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Age-dependent associations of smoking and drinking with non–high-density lipoprotein cholesterol

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Abstract

Serum high-density lipoprotein (HDL) cholesterol levels are influenced by habitual smoking and drinking. Non-HDL cholesterol is known to be a potent predictor of cardiovascular disease. However, it remains to be determined whether the associations of non-HDL cholesterol with smoking and drinking differ with age. The objectives of this study were to investigate relationships among smoking, drinking, and non-HDL cholesterol and to investigate interactions of age with smoking and drinking regarding serum non-HDL cholesterol levels. Subjects (54,020 Japanese men aged 20-69 years) were divided into drinkers and nondrinkers or into smokers and nonsmokers and were further divided into 5 age groups with 10-year intervals. Subjects in each age group were divided into 3 subgroups according to alcohol or cigarette consumption. The mean levels of serum non-HDL cholesterol calculated after adjustment for age and body mass index were compared among the groups. In nondrinkers, non-HDL cholesterol levels of subjects in their 40s or older were significantly higher in heavy smokers than in nonsmokers, whereas non-HDL cholesterol levels of subjects in their 20s and 30s were not significantly different among non-, light, and heavy smokers. In drinkers, non-HDL cholesterol levels of subjects in all age groups were not higher in light and heavy smokers than in nonsmokers. In nonsmokers, non-HDL cholesterol in subjects in their 30s or older was significantly lower in light and heavy drinkers than in nondrinkers, whereas this difference was not observed in subjects in their 20s. In smokers, non-HDL cholesterol levels of subjects in all age groups were significantly lower in light and heavy drinkers than in nondrinkers, and the differences in non-HDL cholesterol between drinkers and nondrinkers tended to increase with advance of age. The difference in non-HDL cholesterol between drinkers and nondrinkers tended to be greater in smokers than in nonsmokers. Thus, the associations of non-HDL cholesterol with smoking and drinking were modified by drinking and smoking, respectively. Smoking is associated with high non-HDL cholesterol in nondrinkers, and drinking is associated with low non-HDL cholesterol in nonsmokers; these associations are shown at middle and elderly ages but not at young ages.
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1. Introduction

Habitual cigarette smoking and alcohol drinking contribute to the pathogenesis of a variety of diseases. Incidences of atherosclerotic diseases, such as stroke, ischemic heart disease, and peripheral arterial disease, are affected by smoking and drinking. Smoking is a major risk factor for atherosclerotic diseases; various pathophysiologic mechanisms, including injury of the vascular endothelium and lipid peroxidation, are involved in the atherosclerotic progression mediated by habitual smoking [1,2]. Smoking also shows atherogenic action through alteration in blood lipid levels: it has been shown that smokers had high serum concentrations of triglyceride and low-density lipoprotein (LDL) cholesterol and low serum concentrations of high-density lipoprotein (HDL) cholesterol compared with nonsmokers [3]. On the other hand, drinking shows diverse effects on progression of atherosclerosis. The harmful effect of alcohol is explained mainly by alcohol-induced hypertension [4,5], whereas the beneficial effect is due to actions of alcohol on lipid metabolism and blood coagulation: HDL cholesterol is higher in drinkers than in

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nondrinkers [6,7], and platelet function is inhibited by alcohol [8].

Non-HDL cholesterol, defined as the difference between total cholesterol and HDL cholesterol, includes all potential atherogenic lipoproteins, such as LDL, very low-density lipoprotein, and its remnants, and has been recommended as a secondary target of therapy for individuals with hypertriglyceridemia by the National Cholesterol Education Program Adult Treatment Panel III [9]. Non-HDL cholesterol has been shown to be more strongly associated with subclinical atherosclerosis than all other conventional lipid values [10]. It has been shown that non-HDL cholesterol was the strongest discriminator for myocardial infarction among all cardiovascular risk factors, whereas smoking was the strongest discriminator for myocardial infarction among the nonlipid risk factors [11]. Our recent study has demonstrated that non-HDL cholesterol was lower in drinkers than in nondrinkers and that the influence of alcohol drinking on non-HDL cholesterol was more prominent in smokers than in nonsmokers [12]. Although smoking influences blood lipid levels as mentioned above, there is limited information on the relationship between non-HDL cholesterol and smoking. A recent cross-sectional study has shown that non-HDL cholesterol in women was significantly higher in smokers than in nonsmokers, whereas the difference was not significant in men [13]. Although atherosclerotic progression is strongly correlated with aging, it remains to be clarified whether or not the relationships of non-HDL cholesterol with smoking and drinking are altered by age. The objectives of this study were therefore to determine the relationships of non-HDL cholesterol with smoking and drinking at different ages. Smoking and drinking affect both HDL cholesterol and non-HDL cholesterol, resulting in modification of non-HDL/HDL ratio, a sensitive marker of proneness to atherosclerosis. However, interactions of age with smoking and drinking regarding non-HDL/HDL ratio are not known. Thus, the relationships of HDL cholesterol and non-HDL/HDL ratio with smoking and drinking were also compared among subject groups of different ages. Because there is a strong association between smoking and drinking habits [14], the relations of non-HDL cholesterol, HDL cholesterol, and non-HDL/HDL ratio to smoking or drinking were investigated separately in nondrinkers and drinkers or in nonsmokers and smokers.

2. Methods

2.1. Subjects

The subjects were 54,020 Japanese men (subject number: 20-29 years old, 7429; 30-39 years old, 9875; 40-49 years old, 18,206; 50-59 years old, 13,617; 60-69 years old, 4893) who underwent a periodic health examination at their workplaces in Yamagata Prefecture from April 1999 to March 2000. In Japan, workers in companies with 50 employees or more must undergo annual health checkups, and the companies are required by law to pay the costs for health checkups of the workers. The present study used a database on workers supplied from a large health checkup company. The number of overall subjects of this study corresponds to about 15% of total population (men at ages of 20-69 years) in Yamagata Prefecture, which has a total population of about 1.2 million; and workers at various kinds of companies (eg, construction, manufacturing, information and communications, transport, wholesale and retail trade, eating and drinking places, accommodations, and services) were included in the subjects. Thus, the subjects of this study are thought to represent the total population of Yamagata Prefecture. This study was approved by the Ethics Committee of Yamagata University School of Medicine. Data of subjects were identified only by number in the database obtained from a local health checkup company. Subjects who indicated in the questionnaire that they had been receiving therapy for dyslipidemia were excluded from the subjects. Average alcohol consumption of each subject per week was reported on questionnaires during the health examinations at each workplace, and average daily alcohol consumption (gram per day) was calculated. Alcoholic beverages include beer, sake (rice wine), wine, shochu (traditional Japanese distilled spirit), and whisky. The subjects in each age group were divided into 3 groups according to mean ethanol consumption per day (nondrinkers; light drinkers, <30 g/d; heavy drinkers, ≥30 g/d). The value of 30 g/d was used to separate heavy drinkers from light drinkers because it is generally accepted that alcohol intake of men should be reduced to less than 30 mL or 20 to 30 g/d from the viewpoint of prevention of hypertension [15,16]. The subjects were also divided into 3 groups by average cigarette consumption (nonsmokers; light smokers, <20 cigarettes per day; heavy smokers, ≥20 cigarettes per day).

2.2. Measurements

Blood was sampled from each subject after fasting. Serum total cholesterol and HDL cholesterol were measured by an enzymatic method (cholesterol oxidase) using commercial kits L-Type CHO H (Wako Pure Chemical Industries, Osaka Japan) and Cholestest N HDL (Daiichi Pure Chemicals, Tokyo Japan), respectively. HDL cholesterol measurement was performed in the presence of a detergent that specifically solubilizes HDL cholesterol. Non–high-density lipoprotein cholesterol was calculated as a difference in total cholesterol and HDL cholesterol. The reproducibility of measurements of total cholesterol and HDL cholesterol was sufficiently high (coefficient of within-batch variation <5%). Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters.

Table 1
Profiles of subjects

	20-<30 y	30-<40 y	40-<50 y	50-<60 y	60-<70 y
n	7429	9875	18206	13617	4893
Age (y)	24.7 ± 2.8	35.0 ± 2.8*	44.7 ± 2.9*	53.9 ± 2.9*	63.3 ± 2.6*
Percentage of smokers					
Light smokers (%)	52.5	43.0	34.7	34.1	37.3
Heavy smokers (%)	24.1	30.6	32.7	23.9	10.7
All smokers (%)	76.6	73.7*	67.5*	58.0*	48.0*
Percentage of drinkers					
Light drinkers (%)	40.3	45.3	37.6	33.4	33.9
Heavy drinkers (%)	15.9	27.9	39.9	42.5	38.0
All drinkers (%)	56.1	73.2*	77.5*	75.9*	72.0*
BMI (kg/m^2)	22.82 ± 3.70	23.52 ± 3.41*	23.46 ± 3.06	23.53 ± 2.91	23.39 ± 2.81
Total cholesterol (mg/dL)	176.0 ± 32.0	193.2 ± 34.2*	197.1 ± 34.0*	194.4 ± 33.3*	189.8 ± 31.4*
HDL cholesterol (mg/dL)	53.3 ± 12.4	53.1 ± 13.6	54.2 ± 14.6*	54.9 ± 15.1*	55.9 ± 15.6*
Non-HDL cholesterol (mg/dL)	122.7 ± 33.4	140.1 ± 36.6*	143.0 ± 36.3*	139.5 ± 35.2*	133.9 ± 32.5*
Non-HDL/HDL ratio	2.47 ± 1.03	2.87 ± 1.20*	2.89 ± 1.21	2.78 ± 1.19*	2.62 ± 1.08*

Number of subjects, percentages of smokers and drinkers, and means with SDs of the variables in each age group are shown.
* Significant differences compared with each 10-years-younger age group ($P < .01$).

2.3. Statistical analysis

The data were presented as means ± SDs or SEs. The effects of age on relationships of alcohol drinking and smoking with each serum lipid variable were investigated by comparison of mean levels of each variable among groups divided by amount of alcohol intake or cigarette consumption, using data stratified by age. Mean values of each variable in different drinking or smoking groups were calculated after adjustment for age and BMI and were compared among groups using analysis of covariance, and then the significance of difference between each pair of groups was determined by the 2-tailed multiple Student *t* test with Bonferroni correction (3 comparisons in 3 groups). Means of BMI and lipid parameters in different age groups were compared using analysis of variance and subsequent Scheffé F test. Percentages of drinkers or smokers in different age groups were compared using χ^2 test. Mean levels in the age groups of differences in each variable between nondrinkers and heavy drinkers or between nonsmokers and heavy smokers were also compared between smokers and nonsmokers or between drinkers and nondrinkers by using paired *t* test. In some analyses, regression analysis using Pearson correlation coefficient was performed to test tendencies of relationships of age with differences in each variable between nonsmokers and heavy smokers or between nondrinkers and heavy drinkers. Probability (*P*) values less than .05 were defined as significant.

3. Results

3.1. Profiles of subjects

Table 1 shows the profiles of subjects in each age group. The percentage of smokers decreased with advance of age, whereas the percentage of drinkers peaked in the 40s age group and then slightly decreased after 50s. Body mass index was significantly lower in the 20s age group than in the 30s age group, whereas there were no significant differences in BMI among subjects in the 30s, 40s, 50s, and 60s age groups. Serum total cholesterol and non-HDL cholesterol levels and non-HDL/HDL ratio were much lower in subjects in the 20s age group than in subjects in the 30s age group and peaked in the 40s age group, then gradually decreased after 50s. Serum HDL cholesterol increased gradually after 40s.

3.2. Associations between cigarette smoking and serum non-HDL cholesterol level

Fig. 1A shows the relationships between smoking and non-HDL cholesterol in nondrinkers (left panel) and drinkers (right panel) of each age group. In nondrinkers, non-HDL cholesterol levels of subjects in their 20s and 30s were not significantly different among non-, light, and heavy smokers. In nondrinkers, non-HDL cholesterol levels of subjects in their 40s or older were significantly higher in heavy smokers than in nonsmokers but were not significantly different between non- and light smokers. In drinkers, non-HDL cholesterol levels of subjects in all age groups were not higher in light and heavy smokers than in nonsmoker, and non-HDL cholesterol levels of subjects in their 40s or older were significantly lower in light smokers than in nonsmokers.

3.3. Associations between cigarette smoking and serum HDL cholesterol level

In nondrinkers (Fig. 1B, left panel) and drinkers (right panel), HDL cholesterol levels of subjects in all age groups were significantly lower in light and heavy smokers than in nonsmokers. In nondrinkers, the difference in HDL cholesterol between heavy smokers and nonsmokers tended to increase with advance of age (Pearson correlation

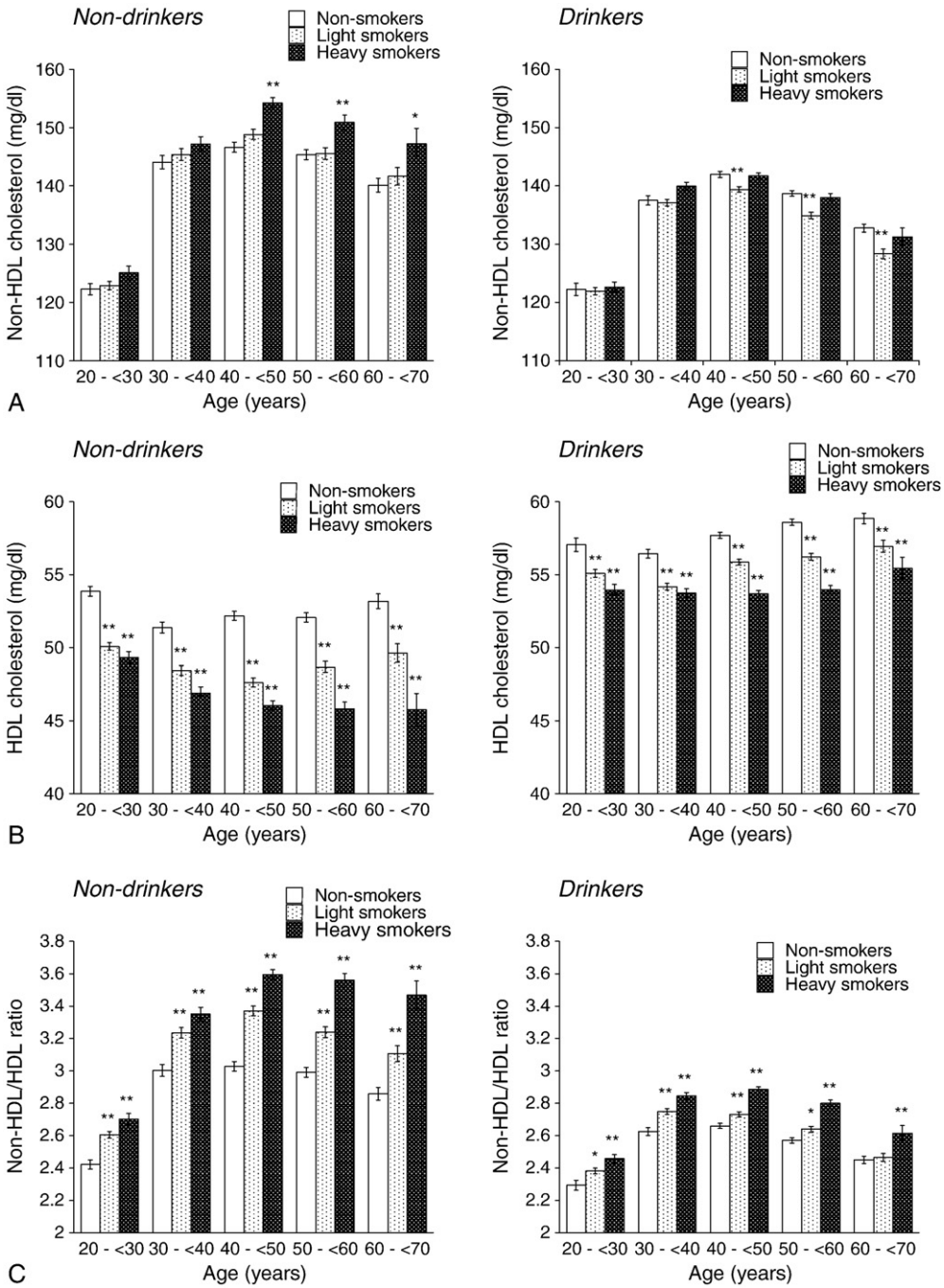

Fig. 1. Relationships of smoking with non-HDL cholesterol (A), HDL cholesterol (B), and non-HDL/HDL ratio (C) in nondrinkers (left panels) and drinkers (right panels). Nondrinkers and drinkers were divided into 5 age groups and further divided into non-, light, and heavy smoker subgroups. Shown are age- and BMI-adjusted means with SEs of each variable in different smoking groups. Asterisks denote significant differences from nonsmokers (*$P < .05$ and **$P < .01$).

coefficient between mean age and difference in mean HDL cholesterol: $r = 0.947$ [$P < .05$]).

3.4. Associations between cigarette smoking and non-HDL/HDL ratio

In nondrinkers (Fig. 1C, left panel) and drinkers (right panel), non-HDL/HDL ratios of subjects in all age groups were significantly higher in light and heavy smokers than in nonsmokers, except for no significant difference in non-HDL/HDL ratio of drinkers between non- and light smokers in their 60s. In nondrinkers, the difference in non-HDL/HDL ratio between heavy smokers and nonsmokers tended to increase with advance of age (Pearson correlation coefficient between mean age and difference in mean non-HDL/HDL ratio: $r = 0.935$ [$P < .05$]).

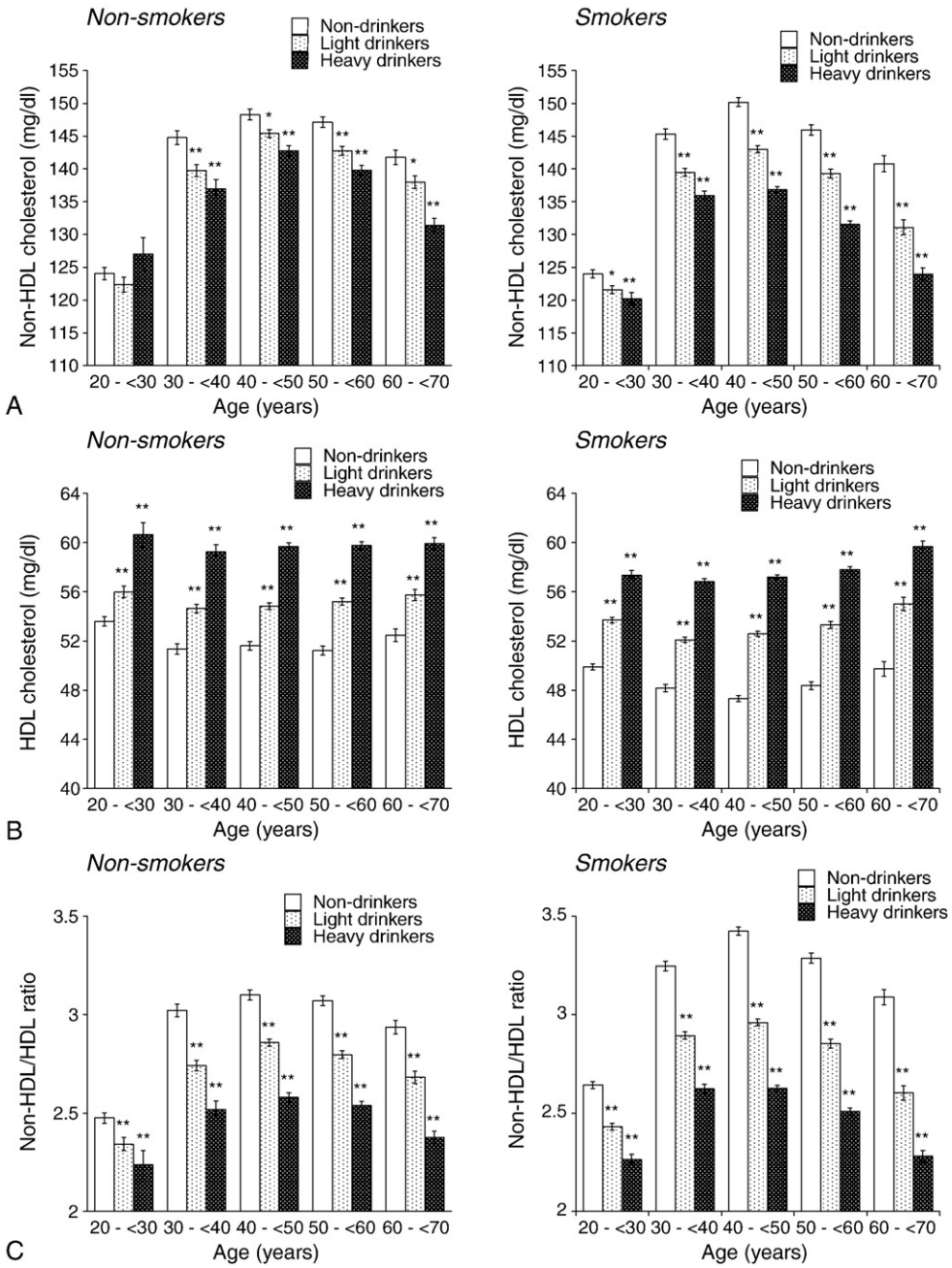

Fig. 2. Relationships of alcohol drinking with non-HDL cholesterol (A), HDL cholesterol (B), and non-HDL/HDL ratio (C) in nonsmokers (left panels) and smokers (right panels). Nonsmokers and smokers were divided into 5 age groups and further divided into non-, light, and heavy drinker subgroups. Shown are age- and BMI-adjusted means with SEs of each variable in different drinking groups. Asterisks denote significant differences from nondrinkers (*$P < .05$ and **$P < .01$).

3.5. Associations between alcohol drinking and serum non-HDL cholesterol level

In nonsmokers (Fig. 2A, left panel), non-HDL cholesterol in subjects in their 30s or older was significantly lower in light and heavy drinkers than in nondrinkers, whereas this difference was not observed in subjects in their 20s. In smokers (right panel), non-HDL cholesterol levels of subjects in all age groups were significantly lower in light and heavy drinkers than in nondrinkers, and the difference in non-HDL cholesterol between drinkers and nondrinkers tended to increase with advance of age (Pearson correlation coefficient between mean age and difference in mean non-HDL cholesterol of non-drinkers and heavy drinkers: $r = 0.970$ [$P < .05$]).

3.6. Associations between alcohol drinking and serum HDL cholesterol level

In both nonsmokers (Fig. 2B, left panel) and smokers (right panel), HDL cholesterol levels of subjects in all age

Table 2
Comparison of differences in levels of each variable of nonsmokers and heavy smokers in the nondrinker group and the drinker group (left side) and comparison of differences in levels of each variable of nondrinkers and heavy drinkers in the nonsmoker group and the smoker group (right side)

	Difference between non- and heavy smokers		Difference between non- and heavy drinkers	
	Nondrinkers	Drinkers	Nonsmokers	Smokers
Non-HDL cholesterol (mg/dL)	5.25 ± 0.99	0.09 ± 0.67*	−5.61 ± 2.28	−11.54 ± 2.28†
HDL cholesterol (mg/dL)	−5.76 ± 0.56	−3.57 ± 0.34†	7.80 ± 0.26	9.08 ± 0.46*
Non-HDL/HDL ratio	0.475 ± 0.067	0.201 ± 0.015*	−0.471 ± 0.059	−0.678 ± 0.082†

Shown are means with SEs of differences in each variable of nonsmokers and heavy smokers (values of heavy smokers minus values of nonsmokers) or differences in each variable of nondrinkers and heavy drinkers (values of heavy drinkers minus values of nondrinkers).

* Significant differences from the nondrinker group or the nonsmoker group ($P < .05$).

† Significant differences from the nondrinker group or the nonsmoker group ($P < .01$).

groups were significantly higher in light and heavy drinkers than in nondrinkers.

3.7. Associations between alcohol drinking and non-HDL/HDL ratio

In both nonsmokers (Fig. 2C, left panel) and smokers (right panel), non-HDL/HDL ratios of subjects in all age groups were significantly lower in light and heavy drinkers than in nondrinkers. The differences in non-HDL/HDL ratios between nondrinkers and heavy drinkers tended to be smaller in subjects in their 20s than in other older groups (nonsmokers, −0.237 [20-29 years] vs −0.504 [30-39 years], −0.520 [40-49 years], −0.533 [50-59 years], and −0.561 [60-69 years]; smokers, −0.379 [20-29 years] vs −0.624 [30-39 years], −0.800 [40-49 years], −0.779 [50-59 years], and −0.809 [60-69 years]).

3.8. Interactions between smoking and drinking regarding each variable

Differences in mean levels of each variable between non- and heavy smokers in each age group were compared between nondrinkers and drinkers (Table 2, left side). Similarly, differences in mean levels of each variable of non- and heavy drinkers in each age group were compared between nonsmokers and smokers (Table 2, right side). Mean differences in non-HDL cholesterol, HDL cholesterol, and non-HDL/HDL ratio between non- and heavy smokers were significantly greater in nondrinkers than in drinkers (Table 2, left side). On the other hand, mean differences in non-HDL cholesterol, HDL cholesterol, and non-HDL/HDL ratio between non- and heavy drinkers were significantly greater in smokers than in nonsmokers (Table 2, right side).

4. Discussion

Although non-HDL cholesterol has recently been shown to be associated with smoking and drinking, it is not known whether there are interactions between smoking and drinking regarding non-HDL cholesterol. This study is the first study demonstrating that smoking and drinking considerably modify the relationships of drinking and smoking, respectively, with non-HDL cholesterol. In addition, this study demonstrated for the first time that age modifies the relationships of non-HDL cholesterol with smoking and drinking habits.

Mean differences in non-HDL cholesterol, HDL cholesterol, and non-HDL/HDL ratio between non- and heavy smokers were significantly greater in nondrinkers than in drinkers, whereas mean differences in non-HDL cholesterol, HDL cholesterol, and non-HDL/HDL ratio between non- and heavy drinkers were significantly greater in smokers than in nonsmokers. Thus, it is suggested that the atherogenic action of smoking through cholesterol metabolism is suppressed by alcohol drinking, whereas the antiatherogenic action of alcohol drinking through cholesterol metabolism is facilitated by smoking.

In nondrinkers, non-HDL cholesterol was significantly higher in heavy smokers than in nonsmokers, and this difference was observed in subjects in their 40s or older but not in those in their 20s and 30s. Therefore, heavy smoking is thought to increase non-HDL cholesterol at ages after 40s but not at younger ages. The present study confirmed the previously reported finding that HDL cholesterol is lower in smokers than in nonsmokers [3]. In nondrinkers, the difference in HDL cholesterol between nonsmokers and smokers tended to increase with advance of age. Consequently, the difference in non-HDL/HDL ratio between heavy smokers and nonsmokers tended to increase with advance of age. Total cholesterol to HDL cholesterol ratio has been reported to be the best variable of lipid profile for the prediction of ischemic heart disease [17]. Because HDL cholesterol is included in total cholesterol, non-HDL/HDL ratio is thought to be a more sensitive marker of proneness to atherosclerosis than total cholesterol to HDL cholesterol ratio. Thus, the above results suggest that the atherogenic action of smoking through lipid metabolism is greater in the elderly than in the young.

Non-HDL cholesterol has been reported to be lower in drinkers than in nondrinkers [12]. The present study has demonstrated for the first time that the association between alcohol drinking and non-HDL cholesterol is influenced by age: non-HDL cholesterol in nonsmokers was significantly lower in drinkers than in nondrinkers in their 30s and older

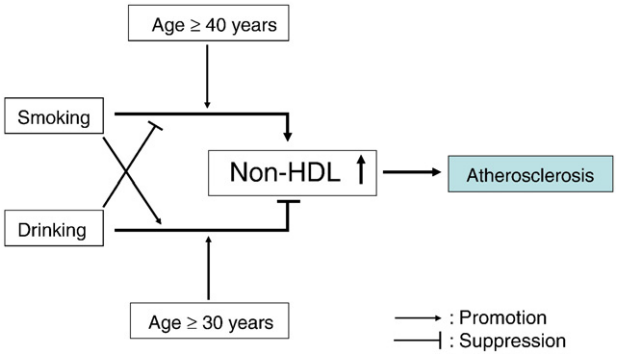

Fig. 3. A scheme summarizing the results of this study. Age influences the associations of smoking and drinking with serum non-HDL cholesterol, which is a potent predictor of atherosclerotic diseases.

but not in those in their 20s. Nonetheless, the association between alcohol drinking and HDL cholesterol was not altered by age. Afterward, the above age-dependent difference in the relationship between non-HDL cholesterol and alcohol drinking results in a difference in the degree of association between non-HDL/HDL ratio and drinking: the decrease in non-HDL/HDL ratio in drinkers was much less in subjects in their 20s than in subjects in their 30s and older. The difference in non-HDL cholesterol between drinkers and nondrinkers was greater in smokers than in nonsmokers. This is reflected by a greater difference in non-HDL/HDL ratio between drinkers and nondrinkers in smokers compared with nonsmokers. Thus, smoking modifies the association between non-HDL cholesterol and drinking.

The above age-dependent relationships of non-HDL cholesterol with smoking and drinking and the interactions of drinking and smoking regarding non-HDL cholesterol levels are summarized in Fig. 3. Non-HDL cholesterol was higher in heavy smokers than in nonsmokers, and this association was found only in subjects in their 40s or older and was stronger in nondrinkers than in drinkers. On the other hand, non-HDL cholesterol was lower in drinkers than in nondrinkers; and this association was found in smokers in all age groups and nonsmokers in their 30s or older but not in those in their 20s and was more prominent in smokers than in nonsmokers. These results suggest that the harmful effect of smoking on atherosclerotic progression through alteration in lipid metabolism increases with advance of age, whereas the beneficial effect of alcohol drinking on lipid metabolism does not decrease in the elderly. Therefore, the results of this study suggest that, from the viewpoint of prevention of dyslipidemia, elderly smokers had better stop or reduce smoking, but elderly drinkers may continue habitual drinking. A major limitation of the present study is that subjects older than 70 years were not included. Non-HDL lipoprotein cholesterol has been reported to be a potential predictor of carotid atherosclerosis in the elderly [18]. Therefore, further studies are needed to determine the relationships of smoking and drinking with non-HDL cholesterol in more elderly people.

Because the present study is a cross-sectional study, longitudinal studies are needed to confirm the causal relationships of age-dependent interactions between smoking and drinking regarding serum lipids. The association of alcohol consumption with blood HDL cholesterol level is known to be mediated by alcohol effects on lipid-metabolizing enzymes such as lipoprotein lipase and cholesteryl ester transfer protein [19]. Formation of acetaldehyde adducts of apolipoprotein B is hypothesized to be a mechanism for alcohol-induced lowering of non-HDL cholesterol: acetaldehyde, the first metabolite in ethanol oxidation, reacts with apolipoprotein B before its secretion from the liver; then the altered very low-density lipoproteins are partially removed before their conversion to LDL [20]. Acetaldehyde modification of LDL has also been shown to accelerate its in vivo catabolism [21]. On the other hand, the mechanisms for effects of smoking on non-HDL cholesterol and HDL cholesterol remain unknown. Moreover, there is a discrepancy in the results regarding the relationship between smoking and LDL cholesterol, a major component of non-HDL cholesterol: higher serum LDL cholesterol levels in smokers than in nonsmokers have been shown in some studies [22-24]; however, a study using Taiwanese subjects showed no significant difference between LDL cholesterol levels in smokers and nonsmokers [25], and a study using Japanese subjects [26] showed lower LDL cholesterol levels in smokers than in nonsmokers. One possible reason for these discrepancies is ethnic and/or racial difference in the relationship between alcohol and LDL cholesterol. Thus, further studies are needed to clarify the mechanisms for the effects of smoking on HDL cholesterol and non-HDL cholesterol as well as the mechanisms for the effects of age on the relationships between alcohol and non-HDL cholesterol and between smoking and non-HDL cholesterol.

There is a possibility of confounding in this study. There are factors, for example, diet, nutrition, physical activity, and socioeconomic status, possibly confounding the relationships of smoking and drinking with non-HDL and HDL cholesterol. Information on these confounding factors was not available in this study; although BMI, which reflects diet, nutrition, and physical activity, was used as a variable for adjustment when the mean of each lipid variable was calculated for comparison among alcohol or smoking groups. It is known that there are polymorphisms of alcohol-metabolizing enzymes in Asians [27,28], and the association between HDL cholesterol and alcohol consumption has been reported to be stronger in subjects showing higher sensitivity to alcohol [29]. However, information on polymorphisms of alcohol-metabolizing enzymes of the subjects was not available in the present study and could modify the relationships of alcohol consumption with non-HDL cholesterol and HDL cholesterol.

In conclusion, non-HDL cholesterol was higher and HDL cholesterol was lower in smokers than in nonsmokers, while non-HDL cholesterol was lower and HDL cholesterol was higher in drinkers than in nondrinkers. Age modified these

associations of smoking and drinking with non-HDL cholesterol, and the atherogenic effects of smoking through deteriorating blood lipid metabolism are thought to be greater in the elderly than in the young.

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