characterized by a high intake of fruits, vegetables, and low-fat dairy foods and a reduced intake of sodium, total fat, saturated fat, and cholesterol) or a Mediterranean-style diet (characterized by a high intake of fruits, vegetables, nuts, and whole grains) are known to be inversely associated with hypertension.[5-9] Thus, high intake of fruits and vegetables (F/V), major components of both the Dietary Approaches to Stop Hypertension diet and Mediterranean-style diets, may have a beneficial effect on the risk of developing hypertension. In a 6-month intervention trial of healthy participants aged 25 to 64 years, encouraging participants to increase their fruit and vegetable consumption to at least five servings daily reduced systolic blood pressure by 4 mm Hg and diastolic blood pressure by 1.5 mm Hg compared with a control group.[10] A prospective cohort study with a 6-year follow-up showed that high consumption of F/V (≥5 servings/day), in participants with low olive oil consumption, was associated with a 44% lower risk of developing hypertension in a Spanish population aged 20 to 95 years.[11]

Fruits and vegetables grown and available in Korea differ from those grown and available in the United States or

Europe because of differing climate conditions. Therefore, Koreans consume many kinds of F/V that may be different from those consumed by Western populations. Cooking methods may differ as well. For example, Koreans boil vegetables or herbs and then add various mixed seasonings. Also, they eat various fermented vegetables. Vegetable intake in the older Korean population is primarily from Kimchi—fermented, salted vegetables that contain high amounts of sodium.[12] Different types of foods or different cooking methods may affect health outcomes including blood pressure. However, the relationship between F/V consumption and the risk of incident hypertension in a Korean population has not been investigated.

Therefore, this study examined the association between F/V intake and the risk of developing hypertension in middle-aged and older Korean adults using data from the Korean Genome and Epidemiology Study (KoGES), which is a large community-based cohort study.

METHODS

Study Population

The KoGES is a prospective, community-based cohort study that began in 2001.[13] The primary goals of the KoGES were to elucidate the interaction between lifestyle factors and genetic risk factors associated with chronic disease, such as diabetes mellitus and hypertension, in Korean adults.

The cohort included 10,030 Korean adults aged 40 to 69 years who lived in Ansan and Ansung and who were enrolled at baseline between 2001 and 2002. Follow-up examinations were performed every 2 years over an 8-year period (2009 to 2010). All participants completed questionnaires on demographic information, lifestyle, medical history, and health conditions at baseline, and anthropometric measurements and biochemical tests were conducted biennially.

Of these 10,030 participants, 3,271 participants who had hypertension at baseline, 707 participants who refused to participate in the follow-up surveys, 111 participants who had cardiovascular disease or cancer, 207 participants who had implausible energy intake (<500 kcal/day or >6,000 kcal/day),[14,15] and 1,477 participants who did not complete the food frequency questionnaire (FFQ) were excluded from the current study. Finally, 4,257 participants (2,085 men and 2,172 women) participated in this study.

The study protocol was approved by the Institutional Review Boards of the Korea Centers for Disease Control and Prevention and Kyung Hee University (KHSIRB-16-022), and written informed consent was obtained from all participants.

Dietary Assessment

Dietary intake was assessed using a validated 103-item semiquantitative FFQ[16] at baseline (2001 to 2002) and a second follow-up survey (2005 to 2006). To assess the validity of this FFQ, 12 days of diet records for 1 year were collected from 124 participants and nutrient intakes from the diet records were compared with those from FFQ. The adjusted correlation coefficients between the FFQ and the 12 days of diet records in Korean population ranged between 0.23 and 0.64 (median for all nutrients 0.39).[16] In the FFQs, participants were asked how often and how much they consumed of each food at a time, on average, during the past year. The answer for frequency was classified into nine categories: never or seldom, once a month, 2 to 3 times/mo, 1 to 2 times/wk, 3 to 4 times/wk, 5 to 6 times/wk, once/day, 2 times/day, 3 times or more/day. The answer for portion size had three categories; $^1/_2$ serving, 1 serving (standard), ≥2 servings. One serving of fruit or vegetable was equal to 100 g and 70 g, respectively. For the analysis, individual food consumption was converted to weekly frequencies. These frequencies were then multiplied by the reported portion sizes for each food. Finally, F/V consumption was classified into four groups (never or rarely, 1 to <2 servings/day, 2 to <4 servings/day, ≥4 servings/day). Consumption of 12 types of fruits and 20 types of vegetables were evaluated. Specific fruits were combined into subgroups of citrus fruits (tangerines, oranges); noncitrus fruits (persimmon or dried persimmon, watermelon, strawberry, grape, pear, oriental melon/melon, peach or prune, apple, banana); and carotene-rich fruits (tangerines, oranges, watermelon, persimmon, tomato). Also, specific vegetables were combined into subgroups of green leafy vegetables (spinach, perilla leaf, chive or water parsley, and red pepper leaf); cruciferous vegetables (Korean cabbage, cabbage, radish, lettuce, and broccoli); carotene-rich vegetables (carrots, spinach, and pumpkin); other vegetables (bean sprouts, fern or sweet potato stems, cucumber, onion, green chili, zucchini, deodeok or balloon flower); and mushrooms. Likewise, intake of individual foods was expressed as food consumption per week and the total intake of each food was summed. Seven meats, including pork, beef, chicken, and processed meat (eg, ham, sausage); five grains, including white rice, barley, and multigrains; and dairy foods including milk, yogurt, and cheese were evaluated. Nutrient intake was measured using a food composition table developed by the Rural Development and Administration.[17]

Definition of Hypertension

Blood pressure was measured after participants rested in a seated position for at least 5 minutes by trained technicians using mercury sphygmomanometers (Baumanometer Standby; W.A. Baum Co Inc). Two readings of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded, and the average of two readings was used for analysis. Hypertension was defined as SBP≥140 mm Hg or DBP≥90 mm Hg or the use of antihypertensive medication at the baseline examination. SBP and DBP were calculated at Korotkoff phase I and Korotkoff phase V, respectively.[18]

Covariates

Demographic factors, socioeconomic status, and lifestyle factors of participants were obtained by trained interviewers using questionnaires. Educational level was categorized into three groups: ≤6 years (elementary school graduates), 7 to ≤12 years (middle school graduates or high school graduates), and >12 years (college graduate or more). Monthly household income was categorized into four groups: <1 million Korean Won (approximately <850 US$ in 2016), 1 to <2 million Korean Won (approximately 850 to <1,700 US$), 2 to <3 million Korean Won (approximately 1,700 to <2,500 US$), and ≥3 million Korean Won (approximately ≥2,500 US$). Smoking status was classified into three groups: lifetime nonsmoker, former smoker, or current smoker. Alcohol consumption was classified into three groups: lifetime