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Gender-specific relationships between alcohol drinking patterns and metabolic syndrome: the Korea National Health and Nutrition Examination Survey 2008

Kayoung Lee*
Department of Family Medicine, Busan Paik Hospital, Inje University College of Medicine, 633-165 Kaegum-dong, Busan Jin-Gu, Busan, South Korea

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Abstract

Objective: To examine gender-specific relationships between alcohol drinking patterns (average drinking frequency, typical drinking quantity and frequency of binge drinking) and the prevalence of metabolic syndrome (MetS) and its components in the Korean population.
Design: Cross-sectional study using complex sampling design analyses.
Setting: The Korea National Health and Nutrition Examination Survey IV, which was conducted in 2008.
Subjects: Current drinkers (*n* 3793, 1963 men and 1830 women).
Results: After adjusting for confounders (age, educational level, income, physical activity, smoking, energy intake and drinking frequency in the analysis for drinking quantity), the associations of drinking quantity and frequency of binge drinking with the prevalence of MetS were gender-specific. Seven or more drinks for men and ≥3 drinks for women per typical occasion and binge drinking ≥1 time/week for both sexes resulted in significantly higher odds for the prevalence of MetS compared with men and women who had 1 or 2 drinks and no instances of binge drinking. The association of drinking quantity and the criteria of MetS was stronger for men with high blood pressure and abdominal obesity, whereas it was stronger for women with high glucose. Binge drinking frequency was dose-dependently associated with high TAG, high glucose, high blood pressure and abdominal obesity in men, and with high glucose and high blood pressure in women. Interestingly, average drinking frequency was not associated with the prevalence of MetS in either sex.
Conclusions: Higher drinking quantity and frequent binge drinking are indicators of a higher prevalence of MetS, and the association strength is thought to be gender-specific.

Keywords
Gender
Alcohol drinking patterns
Metabolic syndrome

Although relationships between alcohol consumption and components of the metabolic syndrome (MetS) have been observed[1], the associations have not been consistent for males and females[2]. Alcohol intake has been associated with an increased risk of hypertension in men[3,4], high blood glucose in women[4] and high TAG in both sexes, whereas it has been associated with a decreased risk of low HDL cholesterol (HDL-C) in both sexes[4]. Similar to the sex differences in the relationships between alcohol intake and each component of MetS, the association between alcohol consumption and MetS per se is gender-specific[5]. In a recent meta-analysis of observational studies, alcohol consumption of <40 g/d in men or <20 g/d in women was associated with reduced prevalence of MetS[5]. Quantifications of daily alcohol consumption can be obtained when there is information about typical drinking quantity, drinking frequency and specific alcoholic beverages. These alcohol drinking patterns may be gender-specific and these gender-specific drinking patterns may contribute to gender differences in the association between alcohol consumption and MetS.

Most current studies have not accounted for different drinking patterns and gender-specific relationships. At least one study reported a relationship between alcohol drinking patterns and MetS in the USA, but gender-specific information was not available[6]. Selection of a reference group in the association between alcohol consumption and MetS has been controversial. Because non-drinkers include lifelong abstainers, former drinkers and irregular abstainers, the combination of these heterogeneous groups could influence a study's validity[5,6]. The previous study on alcohol drinking patterns and MetS also considered this

*Corresponding author: Email kayoung.fmlky@gmail.com

problem, and then chose the reference group as the lowest category of typical drinking quantity and drinking frequency in current drinkers[6]. The present study aimed to examine the gender-specific relationship between alcohol drinking patterns and the prevalence of MetS in current Korean drinkers using data from the Korea National Health and Nutrition Examination Survey (KNHANES) IV.

Methods

The KNHANES IV was conducted in 2008 by the Korea Centers for Disease Control and Prevention[7]. It involved population-based random sampling of 12 528 Koreans in households across 200 national districts and 4600 households. Some 9744 individuals participated in the Healthy Behavior Survey and the Health Examination Survey, or the Nutrition Survey. The data used in the present study were obtained from 3793 current drinkers (1963 men and 1830 women) aged 19 years and older. Current drinkers were defined as participants who consumed any alcoholic drinks during the past year. All participants signed a form that signified their informed consent.

Waist circumference was measured for each participant at a level midway between the lowest lateral border of the ribs and the uppermost lateral iliac crest, with the participant standing. Blood pressure (BP) measurements were performed with a standard manual sphygmomanometer while participants were in a sitting position. Antecubital venous blood samples were taken from all participants after a 12 h overnight fast. The levels of HDL-C, TAG and fasting glucose were measured using an automatic analyser (Hitachi Automatic Analyzer 7600, Hitachi, Japan). The following criteria were used to define abnormalities of MetS components: (i) waist circumference >90 cm in men or >85 cm in women[8]; (ii) BP ≥130/85 mmHg; (iii) fasting glucose ≥5·6 mmol/l (≥100 mg/dl); (iv) HDL-C <1·03 mmol/l (<40 mg/dl) for men or <1·29 mmol/l (<50 mg/dl) for women; and (v) TAG ≥1·63 mmol/l (≥150 mg/dl)[9]. Individuals with at least three abnormal MetS components among the five components mentioned were classified as having MetS[9].

Self-reported questionnaires were used to assess each participant's alcohol consumption patterns during the last year, which included average drinking frequency (<1/month, 1/month, 2–4/month, 2–3/week, ≥4/week), typical drinking quantity per drinking day (1 or 2 drinks, 3 or 4 drinks, 5 or 6 drinks, 7–9 drinks, ≥10 drinks) and frequency of binge drinking, which was defined as ≥7 drinks/drinking day for men and ≥5 drinks/drinking day for women (0, <1/month, 1/month, 1/week, every day). In these questions, a 'drink' was defined as the alcohol quantity contained in a standard cup for specific alcoholic beverages. For example, a drink was defined as 30 ml of liquor and 200 ml of beer (= 10 g of pure alcohol). Self-reported questionnaires were also used to assess smoking status and physical activity (regular walking, high-intensity exercise, moderate-intensity exercise). Face-to-face interviews were used to obtain data about participants' educational level and monthly family income. Daily energy intake was assessed using a 24 h recall method.

All analyses used sampling weights to report estimates that would be representative of the Korean population. These analyses were performed using the statistical software package PASW Statistics 18 release 18·0·0 (SPSS Inc., Chicago, IL, USA) to account for the complex sampling design and to calculate weighted means, percentages, standard errors and odds ratios. Because there was a significant interaction between gender and alcohol consumption pattern, in the multiple logistic regression analysis gender-specific models were conducted to estimate the odds ratios for the prevalence of MetS. Potential confounders in analyses of drinking frequency and drinking quantity were age, educational level, income, physical activity, smoking and energy intake. In addition, drinking frequency was a confounder in the analysis of typical drinking quantity, and typical drinking quantity was a confounder in the analysis of drinking frequency. Multiple logistic regression analyses were used to find associations between the individual criteria of MetS and alcohol consumption patterns after adjusting for potential confounders. Similar multiple logistic regression analyses were performed for the presence of two or more abnormalities among the four MetS components excluding HDL-C as an outcome. Multiple linear regression analysis was applied to examine a linear trend in these relationships. A two-sided P value of <0·05 was considered statistically significant.

Results

Overall, 85 % of men and 44 % of women consumed more than 2 drinks/drinking day. Interestingly, 47 % of men and 13 % of women reported binge drinking ≥1 time/week. About 28 % of men and 19 % of women satisfied the criteria of MetS. High TAG, high glucose and high BP were more frequent in men, whereas low HDL-C was more prevalent in women (Table 1). Men and women who consumed a higher quantity of alcohol on each drinking day had a higher odds ratio for the prevalence of MetS compared with individuals who consumed 1 or 2 drinks/drinking day, even after controlling for drinking frequency (P for linear trend = 0·001 in men, <0·001 in women). This association strength was gender-specific. Women who consumed more than 2 drinks/drinking day were more likely to have MetS than women who consumed 1 or 2 drinks (OR = 1·74 (95 % CI 1·19, 2·54) for 3 or 4 drinks/drinking day; OR = 2·16 (95 % CI 1·26, 3·72) for 5 or 6 drinks/drinking day; OR = 4·08 (95 % CI 2·18, 7·62) for 7–9 drinks/drinking day; OR = 4·51

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Table 1 Characteristics of the study population from KNHANES IV data, 2008

	Men (*n* 1963)		Women (*n* 1830)	
	% or Mean	SE	% or Mean	SE
Average drinking frequency in past year				
<1/month	11·6	0·9	37·0	1·4
1/month	9·1	0·8	19·1	1·0
2–4/month	29·6	1·4	26·8	1·0
2–3/week	33·6	1·4	13·8	1·0
≥4/week	16·2	1·0	3·3	0·4
Typical drinking quantity (drinks/typical occasion)				
1 or 2	14·6	0·9	55·7	1·3
3 or 4	17·1	1·0	23·7	1·1
5 or 6	18·0	1·0	10·3	0·7
7–9	24·3	1·2	6·8	0·8
≥10	26·0	1·3	3·5	0·5
Binge drinking frequency (≥7 drinks (men), ≥5 drinks (women))				
0	15·6	1·0	47·3	1·4
<1/month	16·5	0·9	23·6	1·1
1/month	20·3	1·1	15·2	1·1
1/week	32·8	1·1	9·7	0·8
Every day	14·0	0·9	3·3	0·5
Prevalence of MetS	28·1	1·2	18·6	1·3
Serum TAG ≥ 1·69 mmol/l	43·8	1·2	18·8	1·0
Serum HDL-C < 1·04 mmol/l (men), < 1·29 mmol/l (women)	25·5	1·2	43·2	1·3
FBG ≥ 5·55 mmol/l	34·8	1·3	23·1	1·3
BP ≥ 130/85 mmHg	39·5	1·3	24·4	1·2
WC > 90 cm (men), > 85 cm (women)	27·4	1·3	25·1	1·4
Potential confounders				
Age (years)	45·8	0·3	45·4	0·3
Education ≤ graduated middle school	25·2	1·3	34·	1·4
Monthly family income <$US 1800	29·3	1·5	32·6	1·7
Energy intake (kJ/d; mean and SE)	9481	121	6849	71
Energy intake (kcal/d; mean and SE)	2266	29	1637	17
Current smoker	51·1	1·2	7·1	0·7
Physical activity				
High intensity	19·4	1·0	16·6	0·9
Moderate intensity	14·2	1·0	16·4	1·2
Walking	45·4	1·5	43·0	1·4

KNHANES, Korea National Health and Nutrition Examination Survey; MetS, metabolic syndrome; HDL-C, HDL cholesterol; FBG, fasting blood glucose; BP, blood pressure; WC, waist circumference.
Data are presented as % and SE, unless indicated otherwise.

(95% CI 1·88, 10·85) for ≥10 drinks/drinking day). Compared with men who consumed 1 or 2 drinks/drinking day, men who consumed more than 6 drinks were more likely to have MetS (OR = 2·03 (95% CI 1·24, 3·34) for 7–9 drinks/drinking day; OR = 2·41 (95% CI 1·44, 4·04) for ≥10 drinks/drinking day). The association between frequency of binge drinking and the prevalence of MetS was also dose-dependent in both sexes, and the strength of the association was similar in both sexes. More than one binge drinking episode weekly was associated with higher odds for the prevalence of MetS (OR = 2·13 (95% CI 1·43, 3·16) for 1/week and OR = 2·16 (95% CI 1·39, 3·36) for every day in men; OR = 1·90 (95% CI 1·01, 3·55) for 1/week and OR = 2·56 (95% CI 1·24, 5·28) for every day in women, in both *P* for linear trend <0·001). By comparison, drinking frequency was not significantly associated with the prevalence of MetS in males or females (Table 2).

The association between alcohol drinking patterns and each of the MetS components was also gender-specific. Although individuals with high alcohol consumption had increased odds of high TAG, high glucose, high BP and abdominal obesity in both sexes, the strengths of the association between typical drinking quantities and the MetS components were gender-specific. The association was stronger for men with high BP (from OR = 1·68 for 3 or 4 drinks/drinking day to OR = 3·38 for ≥10 drinks/drinking day, *P* for linear trend <0·001) and abdominal obesity (from OR = 1·72 for 3 or 4 drinks/drinking day to OR = 4·17 for ≥10 drinks/drinking day, *P* for linear trend <0·001), whereas it was stronger for women with high glucose (from OR = 1·64 for 3 or 4 drinks/drinking day to OR = 2·65 for ≥10 drinks/drinking day, *P* for linear trend <0·001). The association between the frequency of binge drinking and four of the five MetS criteria (i.e. high TAG, high glucose, high BP and abdominal obesity) was dose-dependent in men (*P* for linear trend <0·05). In women, the frequency of binge drinking was dose-dependently associated with high glucose and high BP (*P* for linear trend <0·01). Frequent drinking (≥4 times/week for men, 2–3 times/week for women) was associated with lower odds of low HDL-C in both sexes (OR = 0·56 (95% CI 0·32, 0·99) for men, OR = 0·55 (95% CI 0·34, 0·88)

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Table 2 The association between alcohol drinking patterns and MetS from KNHANES IV data, 2008

	Men						Women					
	Prevalence		Model I		Model II		Prevalence		Model I		Model II	
	%	SE	OR	95 % CI	OR	95 % CI	%	SE	OR	95 % CI	OR	95 % CI
Average drinking frequency in past year*												
<1/month	24·5	3·4	1·00	Ref.	1·00	Ref.	21·0	1·9	1·00	Ref.	1·00	Ref.
1/month	24·8	3·6	1·20	0·69, 2·10	0·98	0·53, 1·83	17·6	2·6	0·87	0·55, 1·37	0·75	0·48, 1·18
2–4/month	24·2	2·0	1·07	0·70, 1·64	0·76	0·46, 1·27	16·7	1·9	0·92	0·62, 1·37	0·69	0·45, 1·06
2–3/week	32·1	2·0	1·54	0·96, 2·46	1·00	0·57, 1·77	15·7	2·8	0·90	0·51, 1·57	0·55	0·30, 1·00
≥4/week	31·3	2·8	1·40	0·86, 2·27	0·91	0·52, 1·60	25·4	5·7	1·11	0·53, 2·34	0·67	0·32, 1·43
P for linear trend			0·196		0·464				0·907		0·189	
Typical drinking quantity (drinks/typical occasion)†												
1 or 2	21·9	2·8	1·00	Ref.	1·00	Ref.	16·9	1·5	1·00	Ref.	1·00	Ref.
3 or 4	23·4	2·6	1·09	0·70, 1·72	1·15	0·72, 1·85	19·1	2·2	1·52	1·06, 2·18	1·74	1·19, 2·54
5 or 6	25·8	2·5	1·57	0·96, 2·57	1·66	0·96, 2·88	17·1	3·2	1·77	1·06, 2·99	2·16	1·26, 3·72
7–9	28·6	2·2	1·91	1·22, 2·98	2·03	1·24, 3·34	24·9	4·6	3·16	1·71, 5·85	4·08	2·18, 7·62
≥10	35·8	2·7	2·34	1·52, 3·60	2·41	1·44, 4·04	33·0	6·8	3·67	1·60, 8·44	4·51	1·88, 10·85
P for linear trend			<0·001		0·001				0·002		<0·001	
Binge drinking frequency (≥7 drinks (men), ≥5 drinks (women))												
None	22·1	2·6	1·00	Ref.			18·8	1·8	1·00	Ref.		
<1/month	23·7	2·7	1·32	0·83, 2·09			16·9	2·1	1·32	0·85, 2·04		
1/month	24·4	2·4	1·42	0·94, 2·16			17·6	2·6	1·60	0·98, 2·61		
1/week	33·0	2·0	2·13	1·43, 3·16			19·8	3·5	1·90	1·01, 3·55		
Every day	40·8	10·6	2·16	1·39, 3·36			30·9	7·2	2·56	1·24, 5·28		
P for linear trend			<0·001						<0·001			

MetS, metabolic syndrome; KNHANES, Korea National Health and Nutrition Examination Survey; Ref., referent category.
Model I adjusted for age, education (≤ or > middle school), monthly income (< or ≥ $US 1800), tobacco use (current or non-current), high-intensity physical activity (yes or no), moderate-intensity physical activity (yes or no), regular walking (yes or no) and daily energy intake. Model II adjusted for all variables in model I and other alcohol drinking pattern (*typical drinking quantity or †average drinking frequency).

for women) and higher odds of high BP in women (OR = 1·82 (95 % CI 1·09, 3·03)). When the analyses were performed for MetS components excluding HDL-C, men and women who consumed ≥3 drinks per typical occasion were more likely to have at least two abnormal MetS components compared with those who consumed <3 drinks. In the same model, binge drinking even <1/month in men (OR = 1·70 (95 % CI, 1·16, 2·50)) and 1/month in women (OR = 1·71 (95 % CI 1·12, 2·63)) was associated with higher odds of two or more MetS components (Tables 3 and 4).

Discussion

Current results demonstrated that higher drinking quantity per drinking day and frequent binge drinking were associated with a higher prevalence of MetS in Korean men and women. In addition, the strengths of the associations were gender-specific. Compared with light drinkers (1 or 2 drinks/drinking day), women who consumed ≥3 drinks were at significantly increased risk of MetS, whereas men were at significantly increased risk when they consumed ≥7 drinks. In males and females, binge drinking (≥7 drinks for men and ≥5 drinks for women) was associated with higher odds of MetS when the frequency of binge drinking episodes was once weekly or more. In contrast, the association between drinking frequency and the prevalence of MetS was not distinct in both sexes. Interestingly, typical drinking quantity rather than drinking frequency may play a greater role in the prevalence of MetS in Korean men and women.

Although the relationship between alcohol drinking patterns and MetS has not been extensively studied, previous studies examining daily quantities of alcohol consumption are abundant. A population-based study in the USA showed findings that are consistent with our current results[6]. Fan *et al.* showed that drinking in excess of national guidelines and binge drinking were associated with increased odds ratios for MetS after adjusting for confounders, including sex[6]. Therefore information on gender-specific relationships was not available from that study.

Numerous population-based studies investigating the relationship between daily consumed alcohol quantity and the prevalence of MetS have shown inconsistent results. In addition, a meta-analysis of observational studies demonstrated different alcohol intake levels for men and women (<40 g/d in men and <20 g/d in women)[2,5]. In some studies moderate alcohol consumption was associated with a lower risk of MetS in both sexes[10]; in other studies however, this relationship was significant only in women[11–14]. In addition, several studies did not find an effect of alcohol on the prevalence of MetS[15,16], whereas others found that alcohol increased the odds of MetS[17,18]. Differences in study methods and design may explain the discrepancies between the results (e.g. definition of a reference group; measures of alcohol consumption behaviour; adjustment of confounders or characteristics of study population, such as ethnicity and age)[2]. The definition of reference group has been debated, but most previous studies included a reference group that was a heterogeneous combination of lifetime abstainers, former drinkers and intermittent abstainers[5,6]. In the present study, the reference group was composed of individuals who were categorized as light drinkers (<1/month for drinking frequency, 1 or 2 drinks for typical drinking quantity). For this reason, comparisons between current findings and previous results using a different reference group are not appropriate.

The associations between alcohol drinking patterns and each of the MetS components were also gender-specific. Numerous studies on the relationships between alcohol consumption and individual components of MetS have shown discrepant findings[2]. In most studies, serum HDL-C had a dose-response relationship with alcohol consumption[19]. Serum TAG levels, on the other hand, have been insignificantly[19], positively and inversely associated with long-term alcohol consumption in various studies[2]. Alcohol consumption had a U-shaped relationship with fasting glucose[20], and it was protective for the risk of type 2 diabetes among rare and light drinkers[21]. In addition, BP levels were higher in moderate-to-heavy drinkers[2] and decreased with a reduction in alcohol consumption[22]. Moreover, the risk of abdominal obesity increased with higher alcohol consumption in men[23]. Interestingly, a prospective study demonstrated that light-to-moderate alcohol consumption was protective for the risk of being overweight among women in a normal weight range[24]. The discrepancies between studies may be dependent on the prevalence of individual components of MetS[25]. In our Korean population, typical drinking quantity was positively associated with higher odds of high TAG, high glucose, high BP and abdominal obesity in both sexes, whereas frequent drinking was associated with lower odds of low HDL-C in both sexes. In addition, neither typical drinking quantity nor binge drinking was associated with low HDL-C in males or females. These findings are similar to the results of a study in the USA[6]; however, the present study also showed the gender-specific strengths of the association in each relationship of alcohol drinking patterns with MetS and its components (this information was not available in the US study). Future studies are needed to replicate the gender-specific associations and explore the mechanisms of sex differences in the relationship between alcohol drinking patterns and MetS.

The present findings were derived from a representative Korean population, but they can be generalized to current Korean drinkers. Additionally, as the current findings replicate previous findings of the US population[6], the relationships may not be applied to a specific population.

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Table 3 The association between alcohol drinking patterns and MetS components in men from KNHANES IV data, 2008

	TAG ≥ 1·69 mmol/l		HDL-C < 1·04 mmol/l		FBG ≥ 5·55 mmol/l		BP ≥130/85 mmHg		WC > 90 cm		≥2 abnormal components excluding HDL-C	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Average drinking frequency in past year*												
<1/month	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
1/month	0·68	0·39, 1·17	0·97	0·53, 1·76	1·07	0·63, 1·82	1·36	0·75, 2·46	1·55	0·92, 2·61	1·23	0·72, 2·09
2–4/month	0·73	0·45, 1·18	0·66	0·40, 1·09	1·17	0·74, 1·86	1·10	0·64, 1·89	0·71	0·42, 1·20	0·79	0·49, 1·26
2–3/week	1·09	0·67, 1·76	0·61	0·36, 1·04	1·23	0·74, 2·05	1·66	0·99, 2·78	0·78	0·46, 1·33	1·13	0·68, 1·86
≥4/week	0·87	0·83, 1·45	0·56	0·32, 0·99	1·57	0·95, 2·58	1·67	0·96, 2·82	1·11	0·63, 1·95	1·48	0·89, 2·49
P for linear trend	0·066		0·116		0·478		0·026		0·039		0·013	
Typical drinking quantity (drinks/typical occasion)†												
1 or 2	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
3 or 4	0·98	0·64, 1·50	0·97	0·53, 1·76	1·33	0·86, 2·06	1·68	1·06, 2·67	1·72	1·02, 2·91	1·69	1·09, 2·64
5 or 6	1·24	0·76, 2·01	0·66	0·40, 1·09	1·33	0·89, 2·25	2·34	1·51, 3·64	2·72	1·65, 4·50	3·01	1·83, 4·95
7–9	1·69	1·06, 2·70	0·61	0·36, 1·04	1·70	1·11, 2·61	3·34	2·18, 5·10	2·16	1·26, 3·70	3·39	2·07, 5·58
≥10	1·76	1·10, 2·80	0·56	0·32, 0·99	1·90	1·15, 3·13	3·38	2·18, 5·26	4·17	2·40, 7·24	5·15	3·12, 8·49
P for linear trend	0·005		0·502		0·079		<0·001		<0·001		<0·001	
Binge drinking frequency (≥7 drinks)												
None	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
<1/month	1·05	0·72, 1·53	0·99	0·63, 1·54	1·29	0·82, 2·03	1·11	0·74, 1·66	1·86	1·20, 2·87	1·70	1·16, 2·50
1/month	0·94	0·64, 1·39	0·67	0·43, 1·05	1·50	0·99, 2·27	1·76	1·18, 2·63	2·10	1·38, 3·21	2·10	1·42, 3·12
1/week	1·70	1·19, 2·43	0·74	0·50, 1·09	1·77	1·19, 2·61	2·43	1·61, 3·64	1·92	1·29, 2·86	3·50	2·41, 5·07
Every day	1·36	0·93, 2·00	0·79	0·49, 1·26	2·16	1·37, 3·42	2·53	1·61, 3·96	3·13	2·00, 4·90	4·07	2·66, 6·21
P for linear trend	0·026		0·304		0·006		<0·001		<0·001		<0·001	

MetS, metabolic syndrome; KNHANES, Korea National Health and Nutrition Examination Survey; HDL-C, HDL cholesterol; FBG, fasting blood glucose; BP, blood pressure; WC, waist circumference; Ref., referent category.
Adjusted for age, education (≤ or > middle school), monthly income (< or ≥ $US 1800), tobacco use (current or non-current), high-intensity physical activity (yes or no), moderate-intensity physical activity (yes or no), regular walking (yes or no), daily energy intake and *typical drinking quantity or †average drinking frequency.

Table 4 The association between alcohol drinking patterns and MetS components in women from KNHANES IV data, 2008

	TAG ≥ 1·69 mmol/l		HDL-C < 1·29 mmol/l		FBG ≥ 5·55 mmol/l		BP ≥ 130/85 mmHg		WC > 85 cm		≥2 abnormal components excluding HDL-C	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Average drinking frequency in past year*												
<1/month	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
1/month	0·85	0·57, 1·25)	0·79	0·58, 1·07	0·90	0·61, 1·33	1·32	0·90, 1·95	0·94	0·63, 1·43	0·86	0·60, 1·23
2–4/month	0·87	0·60, 1·26	0·96	0·72, 1·27	0·76	0·51, 1·12	1·08	0·76, 1·69	0·84	0·59, 1·20	0·69	0·47, 1·01
2–3/week	0·78	0·46, 1·33	0·55	0·34, 0·88	0·76	0·46, 1·26	1·82	1·09, 3·03	0·82	0·50, 1·36	0·74	0·45, 1·25
≥4/week	0·57	0·26, 1·26	0·74	0·37, 1·48	0·72	0·31, 1·68	1·28	0·52, 3·19	0·80	0·35, 1·84	0·56	0·27, 1·17
P for linear trend	0·580		0·054		0·677		0·208		0·851		0·314	
Usual quantity (drinks/typical occasion)†												
1 or 2	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
3 or 4	1·48	1·03, 2·12	0·90	0·69, 1·18	1·64	1·20, 2·22	1·24	0·85, 1·82	1·21	0·87, 1·68	1·77	1·29, 2·43
5 or 6	1·38	0·81, 2·35	0·98	0·63, 1·53	2·74	1·77, 4·25	2·23	1·31, 3·80	1·50	0·89, 2·52	2·99	1·87, 4·78
7–9	2·15	1·24, 3·75	0·75	0·43, 1·31	2·42	1·28, 4·56	2·72	1·57, 4·73	2·84	1·66, 4·87	3·69	1·99, 6·85
≥10	3·83	1·78, 8·28	1·30	0·68, 2·47	2·65	1·21, 5·80	1·07	0·35, 3·31	3·27	1·52, 7·04	3·58	1·54, 8·32
P for linear trend	0·005		0·667		<0·001		0·003		<0·001		<0·001	
Binge drinking frequency (≥ 5 drinks)												
None	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.	1·00	Ref.
<1/month	1·02	0·68, 1·52	0·95	0·70, 1·29	1·31	0·93, 1·85	1·08	0·73, 1·60	1·29	0·94, 1·78	1·40	0·96, 2·04
1/month	1·25	0·80, 1·95	0·81	0·58, 1·12	1·40	0·94, 2·08	2·32	1·52, 3·55	1·71	1·14, 2·57	1·71	1·12, 2·63
1/week	1·56	0·95, 2·57	0·63	0·39, 1·02	1·59	0·95, 2·67	2·10	1·14, 3·86	1·79	1·04, 3·10	2·31	1·29, 4·13
Every day	1·99	1·001, 3·94	0·68	0·34, 1·37	3·88	1·80, 8·36	2·55	1·07, 6·03	1·47	0·70, 3·11	2·92	1·42, 5·98
P for linear trend	0·223		0·359		0·002		0·001		0·100		0·013	

MetS, metabolic syndrome; KNHANES, Korea National Health and Nutrition Examination Survey; HDL-C, HDL cholesterol; FBG, fasting blood glucose; BP, blood pressure; WC, waist circumference; Ref., referent category.
Adjusted for age, education (≤ or > middle school), monthly income (< or ≥ $1800), tobacco use (current or non-current), high intensity physical activity (yes or no), moderate physical activity (yes or no), regular walking (yes or no), daily energy intake and *typical drinking quantity or †average drinking frequency.

There are potential limitations, however, that need to be taken into consideration. First, the measurement of alcohol drinking patterns by self-report was not validated, but there is evidence that self-assessment of alcohol consumption is reliable[5]. Second, because the study was cross-sectional, causal inferences cannot be drawn from the current findings. Finally, there may be residual or uncontrolled confounders that influence the associations. For example, weight status and types of alcoholic beverages consumed may play important roles in the relationships. Further studies will be necessary to clarify these limitations.

Conclusions

The present findings in a representative Korean population demonstrate that typical drinking quantity and frequency of binge drinking were associated with the prevalence of MetS in both sexes, and the association strength was gender-specific. Conversely, drinking frequency was not associated with the prevalence of MetS, but frequent drinking may have a favourable effect on HDL-C. From a public health point of view, higher drinking quantity and frequent binge drinking are indicators of a higher prevalence of MetS regardless of sex. In addition, the current findings suggest that the guideline for gender-specific adequate alcohol intake may be extended to gender-specific alcohol drinking patterns.

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