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Prevalence Risk of Metabolic Syndrome Associated with Alcohol Use Behavior in Korean Women

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Objective Considerable research has been conducted on the relationship between alcohol consumption and metabolic syndrome. Although various standards for the amount and frequency of alcohol consumption have been suggested, a tool to measure individual alcohol use behavior against a consistent standard is required. Moreover, the association of alcohol use behavior with health should be examined on the basis of such a standard. In this study, we examined the relationships between alcohol use behavior according to the Alcohol Use Disorders Identification Test (AUDIT) and metabolic syndrome and its components in Korean women.

Methods This study utilized data from the fifth Korean National Health and Nutrition Examination Survey, which was administered from 2010 through 2012. We investigated the relationships between alcohol use behavior and metabolic syndrome and its components in a sample of 2,906 women by using analysis of covariance and logistic regression analysis.

Results After adjusting for confounding variables, alcohol use behavior was significantly associated with metabolic syndrome [odds ratio (OR) 2.877; 95% confidence interval (CI) 1.523–5.435 in the problem use group]. AUDIT score also was significantly related to abdominal obesity (OR 2.263; 95% CI 1.704–4.459 in the problem use group), hypertension (OR 3.377; 95% CI 1.871–6.095 in the problem use group), hypertriglyceridemia (OR 3.204; 95% CI 1.800–5.702 in the problem use group), and impaired fasting glucose (OR 3.034; 95% CI 1.721–5.348 in the problem use group).

Conclusion In this study, positive associations were observed between AUDIT score and risk of metabolic syndrome and its components.
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Key Words Alcohol, AUDIT, Metabolic syndrome, Women, Cross-sectional study.

INTRODUCTION

Metabolic syndrome is a cluster of risk factors including abdominal obesity, dyslipidemia, high blood glucose level, and high blood pressure, and it is known to be associated with cardiovascular disease and diabetes.[1] Global prevalence of metabolic syndrome differs among studies, but is generally 8% to 24% in men and 7% to 46% in women.[2] Additionally, 2010 data regarding the metabolic syndrome in South Korea showed a prevalence of 16.8% in men and 20.7% in women based on the standard suggested by the International Diabetes Federation.[3] The results of the survey illustrated a higher incidence of metabolic syndrome with age: 10.6% in people in their 30s and 14.9% in those in their 40s.[3] The incidence of metabolic syndrome increases rapidly in both men and women over 30 years of age.[3] In particular, women were more sensitive to social, cultural behavior, eating habits, and psychosocial factors than were men. In addition, there was a tendency to further develop metabolic syndrome in response to work stress and low socioeconomic status.[4] Furthermore, waist circumference increases in proportion to age in both men and women, and in women in their 30s and 40s, triglyceride and fasting glucose levels especially increased as does the incidence of metabolic syndrome.[5]

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Environmental factors (such as dietary habits, smoking, physical activity, and alcohol consumption) and genetic factors (such as individual, racial, and ethnic differences) are considered to be causes of metabolic syndrome.[6] Because environmental factors can be controlled, appropriate management of such factors can be helpful to prevent metabolic syndrome, cardiovascular disease, and diabetes.

Alcohol consumption often has been reported as an environmental factor that causes metabolic syndrome.[7-10] Various studies have reported a negative correlation between amount of alcohol consumed and metabolic syndrome,[7,9] a J-shaped correlation,[10] a positive correlation,[8] and even no correlation.[10] Thus, the relationship between alcohol consumption and metabolic syndrome is complex and remains to be elucidated.

Several studies have demonstrated that frequency of alcohol consumption also has a critical effect on coronary artery disease.[11,12] Similarly, it has been reported that prevalence of metabolic syndrome is related to not only amount but also frequency of alcohol consumption.[8] Therefore, in a study on alcohol consumption and prevalence of metabolic syndrome, both amount and frequency of alcohol consumption should be considered. In addition, a standardized method to evaluate alcohol use behavior is required.

The Alcohol Use Disorders Identification Test (AUDIT) has been used in recent studies on the relationship between alcohol consumption and metabolic syndrome.[13,14] According to these studies, risk of metabolic syndrome increased in individuals classified as problematic drinkers. However, subjects in a previous study on women with metabolic syndrome covered a wide age range of 20–75 years, which may yield insignificant results.[14] Therefore, there is a need to study women in more specific age categories, especially given the effects of female sex hormone or menstruation on metabolic syndrome.[15] Herein, we aimed to investigate the relationships between alcohol use behavior according to the AUDIT and risk of metabolic syndrome and its components in premenopausal women in Korea.

METHODS

Data source and ethical considerations

This study used data from the fifth Korean National Health and Nutrition Examination Survey (KNHANES V), which was administered from 2010 through 2012. The KNHANES V was approved by the Korean Ministry of Health and Welfare and was conducted according to the Declaration of Helsinki.[16,17] The protocol of the KNHANES IV was approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention (2010-02CON-21-C, 2011-02CON-06-C, and 2012-01EXP-01-2C). All participants in the KNHANES V provided informed consent. This study was approved by the Institutional Review Board of Seoul St. Mary's Hospital (No. KC15EISI0406). The KNHANES is conducted each year in approximately 10,000 household members aged ≥1 year, by selecting 20 households each in 192 districts according to a stratified cluster sampling method. More information about the sampled participants can be found elsewhere.[15] The total number of participants from 2010 through 2012 was 25,534. A sample of 2,906 satisfied the following conditions for inclusion in this study: 1) woman aged 30 to 49 years, 2) provided complete responses to all physical examination, nutritional, and health surveys, and 3) having regular menstrual periods and not pregnant.

Alcohol use behavior

Individual alcohol use behavior was categorized based on AUDIT score. Main items from the AUDIT include recent alcohol consumption, alcohol dependency, and alcohol-related problems. The test is comprised of 10 questions, each with a possible score of 0 to 4, with the total score ranging from 0 to 40. Previous studies classified that a score of 0 to 7 indicated low-risk drinking; 8 to 15, a medium-level alcohol problem; and ≥16, a high-level alcohol problem.[13,18] Based on the study of Kim et al.[13] we labeled the categories as the normal use group (score of 0–7), hazard use group (score of 8–15), and problem use group (score of ≥16).

Metabolic syndrome

Metabolic syndrome was defined based on the National Cholesterol Education Program Adult Treatment Panel III[19] revised in 2005 and the Korean Society for the Study of Obesity.[20] Metabolic syndrome was determined if ≥3 of the following criteria were met: 1) abdominal obesity (waist circumference ≥85 cm), 2) high blood glucose level (fasting blood glucose level ≥100 mg/dL) or receiving diabetes treatment, 3) hypertriglyceridemia (triglyceride level ≥150 mg/dL) or taking dyslipidemia medications, 4) low high-density lipoprotein (HDL-C) level (HDL level <50 mg/dL) or taking dyslipidemia medications, and 5) high blood pressure (systolic blood pressure ≥130 mm Hg or diastolic blood pressure ≥85 mm Hg) or taking antihypertensive medications.

Statistical analysis

Participants of Korea NHANES were selected based on stratified, multi-stage probability-sampling design. Weights for each respondent, representing the inverse of their sampling probability, were provided by the Korean Center for Disease Control, and participants were included in most analyses that were conducted in order to produce estimates representative of the non-institutionalized Korean civilian population. Based on the survey taken by the representative of each household, the question "Do you menstruate?" was answered "Yes" and "Are you pregnant now?" was answered "No." All statistical analyses were performed using SPSS software (ver. 18.0 for Window; SPSS Inc., Chicago, IL, USA). Groups were determined according to the AUDIT score and were evaluated percentage by χ^2-test to compare demographic characteristics. To analyze metabolic syndrome and its components according to group, analysis of variance (ANOVA) and analysis of covariance (ANCOVA) with post-hoc analysis was used, with adjustment for age, smoking status, physical activity, marital status, household income, and education level, data are presented as mean and standard error. Logistic regression analysis with a post-hoc test was used to evaluated odds ratios (OR) and 95% confidence intervals (CI) of metabolic syndrome and its components. In model 1, age, smoking status, and physical activity were adjusted. In model 2, marital status, household income, and education level were adjusted in addition to factors in model 1. Statistical significance level was set at p=0.05.

RESULTS

Characteristics of the study population

The demographic distribution was examined after the sample was divided into three groups according to AUDIT score. The groups showed significant differences in age, smoking status, marital status, and education level (Table 1).

The problem use group had more women who were current smokers (p<0.001) compared to those in the normal use group. The proportion of women who responded as currently married was significantly different among groups (p<0.001). The proportion of women who did not graduate from college was also significantly different among groups (p<0.001).

Table 1. Characteristics of the study population according to alcohol use behavior

Variables	Normal (N=2,448)	Hazard (N=350)	Problem (N=108)	p value
Age (year)	$39.7^{a}\pm0.2$	$38.4^{b}\pm0.4$	$37.8^{b}\pm0.6$	0.000
Smoking status, N (%)				0.000
Nonsmoker	2,225 (89.9)	230 (63.2)	55 (48.7)	
Ex-smoker	135 (6.1)	53 (13.3)	15 (14.3)	
Current smoker	88 (4)	67 (23.5)	38 (37)	
Physical activity, N (%)*				0.170
Yes	181 (7.2)	26 (7.9)	12 (12.9)	
No	2,267 (92.8)	324 (92.1)	96 (87.1)	
Marital status, N (%)				0.000
Unmarried	155 (7)	46 (11.9)	20 (16.5)	
Married	2,293 (93)	304 (88.1)	88 (83.5)	
Household income, N (%)				0.053
Low	138 (7.4)	25 (8.7)	12 (12.4)	
Middle	1,457 (61.2)	223 (66.3)	68 (64)	
High	852 (31.4)	102 (25)	28 (23.7)	
Education level, N (%)				0.000
<College	1,221 (54.5)	221 (69.8)	70 (67.9)	
≥College	1,227 (45.5)	129 (30.2)	38 (32.1)	
Waist circumference (cm)	$76.09^{a}\pm0.3$	$76.87^{a}\pm0.6$	$80.49^{b}\pm1.1$	0.000
Fasting blood glucose (mg/dL)	91.88 ± 0.4	94.87 ± 1.8	97.30 ± 3.1	0.062
Systolic blood pressure (mm Hg)	$109.35^{a}\pm0.4$	$111.25^{b}\pm0.8$	$115.72^{b}\pm1.5$	0.000
Diastolic blood pressure (mm Hg)	$72.48^{a}\pm0.2$	$74.60^{b}\pm0.7$	$76.86^{b}\pm1$	0.000
Triglyceride (mg/dL)	$96.39^{a}\pm1.7$	$129.95^{ab}\pm17.7$	$137.74^{b}\pm10.4$	0.000
HDL-cholesterol (mg/dL)	$55.52^{a}\pm0.3$	$60.74^{b}\pm1.1$	$62.22^{b}\pm1.8$	0.000
BMI (kg/m^2)	$22.97^{a}\pm0.1$	$23.11^{a}\pm0.2$	$24.17^{b}\pm0.5$	0.033

a<b: *post-hoc* analysis. *physical activity was defined as 5 or more days of walking of at least 30 min per day. BMI: body mass index, normal: normal use group, hazard: hazard use group, problem: problem use group, HDL-cholesterol: high-density lipoprotein cholesterol

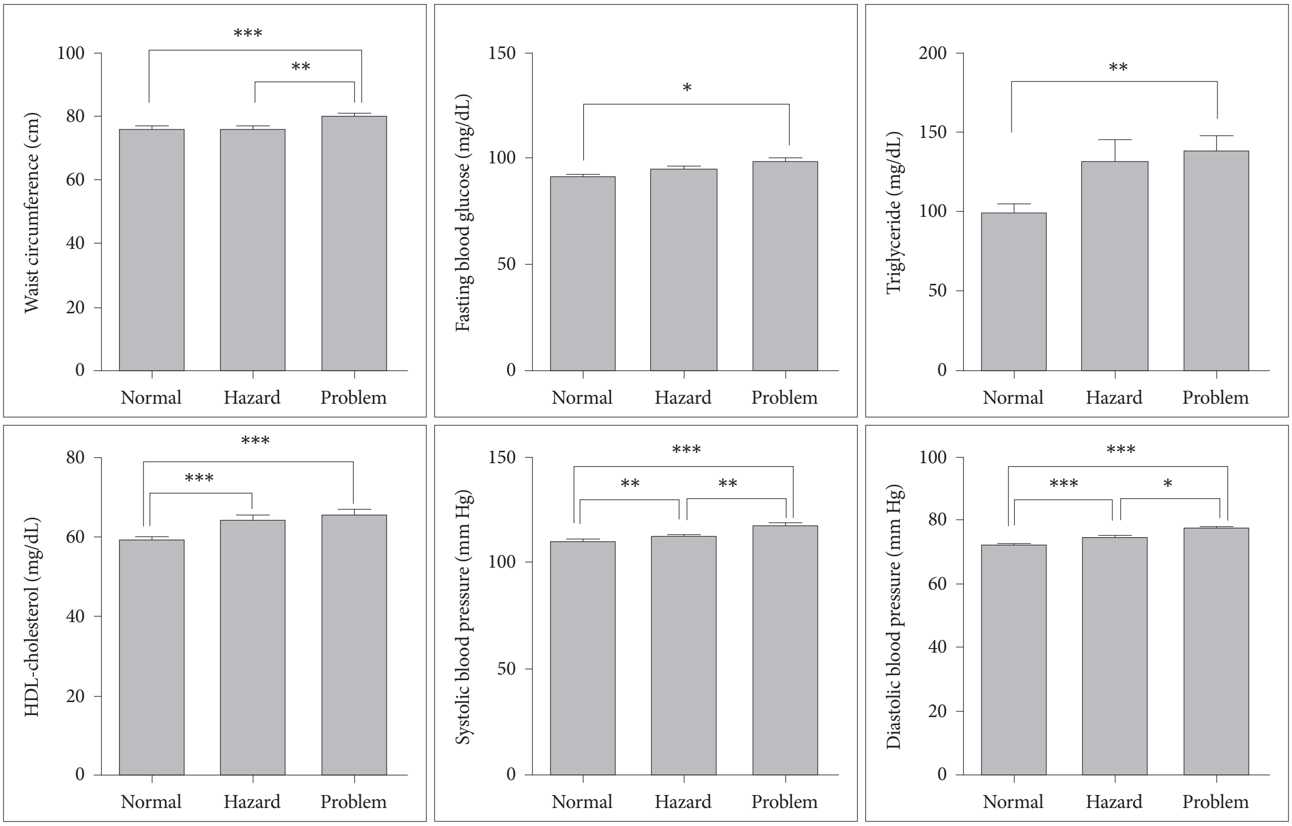

Figure 1. Comparison of levels of metabolic syndrome components according to alcohol use behavior. Values are mean±SE. The adjusted model includes age, smoking status, physical activity, marital status, household income, and education level. *p<0.05, **p<0.01, ***p<0.001 vs. normal. HDL-cholesterol: high-density lipoprotein cholesterol, normal: normal use group, hazard: hazard use group, problem: problem use group.

Metabolic syndrome components

According to unadjusted analysis, waist circumference was larger; systolic blood pressure, diastolic blood pressure, triglyceride level, and HDL-C level were higher in the problem use group than in the normal use group and hazard use group (Table 1). In the ANCOVA to compare risk factors for metabolic syndrome among the three groups waist circumference was larger and fasting blood glucose level, systolic blood pressure, diastolic blood pressure, and HDL-C level were higher in the problem use group than in the normal use group and hazard use group (Figure 1).

Odds ratios for metabolic syndrome and its components

Table 2 shows the ORs and 95% CIs for metabolic syndrome and its components in the hazard use group and problem use group using the normal use group as a reference. Participants in the problem use group had higher odds of presenting with metabolic syndrome compared to that in the normal use group in the unadjusted model (OR 2.996; 95% CI 1.734–5.177). Furthermore, in model 1, there was a positive association between AUDIT score and presenting with metabolic syndrome (OR 3.069; 95% CI 1.635–5.758; p<0.001). All components of the metabolic syndrome also had a positive association. After adjusting for age, smoking status, physical activity, marital status, household income, and education level, the problem use group showed a positive association with metabolic syndrome (OR 2.877; 95% CI 1.523–5.435; p=0.004). The problem use group also showed significant associations with large waist circumference (OR 2.263; 95% CI 1.294–3.957), high fasting blood glucose level (OR 3.034; 95% CI 1.721–5.348), high blood pressure (OR 3.377; 95% CI 1.871–6.095), and high triglyceride level (OR 3.204; 95% CI 1.800–5.702). With regard to low HDL-C level, the OR in the problem use group was 0.534 (95% CI 0.299–0.954), which was significantly lower than that in the normal use group.

DISCUSSION

Metabolic syndrome is considered to be a critical health problem worldwide. It carries a high potential of developing cardiovascular disease and/or diabetes if its related components, such as high blood pressure and triglyceride level, are not managed. The prevalence of metabolic syndrome and its

Table 2. Odds ratios and 95% CIs for metabolic syndrome and its components according to alcohol use behavior

Variables	Normal (N=2,448) OR (95% CI)	Hazard (N=350) OR (95% CI)	Problem (N=108) OR (95% CI)
Large WC			
Unadjusted	1	1.336 (0.932–1.917)	2.756 (1.704–4.459)***
Model 1†	1	1.226 (0.831–1.910)	2.373 (1.385–4.065)**
Model 2‡	1	1.122 (0.752–1.674)	2.263 (1.294–3.957)**
High FBG level			
Unadjusted	1	1.617 (1.127–2.320)**	2.541 (1.505–4.292)***
Model 1†	1	1.849 (1.280–2.672)**	3.143 (1.790–5.526)***
Model 2‡	1	1.790 (1.238–2.590)**	3.034 (1.721–5.348)***
High BP			
Unadjusted	1	1.463 (0.955–2.241)	2.685 (1.602–4.500)***
Model 1†	1	1.724 (1.082–2.745)*	3.479 (1.968–6.149)***
Model 2‡	1	1.656 (1.037–2.645)*	3.377 (1.871–6.095)***
High TG level			
Unadjusted	1	1.519 (1.047–2.202)*	3.612 (2.139–6.097)***
Model 1†	1	1.418 (0.963–2.089)	3.334 (1.847–6.019)***
Model 2‡	1	1.363 (0.921–2.016)	3.204 (1.800–5.702)***
Low HDL-C level			
Unadjusted	1	0.765 (0.567–1.033)	0.605 (0.344–1.065)
Model 1†	1	0.727 (0.525–1.007)	0.555 (0.312–0.986)*
Model 2‡	1	0.703 (0.503–0.983)*	0.534 (0.299–0.954)*
Metabolic syndrome			
Unadjusted	1	1.509 (0.993–2.294)	2.996 (1.734–5.177)***
Model 1†	1	1.515 (0.961–2.387)	3.069 (1.636–5.758)***
Model 2‡	1	1.416 (0.889–2.255)	2.877 (1.523–5.435)**

Values are presented as unadjusted and adjusted ORs (95% CI) for metabolic syndrome [defined as ≥3 of the following: large WC (≥85 cm), high FBG level (≥100 mg/dL), high BP (systolic BP ≥130 mm Hg, diastolic BP ≥85 mm Hg), high TG level (≥150 mg/dL), and low HDL-C level (<50 mg/dL)]. *p<0.05, **p<0.01, ***p<0.001 vs. normal: *post-hoc* analysis, †statistical analysis by logistic regression with adjustment for age, smoking status and physical activity, ‡adjusted for marital status, household income, and education level in addition to factors in model 1. CI: confidence intervals, OR: odd ratio, BP: blood pressure, FBG: fasting blood glucose, HDL-C: high-density lipoprotein cholesterol, WC: waist circumference, normal: normal use group, hazard: hazard use group, problem: problem use group

components is increasing.[20] Alcohol consumption has been reported to be associated with the increasing prevalence of metabolic syndrome, but the relationship is complex and requires further elucidation.[7,9,10,18] The present study used the AUDIT, which considers both amount and pattern of alcohol consumption, and examined the relationship between AUDIT score and risk of metabolic syndrome and its components in Korean women.

Risk of metabolic syndrome and its components increased with an increase in AUDIT score in this study. Accordingly, if amount of alcohol consumed exceeded a certain level, it was considered to increase risk of metabolic syndrome. A previous study conducted in the United States, which examined prevalence of metabolic syndrome related to amount and frequency of alcohol consumption in adults aged 20 to 84 years, also demonstrated increased waist circumference, blood pressure, triglyceride level, and fasting blood glucose level as amount and frequency of alcohol consumption increased.[8] In another study that investigated prevalence of metabolic syndrome by using the AUDIT and the 2008 KNHANES data in men, likelihood of abdominal obesity, high blood glucose level, high blood pressure, high triglyceride level, and metabolic syndrome was higher in those classified in the problem use group compared with the nondrinking group.[13] Previous studies including either adults of both sexes or men only[8,11,21-24] have indicated excessive alcohol consumption affects occurrence of metabolic syndrome in all adults regardless of sex, which is consistent with the current study focused on premenopausal women.

Although this study examined metabolic syndrome and not cardiovascular disease, metabolic syndrome and its components signify cardiovascular-related risks. Moreover, other studies have demonstrated that risk of cardiovascular disease is correlated with excessive drinking.[11,12] Furthermore, excessive alcohol consumption can cause hypertension.[10,24] In a previous meta-analysis, McFadden et al.[25] reported that daily alcohol consumption increased systolic blood pressure by 2.7 mm Hg and diastolic blood pressure by 1.4 mm Hg. Yoon et al.[10] also observed that daily consumption of alcohol exceeding 30 g increased blood pressure, while alcohol consumption at more than a moderate level also increased triglyceride level in the blood. Alcohol increases triglycerides in the blood, inhibits lipid oxidation in adipose tissue, and stimulates fat deposition, which occurs initially in the abdominal area.[22] Duncan et al.[26] reported that excessive drinking changed the level of sex hormones, leading to abdominal obesity, whereas moderate drinking reduced waist circumference. Other studies also demonstrated a significant relationship between excessive alcohol consumption and waist circumference.[27,28] Therefore, caution should be taken against excessive drinking, and the components of metabolic syndrome should be managed with care.

In this study, we observed that risk of low HDL-C level was significantly lower in the hazard use group than in the normal use group, which is consistent with previous studies showing that HDL level was elevated in groups who consumed a large or moderate amount of alcohol.[8,10,29,30] The reason for the consistent findings, despite the fact that previous studies examined both men and women aged ≥20 years, whereas this study examined only women aged 30 to 49 years, is that elevated serum HDL level in alcoholics is highly associated with liver damage.[31]

Furthermore, the negative correlation between HDL-C level and mortality associated with coronary artery disease was reported to be much smaller in a recent study on high level of alcohol consumption.[29] This finding suggests that increased HDL-C level is not necessarily interpreted as cardioprotective. In a previous study of Koreans.[10] the dose-response relationship between alcohol consumption and metabolic syndrome, as measured in ORs, was significant in both high- and low-HDL-C groups. Therefore, the conclusion that a moderate amount of alcohol has an advantage, only based on increased HDL-C level, should be re-evaluated.

The analysis in this population-based study was conducted using a large pool of subjects aged 30 to 49 years. There were significant relationships among AUDIT score, prevalence of metabolic syndrome, and metabolic syndrome components in this group of women. A previous study evaluating a smaller pool of women aged 20 to 75 years did not find an association between AUDIT score and metabolic syndrome.[14] However, they did not specify the women's age or analyze the relationships between AUDIT score and metabolic syndrome components. On the other hand, the current study targeted premenopausal women with similar hormonal status. In this specific age group, there were significant relationships among AUDIT score, metabolic syndrome, and metabolic syndrome components. Moreover, because the AUDIT assesses amount and frequency of alcohol consumption as well as frequency of excessive drinking, it may be used as a scaled score to predict risk of metabolic syndrome. Despite its desirable methodological features, this study has a few limitations. First, a causal relationship cannot be inferred based on the findings of this study due to its cross-sectional design. Second, dietary habits and family history were not considered as risk factors for metabolic syndrome. In spite of these limitations, this study used national representative samples and large-scale samples collected using appropriate statistical procedures designed for complex-sampling design and accurately assessed processes from community-based surveys. In addition we also found that the scales of the AUDIT score can be a tool to predict the risk of metabolic syndrome and its components.

This study used the KNHANES V data and investigated the relationship between alcohol use behavior and metabolic syndrome in women. The results showed that excessive alcohol consumption increased risk of hypertension, diabetes, dyslipidemia, abdominal obesity, and metabolic syndrome, even after adjusting for smoking status, marital status, and education level.

This study provides a basis for future research on prevalence and risk of alcohol-related disease using a scaled score to assess not only amount and pattern of alcohol consumption, but also alcohol-related problems and injuries.

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