Association of binge drinking with risk of hypertension in Korean adults based on the 2010–2012 KNHANES

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ABSTRACT

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We examined the association between frequency of alcohol drinking and hypertension (HTN) in Korean adults. This cross-sectional study included 15,052 participants who participated in the 2010–2012 Korean National Health and Nutrition Examination Survey (KNHANES). HTN was defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or current use of anti-hypertensive medications.

In the study population, HTN prevalence was 28.6% in men and 23.0% in women. Of the total population, 13.8 % of men and 13.6% of women were using anti-hypertensive drugs. Binge drinking pattern was defined for men as consuming 7 or more drinks of ethanol on one occasion, and for women, 5 drinks. In men, binge drinking and drinking frequency were associated with HTN. The adjusted ORs (95% CIs) for HTN were 1.422 (1.141-1.772), 1.479 (1.156-1.893), 1.468 (0.969-2.222) in the monthly, weekly and almost daily binge drinking groups in men after adjusting for all confounding factors. (p for trend = 0.003) Women seems to have the higher risk of HTN in the cases of weekly and almost daily binge drinking group as compared with non bingers.

On the other hand, persons categorized as low risk drinking group in

men and high risk drinking group in women according to total alcohol intake, showed tendency to have increased prevalence of HTN with the frequency of binge drinking. These outcomes were statistically significant. (p for trend = 0.01 and p for trend = 0.001, respectively) In high risk drinkers of men and low risk drinkers of women were likely to increase in the prevalence of HTN according to the frequency of binge drinking, but did not show statistically significant results. (p for trend = 0.092, p for trend = 0.212, respectively)

In conclusion, our study suggested that frequency of binge drinking was related with prevalence of HTN in adult Korean. More detailed studies are necessary to elucidate the causal relationships between binge drinking and HTN in the future.

Key words: hypertension, alcohol, binge drinking, prevalence

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I. INTRODUCTION

Hypertension (HTN) is a worldwide disease associated with a large public health burden.[1] 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 HTN.[2] HTN 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.[3] In 2010, the Global Burden of Disease Study found that high blood pressure (BP) was the leading single risk factor for worldwide economic burden of disease.[4]

It has been long known that alcohol consumption is positively related to HTN.[5] Lifestyle factors play an important role in development of HTN, and population-based prevention techniques and control of elevated BP have been emphasized.[6] Previous studies have reported a J-shaped (or threshold-based) association or a linear dose-response relationship between alcohol and HTN.[7]

In addition to the frequency and volume of drinking, it has been suggested that

the pattern of drinking is also important for adverse cardiovascular effects.[8] There is increasing evidence that irregular episodes of high amounts of alcohol (binge drinking) are related with high risk of coronary heart disease, stroke and metabolic syndrome.[9-11]

In Korea, binge drinking is the prevalent pattern of heavy drinking. Korean drinking culture is related to a residual product of the country's economic success. The high intensity of the labor and the long work hours allowed a short spare time in most Koreans. Tired workers have tended to enjoy binge drinking for a short period of time instead of healthier alcohol drinking pattern or other leisure life. Also, drinking is considered a method of nonverbal communication, a useful means of maintaining a sense of belonging and friendship within a specific group, such as workplace or social meeting. The powerful social influence of alcohol certainly contributes to the continuous growth of high-risk drinking in Korea.[12]

Alcohol-related problems have significantly increased each year in Korea. The total cost for alcohol-related diseases in Korea, including healthcare expenditures, has increased remarkably from 3.2 trillion Korean won in 2005 to 6.1 trillion Korean won in 2009.[13]

Although several studies have reported that alcohol intake is associated with BP elevation in a dose- or frequency-related manner[14], there is a lack of research showing the relation between binge drinking pattern and HTN. Therefore, we investigated the relationship of binge drinking frequency and prevalence of HTN in Korean adults.

II. MATERIALS AND METHODS

1. 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, multistage, 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 BP measurement data (n = 1,104), and those missing data regarding alcohol consumption (n = 3,238). Finally, 15,052 individuals (7,054 men and 7,998 women) were included in these analyses. Participants' 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.

2. *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 BP in the right arm using a standard mercury sphygmomanometer (Baumanometer; Baum, Copiague, NY, USA). Two measurements of systolic and diastolic BP 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 (TC), triglyceride (TG), and high-density lipoprotein cholesterol (HDL-C) levels were analyzed using a Hitachi Automatic Analyzer 7600 (Hitachi, Tokyo, Japan).

3. *Definition of hypertension and lifestyle factors*

The participants were categorized as hypertensive if they had systolic blood BP ≥140 mmHg or diastolic BP ≥90 mmHg or were currently taking anti-hypertensive medications. Lifestyle data were obtained from a questionnaire about recent and current behavior. Alcohol use disorders identification test (AUDIT) questionnaire was developed to screen for excessive alcohol drinking. 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 ≥20 min of vigorous-intensity physical activity at least three days per week or ≥30 min of moderate-intensity physical activity at least 5 days a week.[15] Smoking status involved the classification of participants into never smokers, former smokers, and current smokers.

4. *Alcohol consumption*

Alcohol consumption was assessed by a self-administered questionnaire

regarding the usual quantity and frequency of consumption during the past 12 months before the study. Although changes in alcohol consumption may take place over time, it is generally assumed that such data on average alcohol consumption yield a reasonably good estimate of the long-term average alcohol intake.

Binge drinking pattern was defined for men as consuming 7 or more drinks of ethanol on one occasion, and for women, 5 drinks. High risk alcohol consumption is defined as ≥7 drinks for men and ≥5 drinks for women more than twice a week. Frequency of binge drinking was assessed with the following questions: How often do you have 7 or more drinks on one occasion? (women: 5 or more drinks) and possible responses to this question were as follows: never, less than monthly, monthly, weekly, daily or almost daily. Participants who answered “never or less than monthly” to that question is defined as non bingers.

AUDIT questionnaire includes a question on consuming 7 (men) and 5 (women) or more drinks at a time, and the criterion for binge drinking was chosen to follow this definition. 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 of others in regard to drinking). [16,17] The questionnaire did not allow us to identify those subjects who consumed different types of alcoholic beverages on one occasion and reached a level of binge drinking only when the number of drinks of different beverages was summed.

Finally we categorized drinkers into low, moderate and high risk alcohol drinkers by monthly alcohol intake. Average monthly consumption of alcohol was calculated from drinking frequency and amounts consumed by self-administered AUDIT questionnaire. Consumption was assessed with the following questions: “How often do you have a drink containing alcohol?” and possible responses to this question were as follows: never, less than monthly, monthly, 2~4 times a month, 2~3 times a week, 4 or more times a week, and “How many drinks containing alcohol do you have on a typical day when you are drinking?” and possible responses to this question were as follows: 1~2,

3~4, 5~6, 7~9, 10 or more drinks.

In clinical practice, the guidelines proposed by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) are widely used. According to the NIAAA, Moderate drinking guidelines are drinking up to 2 drinks per day and 14 drinks per week for men, and no more than one drink per day and 7 drinks per week for women. Therefore, high risk drinkers can be determined as those consuming more than 56 drinks per month for men and more than 28 drinks per month for women.

Moderate risk drinkers were determined as those drinking below these limits but more than 28 drinks per month for men and more than 14 drinks per month for women, and the rest were determined as low risk drinkers. We had no choice but to categorize roughly, the data which we obtained were approximate data shown as a range of amount.

5. Statistical analysis

To ensure we were using a dataset that represented the Korean population without biased estimates, sampling weights were applied to each individual's data. The means of continuous variables, such as age, BMI, BP, TC, 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 regular exerciser, current smoker, anti-hypertensives and HTN were obtained using chi-square tests. All data are presented as mean ± standard error (SE). Multivariate logistic regression analyses were performed to calculate the odds ratios (ORs) for HTN according to alcohol-drinking patterns after adjusting for confounding variables.

We used SPSS for Windows (ver 18.0; SPSS Inc., Chicago IL). All statistical tests were two-sided, and a p value <0.05 represented statistical significance.

III. RESULTS

Table 1 shows the characteristics of the study population (unweighted number of participants: 7,054 men and 7,998 women). The mean age was 44.3 ± 0.3 years for men and 44.1 ± 0.3 years for women. The mean systolic and diastolic BP levels were 120.7 ± 0.3 and 79.4 ± 0.2 mmHg for men and 114.4 ± 0.3 and 73.5 ± 0.2 mmHg for women, respectively. Of the total study population, 13.8 ± 0.5% of men and 13.6 ± 0.5% of women were currently using anti-hypertensive drugs.

Table 1. The characteristics of the study population

	Men	Women
Unweighted N	7,054	7,998
Age (years)	44.3 ± 0.3	44.1 ± 0.3
Waist circumference (cm)	84.1 ± 0.2	77.7± 0.2
BMI (kg/m²)‡	24.1 ± 0.1	23.2 ± 0.1
SBP (mmHg)‡	120.7 ± 0.3	114.4 ± 0.3
DBP (mmHg)‡	79.4 ± 0.2	73.5 ± 0.2
FBS (mg/dL)‡	98.4 ± 0.4	93.9 ± 0.3
TC (mg/dL)‡	187.7 ± 0.6	187.6 ± 0.5
TG (mg/dL)‡	154.2 ± 2.1	108.9 ± 1.4
HDL-C (mg/dL)	49.7 ± 0.2	56.1 ± 0.2
Calorie intake (Kcal/day)	2,466.6 ± 18.9	1,723.8 ± 11.2
Household income (USD[a]/month)	4,489.1 ± 160.1	4,576.7 ± 160.4
Regular exerciser (%)† [b]	19.9 ± 0.7	13.6 ± 0.5
Current Smoker (%)†	45.9 ± 0.8	7.2 ± 0.4

All data except regular exerciser, smoking status are represented as mean (SE).

† regular exerciser, smoking status are represented as percentage (SE).

a. 1 USD = 1000 Korean won

b. Regular exerciser: A person who incorporates ≥20 min of vigorous-intensity physical activity for ≥3 days a week or ≥30 minutes of moderate-intensity physical activity ≥5 days a week

‡ Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; FBS, fasting blood sugar

Table 2. Subject characteristics according to frequency of binge drinking in men

Men	<1/month	1/month	1/week	5+/week	*P value**
Unweighted N	3,366	1,267	1,808	613	
Age (years)	47.0 ± 0.4	38.9 ± 0.5	42.8 ± 0.4	47.4 ± 0.8	<0.001
BMI (kg/m²)‡	23.2 ± 0.1	24.0 ± 0.1	24.4 ± 0.1	24.8 ± 0.2	<0.001
SBP (mmHg)‡	119.3 ± 0.4	118.3 ± 0.6	122.6 ± 0.5	127.6 ± 0.9	<0.001
DBP (mmHg)‡	77.5 ± 0.3	78.5 ± 0.4	81.5 ± 0.4	84.1 ± 0.6	<0.001
TC (mg/dL)‡	185.5 ± 0.9	188.2 ± 1.4	189.7 ± 1.2	191.4 ± 2.3	0.005
TG (mg/dL)‡	134.8 ± 2.4	145.0 ± 4.3	172.6 ± 4.3	214.0 ±11.7	<0.001
HDL-C (mg/dL)‡	47.6 ± 0.3	49.5 ± 0.4	51.8 ± 0.4	53.1 ± 0.7	<0.001
Calorie intake (Kcal/day)	2,305 ± 23	2,466 ± 37	2,646 ± 41	2,718 ± 60	<0.001
Household income (USD/month)	4,210 ± 220	4,866 ± 353	4,628 ± 231	4,601 ± 413	0.298
FBS (mg/dL)‡	93.8 ± 0.5	93.6 ± 0.8	99.7 ± 0.7	104.6 ± 1.3	<0.001
Regular exerciser (%)†	19.3 ± 1.0	19.9 ± 1.6	19.7 ± 1.2	23.6 ± 2.6	0.416
Current smoker (%)†	35.6 ± 1.1	46.0 ± 2.0	57.5 ± 1.5	60.6 ± 2.5	<0.001
AUDIT‡	3.7 ± 0.1	10.2 ± 0.2	15.3 ± 0.2	19.4 ± 0.3	<0.001
Hypertensive medication (%)†	15.6 ± 0.7	9.0 ± 0.9	13.1 ± 1.0	18.2 ± 2.1	<0.001
HTN (%)†‡	20.8 ± 0.9	15.4 ± 1.2	22.3 ± 1.3	33.0 ± 2.6	<0.001

All data except regular exerciser, smoking status, anti-hypertensives and HTN are represented as mean (SE).

† regular exerciser, smoking status, anti-hypertensives and HTN are represented as percentage (SE) (%).

* *P-value* from general linear models for continuous outcomes and chi-square test for categorical outcomes comparing differences between groups.

‡ Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; FBS, fasting blood sugar; AUDIT, Alcohol Use Disorders Identification Test; HTN, hypertension

Table 3. Subject characteristics according to frequency of binge drinking in women

Women	<1/month	1/month	1/week	5+/week	*P value**
Unweighted N	6,401	873	615	109	
Age (years)	45.8 ± 0.3	37.9 ± 0.5	38.3 ± 0.6	38.9 ± 1.5	<0.001
BMI (kg/m²)‡	23.3 ± 0.1	23.1 ± 0.2	23.3 ± 0.2	23.2 ± 0.4	0.908
SBP (mmHg)‡	115.0 ± 0.3	111.0 ± 0.6	113.8 ± 0.8	115.2 ± 1.9	<0.001
DBP (mmHg)‡	73.4 ± 0.2	72.9 ± 0.4	74.9 ± 0.5	74.7 ± 1.3	0.015
TC (mg/dL)‡	188.2 ± 0.6	183.2 ± 1.6	188.7 ± 1.7	187.1 ± 4.8	0.045
TG (mg/dL)‡	108.3 ± 1.3	100.4 ± 2.9	121.0 ± 7.8	135.1 ±12.4	<0.001
HDL-C (mg/dL)‡	55.1 ± 0.2	58.1 ± 0.6	61.4 ± 0.7	64.2 ± 2.3	<0.001
Calorie intake (Kcal/day)	1,714 ± 12	1,721 ± 32	1,771 ± 44	2,005 ± 117	0.07
Household income (USD/month)	4,581 ± 180	5,061 ± 496	4,018 ± 265	3,896 ± 518	0.124
FBS (mg/dL)‡	93.9 ± 0.3	92.8 ± 0.9	94.9 ± 1.0	97.0 ± 3.3	0.326
Regular exerciser (%)†	12.8 ± 0.5	18.8 ± 1.7	13.8 ± 1.9	16.2 ± 4.8	0.005
Current smoker (%)†	4.4 ± 0.4	10.6 ± 1.4	21.1 ± 2.2	43.3 ± 6.1	<0.001
AUDIT‡	1.9 ± 0.0	7.7 ± 0.2	12.4 ± 0.3	19.4 ± 0.9	<0.001
Hypertensive medication (%)†	15.5 ± 0.6	7.9 ± 1.0	5.5 ± 1.0	7.1 ± 3.6	<0.001
HTN (%)†	12.8 ± 0.5	18.8 ± 1.7	13.8 ± 1.9	16.2 ± 4.8	<0.001

All data except regular exerciser, smoking status, anti-hypertensives and HTN are represented as mean (SE).

† regular exerciser, smoking status, anti-hypertensives and HTN are represented as percentage (SE) (%).

* *P-value* from general linear models for continuous outcomes and chi-square test for categorical outcomes comparing differences between groups.

‡ Abbreviations: BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; FBS, fasting blood sugar; AUDIT, Alcohol Use Disorders Identification Test; HTN, hypertension

Table 2 shows the subjects with a binge drinking frequency in men had the highest levels of BMI, diastolic BP, TC, TG, HDL-C, daily calorie intake and AUDIT score (all p values ≤ 0.005). Male frequent binge drinkers included the most current smokers. The percentages of men using anti-hypertensives were 15.6 ± 0.7, 9.0 ± 0.9, 13.1 ± 1.0 and 18.2 ± 2.1% in the less than monthly, monthly, weekly and almost daily binge drinking groups, respectively (p value <0.001). The percentage of regular exercisers was not significantly different among the binge drinking groups in men.

Table 3 shows the subjects with a binge drinking frequency in women had the highest levels of HDL-C and percentage of current smokers (all p values <0.001). The percentage of women using anti-hypertensives were 15.5 ± 0.6, 7.9 ± 1.0, 5.5 ± 1.0 and 7.1 ± 3.6% in the less than monthly, monthly, weekly and almost daily binge drinking groups, respectively (p value <0.001).

Table 4. Adjusted odds ratios and 95% confidence intervals (CI) of HTN by frequency of binge drinking[a] (compared with non bingers[b]) in men

	Men				
OR (95% CI)	<1/month N=3366	1/month N=1267	1/week N=1808	5+/week N=613	P for trend
Model 1†	1	1.529 (1.250-1.870)	2.034 (1.707-2.424)	2.819 (2.135-3.723)	<0.001
Model 2‡	1	1.529 (1.248-1.873)	2.077 (1.737-2.484)	2.907 (2.187-3.863)	<0.001
Model 3§	1	1.583 (1.280-1.959)	2.005 (1.654-2.430)	2.583 (1.910-3.492)	<0.001
Model 4*	1	1.422 (1.141-1.772)	1.479 (1.156-1.893)	1.468 (0.969-2.222)	0.003

a. Binge drinking is defined as consuming seven or more standard drinks (male), or five or more drinks (female), on one occasion

b. Participants who answered “never or less than monthly” to the question about binge drinking frequency is defined as non bingers.

† Model 1 was adjusted for age.

‡ Model 2 was adjusted for age, exercise status (Regular exerciser; ≥20 min of vigorous-intensity physical activity for ≥3 times per week or ≥30 minutes of moderate-intensity physical activity ≥5 days a week) and smoking status (never smoker, former smoker, current smoker).

§ Model 3 was adjusted for age, exercise status, smoking status, BMI, TC, daily calorie intake and monthly house income.

*Model 4 was adjusted for age, exercise status, smoking status, BMI, TC, daily calorie intake, monthly house income and monthly total alcohol intake.

Table 5. Adjusted odds ratios and 95% confidence intervals (CI) of HTN by frequency of binge drinking[a] (compared with non bingers[b]) in women

	Women				
OR (95% CI)	<1/month N=6401	1/month N=873	1/week N=615	5+/week N=109	P for trend
Model 1†	1	1.097 0.834-1.443	1.641 1.202-2.242	2.545 1.197-5.414	<0.001
Model 2‡	1	1.110 0.841-1.463	1.730 1.256-2.385	2.790 1.299-5.995	<0.001
Model 3§	1	1.016 0.761-1.356	1.704 1.221-2.379	2.760 1.159-6.573	0.001
Model 4∗	1	0.959 0.711-1.294	1.385 0.931-2.061	1.578 0.619-4.019	0.043

a. Binge drinking is defined as consuming seven or more standard drinks (male), or five or more drinks (female), on one occasion

b. Participants who answered “never or less than monthly” to the question about binge drinking frequency is defined as non bingers.

† Model 1 was adjusted for age.

‡ Model 2 was adjusted for age, exercise status (Regular exerciser; ≥20 min of vigorous-intensity physical activity for ≥3 times per week or ≥30 minutes of moderate-intensity physical activity ≥5 days a week) and smoking status (never smoker, former smoker, current smoker).

§ Model 3 was adjusted for age, exercise status, smoking status, BMI, TC, daily calorie intake and monthly house income.

∗Model 4 was adjusted for age, exercise status, smoking status, BMI, TC, daily calorie intake, monthly house income and monthly total alcohol intake.

Adjusted odds ratios (95% CI) of HTN according to binge drinking frequency are presented in Table 4 & 5. Multivariate logistic regression models were conducted after adjusting for age, exercise, smoking status, BMI, TC, daily calorie intake, monthly household income and monthly total alcohol intake in model 4. The adjusted ORs (95% CIs) for HTN were 1.422 (1.141-1.772), 1.479 (1.156-1.893), 1.468 (0.969-2.222) in the monthly, weekly and almost daily binge drinking groups in men, model 4 and 0.959 (0.711-1.294), 1.385 (0.931-2.061), 1.578 (0.619-4.019) in women, model 4, respectively. Subjects with frequent drinking of larger amounts (binge drinking) had higher prevalence of HTN in men. These outcomes were statistically significant. (p for trend = 0.003)

Women seemed to have the higher risk of HTN in the cases of weekly and almost daily binge drinking group as compared with non bingers. Women showed tendency to have increased prevalence of HTN with the frequency of binge drinking. These outcomes were statistically significant. (p for trend = 0.043) (Table 5).

An alternative analysis of drinking pattern, stratifying drinkers into low, moderate and high risk alcohol drinking groups with similar monthly alcohol intake, relationship of HTN and binge drinking frequency in men and women are presented in Table 6 & 7.

Among persons drinking the similar amount of alcohol, subjects with frequent drinking of larger amounts (binge drinking) had higher prevalence of HTN in low risk drinking group in men and high risk drinking group in women categorized according to total alcohol intake. These outcomes were statistically significant. (p for trend = 0.01 and p for trend = 0.001, respectively)

In moderate risk alcohol drinking group in women, none of the tendency between binge drinking frequency and HTN was shown. Among subjects with moderate risk alcohol drinking in women, after controlling for covariates, the adjusted ORs (95% CIs) for HTN were 0.782 (0.449-1.361) and 0.917 (0.487-1.726) in model 3. We found that, men with moderate risk drinking seemed to have the higher risk of HTN only in the cases of monthly binge drinkers as compared with non bingers. (The adjusted ORs=1.535; 95% CI, 1.021 to 2.307)

In high risk drinkers of men and low risk drinkers of women, prevalence of

HTN were likely to increase according to the frequency of binge drinking, but did not show statistically significant results. (p for trend = 0.092, p for trend = 0.212, respectively)

Table 6. Adjusted odds ratios and 95% confidence intervals (CI) of HTN by frequency of binge drinking among each groups with similar monthly alcohol intake in men

	Men (N=6,202)			
OR (95% CI)	**< 1/month**	**1/month**	**1/week**	**P for trend**
Low risk drinking (N=2,726)	N=2,060	N=545	N=121	
Model 1†	1	1.184 (0.874-1.604)	1.803 (1.102-2.949)	0.017
Model 2‡	1	1.177 (0.869-1.594)	1.884 (1.156-3.072)	0.013
Model 3§	1	1.230 (0.891-1.698)	1.966 (1.151-3.359)	0.010
Moderate risk drinking (N=1,769)	N=411	N=637	N=721	
Model 1†	1	1.399 (0.950-2.061)	1.437 (0.985-2.097)	0.098
Model 2‡	1	1.376 (0.935-2.024)	1.421 (0.976-2.069)	0.105
Model 3§	1	1.535 (1.021-2.307)	1.433 (0.971-2.115)	0.152

OR (95% CI)	**<1/month**	**1/month**	**1/week**	**5+/week**	**P for trend**
High risk drinking (N=1,654)	N=43	N=85	N=966	N=560	
Model 1†	1	1.553 (0.647-3.729)	1.626 (0.797-3.316)	2.212 (1.067-4.587)	0.019
Model 2‡	1	1.496 (0.620-3.614)	1.583 (0.771-3.249)	2.154 (1.031-4.500)	0.020
Model 3§	1	1.436 (0.545-3.780)	1.590 (0.683-3.705)	1.950 (0.825-4.612)	0.092

† Model 1 was adjusted for age.

‡ Model 2 was adjusted for age, exercise status (Regular exerciser; ≥20 min of vigorous-intensity physical activity for ≥3 times per week or ≥30 minutes of moderate-intensity physical activity ≥5

days a week) and smoking status (never smoker, former smoker, current smoker).

§ Model 3 was adjusted for age, exercise status, smoking status, BMI, TC, daily calorie intake and monthly house income.

Table 7. Adjusted odds ratios and 95% confidence intervals (CI) of HTN by frequency of binge drinking among each groups with similar monthly alcohol intake in women

	Women (N=3,668)			
OR (95% CI).	**< 1/month**	**1/month**	**1/week**	**P for trend**
Low risk drinking (N=1,748)	N=1,443	N=275	N=30	
Model 1†	1	1.167 (0.724-1.882)	2.757 (0.985-7.72)	0.101
Model 2‡	1	1.186 (0.731-1.925)	2.696 (0.948-7.672)	0.099
Model 3§	1	1.056 (0.628-1.776)	2.847 (0.967-8.381)	0.212
Moderate risk drinking (N=1,013)	N=500	N=363	N=150	
Model 1†	1	0.864 (0.517-1.444)	1.046 (0.541-2.020)	0.974
Model 2‡	1	0.867 (0.514-1.460)	1.082 (0.559-2.094)	0.954
Model 3§	1	0.782 (0.449-1.361)	0.917 (0.487-1.726)	0.642

OR (95% CI)	**<1/month**	**1/month**	**1/week**	**5+/week**	**P for trend**
High risk drinking (N=1,654)	N=169	N=199	N=432	N=103	
Model 1†	1	1.942 (0.759-4.967)	2.689 (1.307-5.529)	3.751 (1.384-10.167)	0.004
Model 2‡	1	2.003 (0.790-5.076)	2.827 (1.380-5.793)	4.234 (1.561-11.479)	0.002
Model 3§	1	1.481 (0.589-3.722)	3.272 (1.569-6.825)	4.332 (1.469-12.775)	0.001

† Model 1 was adjusted for age.

‡ Model 2 was adjusted for age, exercise status (Regular exerciser; ≥20 min of vigorous-intensity

physical activity for ≥3 times per week or ≥30 minutes of moderate-intensity physical activity ≥5 days a week) and smoking status (never smoker, former smoker, current smoker).

§ Model 3 was adjusted for age, exercise status, smoking status, BMI, TC, daily calorie intake and monthly house income.

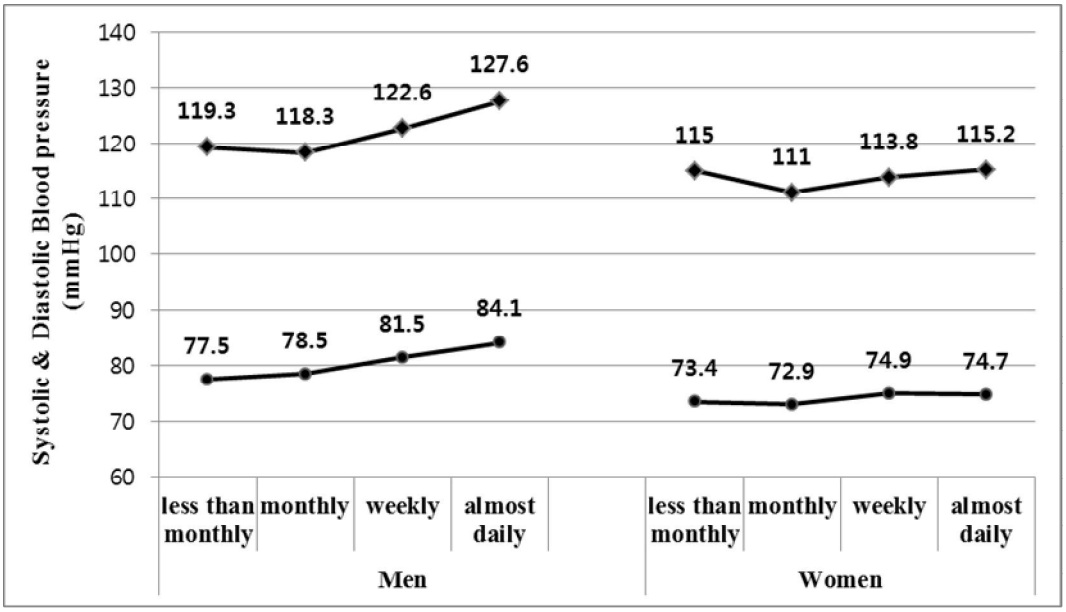

Figure 1. Systolic and diastolic BP by frequency of binge drinking in men and women

IV. DISCUSSION

In this study, we found that binge drinkers were at higher risk of HTN after adjustment for possible covariates, such as age, BMI, TC, lifestyle factors (smoking and exercise status), monthly household income, monthly total alcohol intake using nationally representative data from the 2010–2012 KNHANES. Binge drinking was the main focus of this study, because it has been previously linked with increased risk of HTN and cardiovascular risk in general. Men and women showed tendency to have increased prevalence of HTN with the frequency of binge drinking.

We categorized drinkers by approximate monthly alcohol intake, relationship of HTN and binge drinking in low risk drinkers of men and high risk drinkers of women showed tendency to have increased prevalence of HTN with the frequency of binge drinking. These outcomes were statistically significant. (p for trend = 0.01 and p for trend = 0.001, respectively)

Although several studies have reported a positive dose-dependent association between excessive alcohol intake and HTN, there is little study about the association between binge drinking and prevalence of HTN.

The burden of HTN and its related diseases has considerably increased recently. From 2005 through 2009, medical expenditures for HTN increased from 1.4 billion to 2.3 billion United States dollars (USD).[18] As Korean society is quickly changing into an aging society, the future economic burden of HTN and its comorbidities is predicted to increase steadily and steeply if proper intervention is not taken.

In the INTERSALT study, an international multicenter epidemiological study reported a positive relationship between alcohol intake and BP. In the study, men who consumed 300–499 mL/week and more than 500 mL/week had higher mean systolic/diastolic BP than non-drinkers even after adjusting for confounding factors. Like men's results, women who drank at least 300 mL of alcohol a week had higher BP levels.[14]

Recently, alcohol drinking pattern has been suggested as an important factor of cardiovascular risk in addition to the volume of drinking. Acute episodic consumption of high amounts of alcohol (binge drinking) was reported to be related with high risk of

stroke and ischemic heart disease. So far, however, only a few studies have assessed the effects of different drinking patterns on HTN risk.

In the PRIME study, the largest population-based study proposed that Northern Irish drinkers had BP levels that were high on Mondays and decreased until Thursday, possibly reflecting weekend drinking. Binge drinking of weekend drinker is common in Northern Ireland. The fluctuations in BP levels due to the binge drinking pattern could also partly explain the higher incidence of myocardial Infarction (MI) on Mondays, via an increase in SBP and DBP levels.[19] Abramson et al. found that higher levels of ambulatory BP in binge drinkers after controlling for weekly drinking volume.[20] However, population-based studies using individual data did not find significantly increased rates of HTN in weekend-only drinkers (similar to binge drinkers) or in persons drinking similar quantities over fewer sessions.[20-23] According to HAPIEE study, among men drinking ≥6L of pure ethanol annually, levels of BP were slightly higher among infrequent drinkers after controlling of annual alcohol intake. However, those results were statistically insignificant.[24]

Heavy alcohol consumption might be associated with the pathogenesis of HTN. Several possible mechanisms have been suggested. There is increasing evidence that alcohol initiates central and peripheral reactions, which synergistically produce hypertensive actions.[25] It has been suggested that alcohol induces the stimulation of the sympathetic outflow, which results in secretion of corticotropin-releasing hormone, leading to stimulation of cortisol secretion.[26] Alcohol consumption impairs the baroreflex by interacting with receptors in the brainstem.[25] Some investigators have reported that baroreceptor reflex sensitivity was diminished in ethanol-fed rats compared with controls when challenged with vasoconstrictors (phenylephrine and angiotensin II).[27] The serum levels of vasoactive substances, such as renin-aldosterone, have been reported to be influenced by alcohol intake.[28] In patients who consume large amounts of alcohol, plasma renin activity shows a significant increase compared to that in mild or moderate alcohol drinkers.[29] Elevated plasma renin activity has been linked to increased extracellular fluid, indicating increased sympathetic stimulation.[30] Alcohol intake is correlated with elevated tissue angiotensin II level and causes endothelial injury in rats. Loss of relaxation due to

inflammation and oxidative injury of the endothelium leads to a decrease in vasodilators, such as nitric oxide. This is the most likely factor implicated in alcohol-induced HTN.[31]

Early detection of alcohol-related problems using an AUDIT questionnaire can reduce the harmful effects of high risk drinking. The National Health Insurance Service (NHIS) in Korea provides various health check-up programs, including cancer screenings and lifetime transition period health check-ups. A lifetime transition period health check-up is recommended for all adults aged 40 to 66 years, and evaluates mental health, cognitive function, and lifestyle habits such as physical activity, smoking, and alcohol use. An AUDIT test is routinely used to evaluate alcohol-use disorder during the lifetime transition period health check-up.

The present study has several strengths. First, we investigated alcohol-drinking patterns in addition to the quantity and frequency of drinking. Therefore, researchers have recommended that drinking patterns should be taken into account in making drinking guidelines. Second, to represent the general population of Koreans 20 years old or older, we applied sampling weights to all analyses. Various confounding factors, such as age and lifestyle factors (smoking and exercise status), were adjusted in all analyses. Thus, the study findings can be generalized to appropriately represent the entire population of Korea.

Some limitations of this study must be considered when interpreting the results. First, this study was a cross-sectional study, which makes it difficult to determine causality between binge drinking and prevalence of HTN. Second, we excluded participants who were younger than 20 years, had missing BP data, or had missing data regarding alcohol consumption. Excluding these participants might have caused a selection bias. Third, we assessed participants as binge drinking groups based on a self-reported questionnaire. Some could raise an issue of validity for this. The use of self-reported information on alcohol-drinking pattern could lead to misclassification of actual drinking styles because participants could be motivated to under-report their true alcohol consumption. In women, underreporting can be more pronounced, because there is a prejudice against women who drink heavily in Korea. Fourth, no examination into the take of > 2 types of alcoholic beverages on 1 occasion could remain a limitation of

alcohol assessment. The “bomb shot,” or “poktanju” that is mixed with soju and beer is usual in an after-hours dinner engagement from work in South Korea.

V. CONCLUSION

In conclusion, our study suggests that frequency of binge drinking was associated with HTN. We found that, men and women with low and high risk drinking seem to have the higher risk of HTN as compared with non bingers after controlling for the volume of drinking by categorizing drinkers according to monthly alcohol intake. More detailed analyses are needed to examine the patterns of drinking as well as problem caused by different level of alcohol consumption.

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ABSTRACT (IN KOREAN)

한국 성인에서 폭음과 고혈압 유병률과의 연관성 (2010-2012 국민건강영양조사)

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본 연구에서는 한국 성인에서 폭음과 고혈압 유병률과의 연관성에 대해 분석하였다. 본 단면 연구는 2010-2012년에 시행된 국민건강영양조사 자료를 이용하여 총 15,052 명의 참가자를 대상으로 하였다. 고혈압 환자는 수축기 혈압 ≥140 mmHg, 이완기 혈압 ≥90 mmHg 또는 고혈압 약을 복용하고 있는 자로 정의한다. 통계학적 분석으로는 chi-square 검정 및 로지스틱 회귀분석을 시행하였다.

조사 대상자의 고혈압 유병률은 남성에서 28.6%, 여성에서 23.0%로 나타났으며, 남성의 13.8%, 여성의 13.6%에서 고혈압 약을 현재 복용 중인 것으로 나타났다.

폭음은 소주, 양주에 관계없이 한번의 술자리에서 남성의 경우 7잔, 여성의 경우 5잔 이상의 술을 마시는 것으로 정의하였다.

폭음 빈도에 따른 교차 위험비를 분석한 결과 남성은 폭음 빈도가 증가하면 고혈압 위험이 커지는 것으로 나타났고, 여성은 주 1회, 거의 매일 폭음하는 음주 군의 경우에 비폭음군 (월 1회 미만의 폭음) 보다 고혈압 유병률이 유의하게 높게 나타났다. 남성의 경우 다른 변수들을 모두 통제하고 비폭음군과 비교하였을 때, 월 1회 정도, 주 1회, 거의 매일 폭음하는 음주군의 경우 고혈압 유병률은 1.422 (1.141-1.772), 1.479 (1.156-1.893), 1.468 (0.969-2.222)배 높은 것으로 나타났다. (p for trend = 0.003)

또한 한달 간 섭취한 전체 알코올 섭취량에 따라 음주자를 저위험, 중등도위험, 고위험 음주군으로 나누어 분석하였을 때 남성에서 저위험군, 여성에서 고위험군에서는 폭음 빈도에 따라 고혈압 유병률이 통계적으로

의미있게 증가하는 경향을 보였다. (각각 p for trend = 0.01, p for trend = 0.001)

남성에서 고위험군, 여성에서 저위험군에서는 폭음 빈도에 따라 고혈압 유병률이 증가하는 가능성이 있기는 하였지만 통계적으로 유의한 결과를 보이지는 않았다. (각각 p for trend = 0.092, p for trend = 0.212)

결론적으로 한국 성인에서 폭음 빈도와 고혈압 유병률은 관련성이 있다. 향후 이에 대한 대규모 연구 및 인과 관계를 밝히기 위한 연구가 필요하다.

핵심되는 말 : 고혈압, 알코올, 폭음, 유병률