



## Association of alcohol consumption pattern with risk of hypertension in Korean adults based on the 2010–2012 KNHANES



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### ABSTRACT

We examined the association between alcohol-drinking pattern and hypertension in Korean adults. This cross-sectional study included 15,052 participants (7054 men and 7998 women) who were included in the 2010–2012 Korean National Health and Nutrition Examination Survey (KNHANES). We categorized alcohol-drinking patterns into three groups based on the Alcohol Use Disorders Identification Test (AUDIT) score: low-risk (score: 0–7), intermediate-risk (score: 8–14), and high-risk (score:  $\geq 15$ ). Hypertension was defined as systolic blood pressure  $\geq 140$  mm Hg, diastolic blood pressure  $\geq 90$  mm Hg, or current use of anti-hypertensive medications. In the study population, 25.2% of men and 4.6% of women were high-risk drinkers. Hypertension prevalence was 30.8% in men and 20.6% in women. Of the total population, 13.8% of men and 13.6% of women were using anti-hypertensive drugs. Age-adjusted hypertension prevalence was 30.8, 40.9, and 45.3% in men, and 24.6, 27.0, and 32.3% in women in the low-, intermediate-, and high-risk drinking group, respectively. Compared to the low-risk drinking group, the prevalence ratio (95% confidence interval [CI]) for hypertension was 1.664 (1.4331.933) and 2.070 (1.772–2.418) for men and 1.012 (0.774–1.323) and 1.650 (1.080–2.522) for women in the intermediate- and high-risk drinking group, respectively, after adjusting for age and other confounding factors. In conclusion, our study suggests high-risk drinking appears to be associated with a higher risk of hypertension in men and women.

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### Introduction

Hypertension is a worldwide disease associated with a large public health burden (Min et al., 2014). According to data collected from 2007 to 2010, the American Heart Association estimated that 33.0% of United States (US) adults older than 20 years were hypertensive. These up-to-date statistics indicate that 78 million US adults have hypertension (Go et al., 2013). Hypertension has been identified as a major risk factor for cardiovascular disease and mortality. The high prevalence of hypertension worldwide has resulted in the current pandemic of cardiovascular disease (Kearney

et al., 2005). In 2010, the Global Burden of Disease Study found that high blood pressure was the leading single risk factor for worldwide economic burden of disease (Bromfield & Muntner, 2013).

Lifestyle factors play an important role in development of hypertension, and population-based prevention techniques and control of elevated blood pressure have been emphasized (Hedner, Kjeldsen, & Narkiewicz, 2012). It has long been recognized that alcohol consumption is positively related to hypertension (Moreira, Fuchs, Moraes, Bredemeier, & Duncan, 1998). Previous studies have reported a J-shaped (or threshold-based) association between alcohol and hypertension or a linear dose–response relationship (Gordon & Kannel, 1983). Some authors have suggested a J-shaped curve with a consumption threshold of three drinks a day (30 g ethanol) (Pajak et al., 2013). However, no agreement has been reached regarding this matter. Alcohol-related problems have significantly increased each year in Korea. The total cost for alcohol-related diseases in Korea, including health care expenditures, has increased remarkably from 3.2 trillion Korean won in 2005 to 6.1

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trillion Korean won in 2009 (1 USD = 1000 Korean won) (Corporation N.H.I, 2005, 2007, 2009). Drinking alcohol is considered a necessary evil for making and maintaining social relationships, as it is very common to drink alcohol in Korea. The powerful social influence of alcohol certainly contributes to the continuous growth of high-risk drinking in Korea (S. Chun, 2012).

The Alcohol Use Disorders Identification Test (AUDIT) questionnaire was developed to screen for excessive alcohol-drinking. The AUDIT includes three domains: hazardous alcohol use (frequency of drinking, typical quantity, and frequency of heavy drinking), dependence symptoms (impaired control over drinking, increased salience of drinking, and morning drinking), and harmful alcohol use (guilt after drinking, blackouts, alcohol-related injuries, and concern from others in regard to drinking) (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Skipsey, Burlison, & Kranzler, 1997). High-risk drinkers can be identified using the AUDIT questionnaire, which assesses comprehensive concepts of alcohol abuse. In particular, the AUDIT questionnaire is a reliable test to measure high-risk drinking, suggesting its appropriateness for our study (Skipsey et al., 1997).

Although several studies have reported that alcohol intake is associated with blood pressure elevation in a dose- or frequency-related manner, there is a lack of research showing the relation between alcohol-drinking pattern and hypertension (Pajak et al., 2013). Therefore, we investigated the relationship of alcohol-drinking pattern using the AUDIT score and correlating it with the prevalence of hypertension in Korean adults.

## Methods

### Study population

This study was based on data obtained from the 2010–2012 Korean National Health Examination and Nutrition Survey (KNHANES), which is a nationally representative survey conducted by the Korean Ministry of Health and Welfare. The sampling units were households that were selected through a stratified, multi-stage, probability-sampling design according to geographic area, sex, and age group based on household registries. Sampling weight indicating the probability of being sampled was assigned to each participant. Therefore, these results appropriately represent the entire Korean population. Study participants were asked to complete four parts of a questionnaire that was composed of a health interview survey, a health behavior survey, a health examination survey, and a nutrition survey. At the time of the 2010–2012 KNHANES, citizens were informed that they had been randomly selected as a household to voluntarily participate in the national survey. Written informed consent was provided by all participants, and they were also given the right to refuse to participate according to the National Health Enhancement Act.

The Korea Centers for Disease Control and Prevention also obtained participant consent to use blood samples for further research. Physical examinations were performed by trained medical staff according to a standardized procedure. Participants responded to questionnaires regarding lifestyle behaviors, including cigarette smoking, alcohol consumption, physical activity, and dietary patterns. We excluded individuals younger than 20 years of age ( $n = 6140$ ), those without complete blood pressure measurement data ( $n = 1104$ ), and those missing data regarding alcohol consumption ( $n = 3238$ ). Finally, 15,052 individuals (7054 men and 7998 women) were included in these analyses. Patient ages ranged from 20 to 91 years old in men and from 20 to 92 years old in women. This study was approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention.

### Measurement of anthropometric and laboratory data

Body mass and height were measured to the nearest 0.1 kg and 0.1 cm while the participants wore light indoor clothing without shoes. Body mass index (BMI) was calculated as the ratio of mass (kg) to height squared ( $m^2$ ). Medical staff obtained participant blood pressure in the right arm using a standard mercury sphygmomanometer (Baumanometer; Baum, Copiague, NY, USA). Two measurements of systolic and diastolic blood pressure were taken in all participants at 5 min intervals. The average of these two measurements was used for the data analyses. Blood samples were collected from the antecubital vein in the morning after an overnight fast. Fasting plasma glucose, total cholesterol, triglyceride (TG), and high-density lipoprotein cholesterol (HDL-C) levels were analyzed using a Hitachi Automatic Analyzer 7600 (Hitachi, Tokyo, Japan).

### Definition of hypertension and lifestyle factors

The participants were categorized as hypertensive if they had systolic blood pressure  $\geq 140$  mm Hg or diastolic blood pressure  $\geq 90$  mm Hg or were currently taking anti-hypertensive medications. Lifestyle data were obtained from a questionnaire about recent and current behavior. The cut-off points for AUDIT score were categorized into three groups: low-risk drinkers, 0–7; intermediate-risk drinkers, 8–14; and high-risk drinkers,  $\geq 15$  points, based on previous studies regarding hazardous and harmful alcohol-drinking behavior (Allen, Litten, Fertig, & Babor, 1997; Babor et al., 2001). To estimate physical activity levels, the International Physical Activity Questionnaire short form, which was translated into Korean, was used. According to the questionnaire, a regular exerciser was categorized as an individual who engaged in  $\geq 20$  min of vigorous-intensity physical activity at least three days per week or  $\geq 30$  min of moderate-intensity physical activity at least 5 days a week (M. Y. Chun, 2012). Smoking status involved the classification of participants into never smokers, former smokers, and current smokers.

### Statistical analysis

To ensure that the dataset represented the entire Korean population without biased estimates, sampling weights were applied to each participant's data. The means of continuous variables, such as age, BMI, blood pressure, total cholesterol, TG, HDL-C, calorie intake, household income, and fasting plasma glucose, were compared using general linear models based on a complex sampling plan for descriptive analysis. The means of categorical variables, including high-risk drinker, regular exerciser, current smoker, and hypertension, were obtained using chi-square tests. All data are presented as mean  $\pm$  standard error (SE). We used analysis of covariance (ANCOVA) to calculate the age-adjusted means of continuous variables according to alcohol-drinking pattern. We used a logistic regression model to obtain estimates of prevalence ratios (PRs) for hypertension according to alcohol-drinking patterns after adjusting for confounding variables.

We used SAS statistical software, version 9.4 (SAS Institute, Cary, NC, USA) for all analyses. All statistical tests were two-sided, and a  $p$  value  $< 0.05$  represented statistical significance.

## Results

Table 1 shows the characteristics of the study population (unweighted number of participants: 7054 men and 7998 women). The mean age was 44.3 years for men and 44.1 years for women. The mean systolic and diastolic blood pressure levels were 120.7 and

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