



# Patterns of Alcohol Consumption and Suicidal Behavior: Findings From the Fourth and Fifth Korea National Health and Nutritional Examination Survey (2007–2011)

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**Objectives:** The purpose of this study was to investigate the association between suicidal behavior and patterns of alcohol consumption in Korean adults.

**Methods:** This study was based on data provided by the Korea National Health and Nutritional Examination Survey from 2007 to 2011. A total of 42 347 subjects were included in the study, of whom 19 292 were male and 23 055 were female. Logistic regression analysis was performed to assess the association between patterns of alcohol consumption and suicidal behavior.

**Results:** Among the study subjects, 1426 males (11.3%) and 3599 females (21.2%) had experienced suicidal ideation, and 106 males (0.8%) and 190 females (1.1%) had attempted suicide during the previous 12 months. Alcohol Use Disorders Identification Test (AUDIT) scores were found to be associated with suicidal ideation in males and associated with both suicidal ideation and suicide attempts in females. Alcoholic blackouts were associated with suicidal ideation and suicide attempts in males, and were also associated with suicidal ideation in females.

**Conclusions:** In this study, we found that certain patterns of alcohol consumption were associated with suicidal behaviors. In particular, only alcoholic blackouts and categorized AUDIT scores were found to be associated with suicidal behavior in males. We therefore suggest that further research is needed to examine this relationship prospectively and in other settings.

**Key words:** Alcohol consumption, Suicidal ideation, Suicide, Attempted

## INTRODUCTION

Suicide is a common cause of death in most developed countries. In Korea, it was the fourth leading cause of death (28.1 per 100 000) in 2012 [1]. Additionally, Korea is ranked first among

the Organization for Economic Cooperation and Development (OECD) countries in suicide mortality [2]. Suicidal ideation and suicidal behavior, such as prior suicide attempts, are strong indicators of suicide, but only a minority of those attempting suicide seek medical attention from health care facilities [3-6], while the majority of unsuccessful attempts go unnoticed [7].

Alcohol is one of the leading causes of the global burden of disease [8], and alcohol use disorders are known to be a major risk factor for suicide [9]. Individuals with an alcohol use disorder are at high risk for multiple suicide attempts [10,11]. The risk of suicidal behavior, such as suicide attempts and completed suicide, in alcohol-dependent individuals is epidemiologically and clinically significant [12].

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The Alcohol Use Disorders Identification Test (AUDIT) is one of the most frequently used tools in the world for assessing drinking problems in individual patients. The AUDIT score is calculated by summing the scores of 10 questionnaires about alcohol consumption, including questions about frequency of consumption and the amount of alcohol consumed per occasion. The total score is between 0 and 40; a score of 0 to 7 is considered to reflect low risk of alcohol dependence, while a score of 8 to 15 reflects medium risk of alcohol dependence, a score of 16 to 19 corresponds to high risk of alcohol dependence, and a score of 20 to 40 reflects alcohol dependence [13]. Alcoholic blackout refers to amnesia involving the events of any part of a drinking episode, without loss of consciousness, and can occur during alcohol intoxication in individuals with or without an alcohol use disorder [14]. AUDIT scores and alcoholic blackouts are associated with alcohol use disorders, which are, in turn, associated with suicide [15], but the relationship between alcohol use and suicidal behavior in the general population has not been well established.

Various studies have been conducted to evaluate possible associations between alcohol consumption and suicidal ideation or suicide attempts. However, most studies have examined associations involving the frequency of alcohol consumption, the amount of alcohol consumed, and the frequency of binge drinking [16,17]. Therefore, in this study using data from nationwide surveys, we investigated the association between patterns of alcohol consumption, including alcoholic blackouts, and suicidal behavior in Korean adults.

## METHODS

### Study Design and Participants

This study was based on data from the fourth and fifth Korea National Health and Nutritional Examination Survey (KNHANES) from 2007 to 2011. The KNHANES consisted of three components: a health interview survey, a nutrition survey, and a health examination survey. A total of 42 347 subjects were included.

We used data from the health interview for this study. Items pertaining to socioeconomic status, the presence of diseases, the assessment of medical services, and nutrition were presented by trained interviewers and items related to health behavior, including smoking status, alcohol consumption, and mental health were based on self-reported questionnaires. All participants provided written informed consent to participate in the survey, which was approved by the institutional review board

of the Korea Centers for Disease Control and Prevention [18].

### Measurement of Variables

We used the AUDIT score to assess patterns of alcohol use. The frequency of alcohol consumption during the previous year was categorized as follows: never during the last year, less than monthly, monthly, two to four times a month, two to three times a week, more than four times a week, and non-drinking. In this analysis, respondents who reported not drinking during the previous year were considered to be non-drinking. The quantity of alcohol consumption per occasion during the previous year was categorized as follows: one to two drinks, three to four drinks, five to six drinks, seven to nine drinks, more than ten drinks, and non-drinking. The frequency of alcoholic blackouts during the previous year was categorized as follows: never, less than monthly, monthly, weekly, almost daily, and non-drinking. We regarded non-drinking respondents as falling into the category of "never," and combined the weekly and almost daily categories because of the small number of female responders in these categories. We divided the AUDIT scores into four categories in order to facilitate comparison: 0 to 7, 8 to 15, 16 to 19, and 20 to 40 [13]. People with suicidal ideation were defined as those who had experienced suicidal ideation during the previous 12 months, and suicide attempters were defined as those who had attempted suicide during the previous 12 months. Several factors affected the prevalence of suicidal ideation and suicide attempts, such as age, educational level, household income level, region, employment status, living alone, private insurance, smoking status, and history of major depression during the previous 12 months.

### Statistical Analysis

Characteristics of the study population relating to suicidal ideation and suicide attempts were compared using the chi-squared test for categorical variables and the Student's *t*-test for continuous variables. In order to assess the association between alcohol use and suicide attempts, logistic regression analysis was performed to determine odds ratios (ORs) and 95% confidence intervals (CIs). In order to compare the influence of the AUDIT categories on suicidal ideation and suicide attempts to that of the frequency or quantity of drinking and the frequency of alcoholic blackouts, the independent variable was switched from the categorized AUDIT score to the other parameters, without any change in the confounders. Thus, four models were generated: categorized AUDIT scores, drinking

frequency, drinking quantity, and frequency of alcoholic blackouts. A  $p$ -value  $<0.05$  was considered statistically significant. Statistical analysis was performed using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA).

**Table 1.** General characteristics and alcohol consumption patterns of study subjects by sex

	Males (n=19 292)	Females (n=23 055)	p-value
Age (y)			<0.001
<40	9344 (56.4)	10 422 (52.4)	
40-64	5853 (34.9)	7558 (34.8)	
≥65	2866 (8.7)	4020 (12.8)	
No. of household members			<0.001
1-2	4047 (18.7)	5611 (20.5)	
3	3923 (23.9)	4570 (22.2)	
4	6582 (38.0)	7254 (35.2)	
≥5	3468 (19.4)	4522 (22.1)	
Education level			<0.001
≤Elementary school	6885 (27.7)	9824 (37.2)	
Middle school	2235 (12.6)	2375 (12.2)	
High school	4651 (32.9)	5523 (29.7)	
≥College	4050 (26.8)	4015 (20.9)	
Household income level			<0.001
Low	2925 (14.1)	4203 (16.8)	
Mid-low	4551 (26.2)	5554 (27.0)	
Mid-high	5188 (30.1)	6086 (29.2)	
High	5072 (29.6)	5701 (27.0)	
Region			0.14
Megalopolis <sup>1</sup>	3274 (21.1)	4001 (21.9)	
Metropolitan <sup>2</sup>	4643 (25.3)	5778 (25.3)	
Others	10 146 (53.6)	12 221 (52.9)	
Employment state			<0.001
Employed	9348 (76.4)	7932 (51.0)	
Unemployed	3582 (23.6)	8726 (49.0)	
Lives with spouse			<0.001
Yes	9957 (59.4)	11 710 (56.9)	
No	6655 (40.6)	8933 (43.1)	
Private insurance			0.17
Yes	12 732 (74.7)	15 424 (74.0)	
No	4935 (25.3)	6,155 (26.0)	
Smoking status			<0.001
Non	5709 (31.3)	18 066 (88.2)	
Ex-smoker	2111 (11.4)	405 (2.4)	
Current smoker	8172 (57.3)	1596 (9.4)	

(Continued to the next)

## RESULTS

The general characteristics and alcohol consumption patterns of the study subjects are shown in Table 1. Of the 42 347 study subjects, 19 292 participants were male and 23 055 were female. Statistically significant differences were found between

**Table 1.** Continued

	Males (n=19 292)	Females (n=23 055)	p-value
History of major depression			<0.001
No	13 057 (90.6)	15 304 (82.4)	
Yes	1419 (9.4)	3330 (17.6)	
Frequency of alcohol drinking			<0.001
Never	5657 (26.4)	9806 (42.8)	
Less than monthly	1531 (10.2)	4331 (21.9)	
Monthly	1125 (7.9)	1978 (10.6)	
2-4 times/mo	3423 (25.0)	2960 (16.5)	
2-3 times/wk	3027 (20.2)	1146 (6.3)	
≥4 times/wk	1835 (10.3)	359 (1.9)	
Quantity of alcohol drinking per occasion (drinks)			<0.001
0	5627 (26.3)	9772 (42.6)	
1-2	2018 (11.1)	5892 (28.7)	
3-4	2218 (13.2)	2612 (14.3)	
5-6	2098 (14.6)	1211 (7.3)	
7-9	2186 (15.8)	608 (3.7)	
≥10	2448 (19.0)	495 (3.5)	
Categorized AUDIT scores			<0.001
0-7	11 705 (59.2)	20 079 (89.1)	
8-15	3744 (24.3)	1485 (8.4)	
16-19	1306 (8.3)	216 (1.1)	
≥20	1308 (8.2)	220 (1.4)	
Frequency of alcoholic blackouts			<0.001
Never	12 210 (73.2)	18 749 (91.7)	
Less than monthly	2205 (15.8)	911 (5.7)	
Monthly	1132 (8.1)	294 (1.9)	
More than once a week	440 (2.9)	105 (0.7)	<0.001
Suicidal ideation			
Ever	1613 (10.2)	3908 (20.5)	
Never	12 855 (89.8)	14 719 (79.5)	
Suicide attempt			<0.001
Ever	116 (0.6)	206 (1.0)	
Never	16 510 (99.4)	20 389 (99.0)	

Values are presented as number (%).

AUDIT, Alcohol Use Disorders Identification Test.

<sup>1</sup>Megalopolis characterizes those living in Seoul.

<sup>2</sup>Metropolitan refers to those living in other large cities.

**Table 2.** Characteristics affecting suicidal ideation and suicide attempts by sex

	Male				Female			
	Suicidal ideation		Suicide attempt		Suicidal ideation		Suicide attempt	
	Never	Ever	Never	Ever	Never	Ever	Never	Ever
Age (y)								
<40	5381 (91.5)	514 (8.5)	8009 (99.6)	27 (0.4)	5980 (82.1)	1248 (17.9)	9136 (99.1)	67 (0.9)
40-64	5147 (89.2)	623 (10.8)	5732 (99.2)	48 (0.8)	6102 (81.5)	1380 (18.5)	7400 (98.9)	74 (1.1)
≥65	2327 (83.5)	476 (16.5)	2769 (98.5)	41 (1.5)	2637 (65.5)	1280 (34.5)	3853 (98.4)	65 (1.6)
p-value	<0.001		<0.001		<0.001		0.02	
No. of household members								
1-2	3392 (87.6)	558 (12.4)	3936 (98.8)	47 (1.2)	4032 (73.2)	1475 (26.8)	5451 (98.6)	72 (1.4)
3	3033 (89.6)	365 (10.4)	3696 (99.4)	27 (0.6)	3235 (79.1)	833 (20.9)	4344 (99.1)	37 (0.9)
4	4278 (90.8)	453 (9.2)	5847 (99.6)	26 (0.4)	4654 (83.0)	957 (17.0)	6554 (99.1)	58 (0.9)
≥5	2134 (90.7)	234 (9.3)	3011 (99.4)	16 (0.6)	2788 (81.6)	640 (18.4)	4019 (99.0)	39 (1.0)
p-value	0.001		0.001		<0.001		0.02	
Education level								
≤Elementary school	2896 (83.8)	608 (16.2)	5592 (99.0)	53 (1.0)	4741 (70.8)	1946 (29.2)	8544 (98.7)	111 (1.3)
Middle school	1965 (88.2)	267 (11.8)	2201 (98.7)	30 (1.3)	1894 (78.7)	478 (21.3)	2340 (98.6)	25 (1.4)
High school	4206 (90.7)	439 (9.3)	4624 (99.5)	24 (0.5)	4583 (82.5)	936 (17.5)	5460 (98.9)	54 (1.1)
≥College	3755 (92.9)	289 (7.1)	4036 (99.8)	8 (0.2)	3475 (86.4)	536 (13.6)	3994 (99.7)	16 (0.3)
p-value	<0.001		<0.001		<0.001		<0.001	
Household income level								
Low	2092 (83.3)	492 (16.7)	2716 (98.4)	51 (1.6)	2673 (68.6)	1225 (31.4)	3968 (97.9)	84 (2.1)
Mid-low	3129 (88.9)	419 (11.1)	4188 (99.5)	20 (0.5)	3580 (78.3)	1027 (21.7)	5146 (98.8)	56 (1.2)
Mid-high	3681 (91.8)	338 (8.2)	4696 (99.6)	20 (0.4)	4039 (82.7)	864 (17.3)	5575 (99.3)	42 (0.7)
High	3729 (91.9)	329 (8.1)	4637 (99.6)	20 (0.4)	4161 (85.4)	692 (14.6)	5313 (99.5)	19 (0.5)
p-value	<0.001		<0.001		<0.001		<0.001	
Region								
Megalopolis <sup>1</sup>	2397 (91.2)	249 (8.8)	3013 (99.2)	21 (0.8)	2785 (80.5)	644 (19.5)	3733 (99.0)	36 (1.0)
Metropolitan <sup>2</sup>	3321 (90.0)	395 (10.0)	4212 (99.6)	28 (0.4)	3874 (79.8)	976 (20.2)	5325 (99.0)	53 (1.0)
Others	7137 (89.1)	969 (10.9)	9285 (99.4)	67 (0.6)	8060 (79.0)	2288 (21.0)	11 331 (98.9)	117 (1.1)
p-value	0.05		0.29		0.33		0.98	
Employment state								
Employed	8460 (91.2)	877 (8.8)	9289 (99.5)	54 (0.5)	6422 (81.5)	1500 (18.5)	7842 (99.0)	70 (1.0)
Unemployed	3027 (86.0)	545 (14.0)	3519 (98.8)	54 (1.2)	6739 (78.1)	1962 (21.9)	8594 (98.8)	107 (1.2)
p-value	<0.001		<0.001		<0.001		0.2	
Lives with spouse								
Yes	8792 (90.4)	1039 (9.6)	9781 (99.4)	67 (0.6)	9468 (82.4)	2131 (17.6)	11 485 (99.1)	101 (0.9)
No	3337 (88.4)	509 (11.6)	5337 (99.3)	44 (0.7)	4629 (74.0)	1645 (26.0)	7595 (98.7)	95 (1.3)
p-value	0.005		0.45		<0.001		0.07	
Private insurance								
Yes	8853 (91.3)	858 (8.7)	11 565 (99.6)	54 (0.4)	10 488 (82.9)	2157 (17.1)	14 273 (99.3)	98 (0.7)
No	3740 (85.4)	726 (14.6)	4622 (98.9)	60 (1.1)	3974 (70.4)	1684 (29.6)	5760 (98.0)	104 (2.0)
p-value	<0.001		<0.001		<0.001		<0.001	
Smoking status								
Non	3243 (92.6)	306 (7.4)	5683 (99.6)	24 (0.4)	12 921 (81.2)	3142 (18.8)	17 894 (99.2)	138 (0.8)
Ex-smoker	1902 (90.7)	209 (9.3)	2096 (99.5)	15 (0.5)	300 (73.2)	104 (26.8)	396 (97.9)	8 (2.1)
Current smoker	7146 (88.6)	1018 (11.4)	8092 (99.3)	72 (0.7)	1040 (67.0)	553 (33.0)	1536 (96.5)	55 (3.5)
p-value	<0.001		0.13		<0.001		<0.001	

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**Table 2.** Continued from the previous page

	Male				Female			
	Suicidal ideation		Suicide attempt		Suicidal ideation		Suicide attempt	
	Never	Ever	Never	Ever	Never	Ever	Never	Ever
History of major depression								
No	12 113 (93.5)	936 (6.5)	13 023 (99.8)	32 (0.2)	13 308 (87.5)	1991 (12.5)	15 238 (99.6)	49 (0.4)
Yes	741 (54.1)	677 (45.9)	1327 (94.9)	84 (5.1)	1410 (41.9)	1917 (58.1)	3154 (95.2)	157 (4.8)
<i>p</i> -value	<0.001		<0.001		<0.001		<0.001	
Frequency of alcohol drinking								
Never	3048 (88.2)	448 (11.8)	5618 (99.4)	34 (0.6)	6037 (78.7)	1769 (21.3)	9707 (99.2)	83 (0.8)
Less than monthly	1366 (90.0)	165 (10.0)	1521 (99.6)	8 (0.4)	3476 (80.5)	852 (19.5)	4279 (98.9)	41 (1.1)
Monthly	1014 (91.8)	110 (8.2)	1113 (99.1)	12 (0.9)	1640 (83.0)	335 (17.0)	1962 (99.2)	15 (0.8)
2-4 times/mo	3125 (91.6)	295 (8.4)	3404 (99.6)	16 (0.4)	2402 (81.0)	558 (19.0)	2926 (99.0)	30 (1.0)
2-3 times/wk	2742 (90.8)	282 (9.2)	3007 (99.5)	19 (0.5)	876 (75.2)	270 (24.8)	1120 (98.0)	22 (2.0)
≥ 4 times/wk	1523 (84.5)	310 (15.5)	1807 (98.5)	27 (1.5)	245 (67.9)	114 (32.1)	342 (95.5)	15 (4.5)
<i>p</i> -value	<0.001		0.003		<0.001		<0.001	
Quantity of alcohol drinking per occasion (drinks)								
0	12 818 (0.0)	446 (11.9)	5588 (99.4)	34 (0.6)	6008 (78.7)	1764 (21.3)	9673 (99.1)	83 (0.9)
1-2	1799 (90.7)	216 (9.3)	2001 (99.3)	16 (0.7)	4809 (82.3)	1079 (17.7)	5832 (99.1)	46 (0.9)
3-4	1983 (90.0)	233 (10.0)	2197 (99.4)	16 (0.6)	2106 (80.5)	506 (19.5)	2581 (99.0)	27 (1.0)
5-6	1896 (91.3)	201 (8.7)	2085 (99.4)	13 (0.6)	964 (78.8)	246 (21.2)	1184 (98.1)	26 (1.9)
7-9	1947 (89.5)	237 (10.5)	2169 (99.5)	16 (0.5)	455 (73.4)	152 (26.6)	599 (99.1)	7 (0.9)
≥ 10	2171 (89.8)	276 (10.2)	2427 (99.3)	21 (0.7)	341 (69.2)	154 (30.8)	477 (97.0)	17 (3.0)
<i>p</i> -value	0.05		0.93		<0.001		<0.001	
Categorized AUDIT scores								
0-7	7240 (90.3)	874 (9.7)	10 204 (99.4)	66 (0.6)	13 319 (80.6)	3388 (19.4)	18 520 (99.1)	158 (0.9)
8-15	3381 (90.8)	363 (9.2)	3727 (99.7)	17 (0.3)	1128 (75.5)	356 (24.5)	1456 (98.7)	26 (1.3)
16-19	1169 (90.5)	133 (9.5)	1293 (99.1)	13 (0.9)	142 (64.5)	74 (35.5)	208 (96.0)	8 (4.0)
≥ 20	1065 (83.3)	243 (16.7)	1286 (98.7)	20 (1.3)	130 (59.7)	90 (40.3)	205 (94.1)	14 (5.9)
<i>p</i> -value	<0.001		0.005		<0.001		<0.001	
Frequency of alcoholic blackouts								
Never	9005 (90.5)	1039 (9.5)	12 132 (99.5)	69 (0.5)	13 314 (80.4)	3428 (19.6)	18 543 (99.1)	166 (0.9)
Less than monthly	1971 (90.6)	233 (9.4)	2187 (99.4)	18 (0.6)	671 (71.8)	239 (28.2)	893 (98.4)	18 (1.6)
Monthly	979 (88.5)	152 (11.5)	1122 (99.5)	8 (0.5)	208 (72.3)	86 (27.7)	283 (96.9)	10 (3.1)
More than once a week	333 (76.0)	106 (24)	426 (97.1)	14 (2.9)	60 (55.8)	45 (44.2)	97 (93.9)	7 (6.1)
<i>p</i> -value	<0.001		<0.001		<0.001		<0.001	

Values are presented as number (%).

AUDIT, Alcohol Use Disorders Identification Test.

<sup>1</sup>Megalopolis characterizes those living in Seoul.

<sup>2</sup>Metropolitan refers to those living in other large cities.

males and females for most sociodemographic factors and alcohol consumption patterns. Among the study subjects, 1613 males (10.2%) and 3908 females (20.5%) reported that they had experienced suicidal ideation in the previous 12 months, and 116 males (0.6%) and 206 females (1.0%) had attempted suicide during the previous 12 months.

The sociodemographic characteristics affecting suicidal ide-

ation and suicide attempts are shown in Table 2. The prevalence of suicidal ideation and suicide attempts decreased as education level and household income level increased. The prevalence of suicidal ideation was greater among participants living in rural areas, but this tendency was not statistically significant in suicide attempters. The prevalence of suicidal ideation and suicide attempts was greater among those who were

unemployed, living alone, or who had no private insurance. Differences in suicidal ideation were found depending on smoking status, but smoking status had no association with suicide attempts. Significant differences were found depending on whether a history of major depression was present, with a greater prevalence of both suicidal ideation and suicide attempts, among those with a history of major depression.

The prevalence of suicidal ideation and suicide attempts in females was higher than in males. As the level of education and household income increased, the prevalence of suicidal behavior decreased. The effects of characteristics involving region of residence, employment status, living alone, and private insurance were similar to those found in males. However,

the prevalence of suicide attempts by smoking status increased from non-smokers to ex-smokers and current smokers. The effect of a history of major depression was similar to that found in males.

Table 3 shows the results of all adjusted logistic regression analyses between patterns of alcohol consumption and suicidal behavior. We display the associations of the four types of alcohol consumption patterns that were analyzed (drinking frequency, drinking quantity, frequency of alcoholic blackouts, and categorized AUDIT score) with suicidal ideation and suicide attempts in males and females.

In males, no significant associations were found between either drinking frequency or drinking quantity and suicidal be-

**Table 3.** Logistic regression results regarding the associations of patterns of alcohol consumption with suicidal ideation and suicide attempts by sex

	Male				Female			
	Suicidal ideation		Suicide attempts		Suicidal ideation		Suicide attempts	
	OR (95% CI)	p for trend	OR (95% CI)	p for trend	OR (95% CI)	p for trend	OR (95% CI)	p for trend
Frequency of alcohol drinking		0.50		0.43		0.004		0.09
Never	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Less than monthly	1.01 (0.73, 1.40)		0.54 (0.14, 2.02)		1.22 (1.06, 1.40)		1.11 (0.63, 1.95)	
Monthly	0.79 (0.54, 1.14)		0.99 (0.40, 2.47)		1.02 (0.83, 1.25)		1.17 (0.52, 2.63)	
2-4 times/mo	0.87 (0.65, 1.18)		0.87 (0.35, 2.18)		1.13 (0.95, 1.34)		1.16 (0.61, 2.22)	
2-3 times/wk	0.88 (0.65, 1.20)		0.84 (0.39, 1.80)		1.41 (1.11, 1.80)		1.26 (0.58, 2.75)	
≥4 times/wk	1.22 (0.91, 1.64)		1.26 (0.63, 2.52)		1.57 (1.12, 2.20)		2.85 (1.18, 6.87)	
Quantity of alcohol drinking per occasion (drinks)		0.05		0.08		<0.001		0.18
0	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
1-2	0.83 (0.61, 1.12)		0.85 (0.36, 2.03)		1.06 (0.93, 1.21)		1.03 (0.59, 1.79)	
3-4	0.99 (0.73, 1.34)		0.81 (0.35, 1.87)		1.34 (1.13, 1.59)		1.35 (0.69, 2.65)	
5-6	0.88 (0.64, 1.21)		1.04 (0.40, 2.74)		1.27 (1.01, 1.59)		2.24 (1.13, 4.41)	
7-9	1.10 (0.80, 1.50)		0.89 (0.41, 1.95)		1.51 (1.14, 2.00)		0.51 (0.18, 1.48)	
≥10	1.02 (0.74, 1.40)		1.07 (0.49, 2.36)		1.84 (1.28, 2.65)		1.92 (0.80, 4.60)	
Frequency of alcoholic blackouts		<0.001		0.17		<0.001		0.06
Never	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
Less than monthly	1.13 (0.91, 1.41)		0.87 (0.43, 1.78)		1.63 (1.29, 2.07)		1.19 (0.60, 2.38)	
Monthly	1.17 (0.90, 1.52)		0.64 (0.26, 1.57)		1.42 (0.99, 2.05)		1.76 (0.71, 4.40)	
More than once a week	2.14 (1.47, 3.13)		2.37 (1.14, 4.94)		2.16 (1.20, 3.89)		2.51 (0.82, 7.65)	
Categorized AUDIT scores		<0.001		0.36		<0.001		0.01
0-7	1.00 (reference)		1.00 (reference)		1.00 (reference)		1.00 (reference)	
8-15	1.16 (0.94, 1.43)		0.38 (0.18, 0.83)		1.41 (1.17, 1.71)		1.38 (0.77, 2.49)	
16-19	1.12 (0.85, 1.47)		1.31 (0.61, 2.82)		1.52 (1.01, 2.30)		1.90 (0.66, 5.41)	
≥20	1.68 (1.28, 2.10)		1.31 (0.66, 2.61)		2.65 (1.68, 4.17)		2.64 (1.17, 5.96)	

Adjusted for age, number of household member, education level, household income level, region, employment status, living alone, private insurance, smoking status, and history of major depression.

OR, odds ratio; CI, confidence interval; AUDIT, Alcohol Use Disorders Identification Test.



havior. A greater than weekly frequency of alcoholic blackouts was associated with an OR for suicidal ideation of 2.14 (95% CI, 1.47 to 3.13), and AUDIT scores of 20 and over were associated with an OR for suicidal ideation of 1.68 (95% CI, 1.28 to 2.10). The trend tests for suicidal ideation were statistically significant depending on the frequency of alcoholic blackouts and AUDIT scores. A greater than weekly frequency of alcoholic blackouts was associated with an OR for suicide attempt of 2.37 (95% CI, 1.14 to 4.94), but the trend was not significant.

A drinking frequency of two to three times per week was associated with an OR for suicidal ideation of 1.41 (95% CI, 1.11 to 1.80), and a drinking frequency of more than four times per week was associated with an OR for suicidal ideation of 1.57 (95% CI, 1.12 to 2.20). The consumption of three or more drinks per occasion was associated with suicidal ideation, that were significantly higher than what was observed for non-drinkers. A greater than weekly frequency of alcoholic blackouts was associated with an OR for suicidal ideation of 2.16 (95% CI, 1.20 to 3.89). Higher AUDIT scores were associated with a significantly increased OR for suicidal ideation. The trends of suicidal ideation were found to be statistically significant for all patterns of alcohol consumption that were analyzed. A drinking frequency of four times per week or more was associated with an OR for suicide attempts of 2.85 (95% CI, 1.18 to 6.87), and AUDIT scores of 20 and over were associated with an OR for suicide attempts of 2.64 (95% CI, 1.17 to 5.96).

## DISCUSSION

According to the 2007–2011 KNHANES results, 10.2% of males and 20.5% of females have experienced suicidal ideation, and 0.6% of males and 1.0% of females attempt suicide each year in Korea. According to data from Statistics Korea, the suicide rate in Korea was 31.7 per 100 000 people, making suicide the fourth leading cause of death in 2011 [19]. In the US, the 12-month prevalence estimate of suicide attempts was 0.4%, according to the National Comorbidity Survey, and the suicide rate was approximately 11.0 per 100 000 [18]. Considering that the mean suicide rate of OECD countries has been lower than 15 per 100 000 people since 2000 [20], suicide is clearly a major public health problem in Korea.

Numerous factors influence suicidal ideation and suicide attempts. Social factors such as economic deprivation, poor educational attainment, unemployment, or the death of a spouse are related to suicide and physical illnesses like cancer, AIDS, di-

abetes, schizophrenia, and alcohol use disorders. Previous studies have shown that a history of major depression and high emotional stress increase the risk of suicide attempts [4,21–25]. Korea is engaged in several suicide prevention campaigns, but they have not yet shown clear effects.

One of the neurobiological mechanisms associated with suicide is an abnormal serotonergic reaction, as indicated by features such as increased serotonin receptors and decreased serotonin metabolites (e.g., 5-hydroxyindoleacetic acid) [26]. It is well known that chronic alcohol exposure is linked to the action of serotonin, and that alcohol suppresses functional changes in serotonin [27].

We found that AUDIT scores were associated with suicidal ideation in males and associated with suicidal ideation and suicide attempts in females. Especially in females, higher AUDIT scores were associated with significantly higher ORs for suicidal ideation than were found with AUDIT scores of 7 and lower, and a tendency was noted for increased ORs for suicidal ideation to correlate with increased AUDIT scores. McCloud et al. [28] found that AUDIT scores were associated with suicidal behavior in a psychiatric population. Their results were similar to ours, but they did not find a sex difference. Their study subjects were limited to psychiatric patients, which could have affected their results. We were unable to find any study evaluating these associations in the general adult population. Thus, to our knowledge, this is the first study to examine the association between AUDIT scores and suicidal behavior in the general adult population.

Alcoholic blackouts were associated with suicidal ideation and suicide attempts in males, and were associated with suicidal ideation in females. In males, a frequency of alcoholic blackouts of more than once a week was associated with a significantly higher OR for suicidal ideation and suicide attempts. In females, a non-zero frequency of alcoholic blackouts was associated with suicidal ideation ORs higher than that found among those who had never experienced alcoholic blackouts, but a monthly frequency of blackouts was not found to have a significant effect. To the best of our knowledge, this is the first study to examine the association between alcoholic blackouts and suicidal behavior.

In this study, patterns of alcohol consumption and suicidal behavior were found to be different among males and females. Previous studies have shown that patterns of alcohol consumption and emergence of drinking problem were different by sex, and they were associated with the weight of body water [29,30]. It is also known that the risk factors of suicide differ ac-

cording to sex [31,32]. In a study conducted on middle-aged adults in Korea, risk factors relating to suicide in males were associated with marital status, while risk factors relating to suicide among females were associated with type of occupation and income [33].

This study has some limitations. These results are not able to address the causality of alcoholic behavior and suicidal behavior because we used cross-sectional data. The problem of reverse causation is most likely derived from depression. Alcohol abuse can lead to depression, causing suicide, while patients with depression may use alcohol to alleviate depression [20]. However, we controlled for major depression, which refers to a depressive state lasting more than two weeks during the previous 12 months. Furthermore, most of the data were self-reported, so recall bias may also be a factor. Additionally, selection bias may be present due to the rejection of some responses in the formulation of the KNHANES. Although the rate of suicide attempts is high in adolescence [34], we were unable to examine this age range due to limitations of the survey data. However, the study population of previous studies about alcohol use and suicide attempts included only alcohol-dependent individuals. One advantage of this study is that we used data from a nationwide survey. Another advantage is that this is the first study to compare the strength of associations between four types of behavior regarding alcohol consumption and suicidal behavior.

Suicide is an important public health problem in Korea. In this study we found that distinct patterns of alcohol consumption were associated with suicidal behaviors. In particular, only alcoholic blackouts and categorized AUDIT scores were associated with suicidal behavior in males. We therefore suggest that further research is needed to examine this relationship prospectively and in other settings.

## CONFLICT OF INTEREST

The authors have no conflicts of interest related to the material presented in this paper.

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