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Alcohol consumption and blood lipids in elderly coronary patients

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Abstract

Alcohol may have a beneficial effect on coronary heart disease (CHD) that could be mediated by elevation of high-density lipoprotein cholesterol (HDLC). Data on alcohol consumption and blood lipids in coronary patients are scarce. We studied whether total ethanol intake and consumption of specific types of beverages are associated with blood lipids in older subjects with CHD. Blood lipids were measured in 1052 myocardial infarction patients aged 60 to 80 years (78% male). Intake of alcoholic beverages, total ethanol, and macronutrients was assessed by food frequency questionnaire. Seventy percent of the subjects used lipid-lowering medication. Total cholesterol was on average 5.14 mmol/L, and HDLC was on average 1.28 mmol/L. Among men, total ethanol intake was positively associated with HDLC (difference of 0.094 mmol/L for ≥15 g/d vs 0 g/d, $P = .024$), whereas the association with HDLC among women was not significant (difference of 0.060 mmol/L for ≥5 g/d vs 0 g/d, $P = .560$) after adjustment for dietary, lifestyle, and CHD risk factors. Liquor consumption was weakly positively associated with HDLC in men ($P = .045$). Beer consumption in men and wine consumption in women were also positively associated with HDLC, but were not significant in the fully adjusted model. In conclusion, moderate alcohol consumption may elevate HDLC in treated post–myocardial infarction patients. This may be due to ethanol and not to other beneficial substances in alcoholic beverages. Based on this finding, further research needs to be done to examine the effects of the residual substances from different types of alcoholic beverages on HDLC.

1. Introduction

Coronary heart disease (CHD) is the major cause of mortality in Western societies, including the Netherlands. Epidemiologic data suggest a beneficial effect of moderate alcohol intake on CHD and cardiovascular disease (CVD) morbidity and mortality, of which the nature is probably J-shaped [1-4]. Two alcoholic drinks (20-40 g alcohol per day) could decrease risk of CHD mortality [5-7], whereas heavy drinking increases risk [8,9]. Individuals with previous myocardial infarction who consumed moderate amounts of alcohol had a lower mortality than abstainers [10-12]. The protective effect of alcohol is most apparent in middle-aged men and in postmenopausal women with one or more risk factors for CVDs [1,3,8,11].

There are several plausible mechanisms for the beneficial effect of moderate drinking on CHD. The effect could be mediated by alterations in plasma lipoproteins, particularly an increase in high-density lipoprotein cholesterol (HDLC) [5,13-15]. High-density lipoprotein cholesterol is involved in the transport of excess cellular cholesterol to the liver for excretion in bile. Individuals who consume alcohol not only have higher serum levels of HDLC but also have lower levels of low-density lipoprotein cholesterol (LDLC) than abstainers [16]. The effect of moderate alcohol intake on triglycerides is small, although elevated triglycerides have been noted in heavy drinkers [5,17]. Furthermore, alcohol has a favorable effect on platelet aggregation; and the fibrinogen concentration in blood is lower in drinkers compared with abstainers [5,18,19].

It has been suggested that specific alcoholic beverages have different effects on CHD, indicating that compounds other than ethanol may be of importance [20-22]. Wine has received much attention because of the low incidence of CVD in countries where wine is the predominant alcoholic beverage [23,24]. Mukamal et al [25], on the other hand, observed in the Health Professionals Follow-up Study an inverse association of alcohol consumption with risk of

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myocardial infarction for beer and liquor, the predominant types of alcoholic beverages consumed by men aged 40 to 75 years old. Data on alcohol consumption in coronary patients are still scarce. In the present study, we examined the relation of ethanol intake and the consumption of specific types of alcoholic beverages with blood lipids in older subjects with established CHD.

2. Methods

2.1. Study population

For the present cross-sectional analysis, we used baseline data of the Alpha Omega Trial, an ongoing intervention study of omega-3 fatty acids (in margarines) and CVD mortality. In total, 4837 Dutch subjects aged 60 to 80 years who have a history of myocardial infarction up to 10 years before entering the study have been enrolled. Subjects were excluded for the following reasons: living in an institution, daily margarine intake <10 g, daily fish intake >150 g, use of omega-3 supplements, life expectancy <1 year, cognitive decline (as assessed by Mini Mental State Examination score <22), unintended weight loss of >5 kg in the past year, and alcohol intake >6 drinks per day. The Alpha Omega Trial was approved by the Medical Ethics Committee "Zuidwest Holland," and all subjects signed informed consent.

The cohort for the present analysis comprises 1049 participants who were enrolled during the early phase of the Alpha Omega Trial in 2002-2003. In addition, we deliberately oversampled subjects who did not use lipid-lowering medication (n = 151) to be able to examine the relation of alcohol intake with blood lipids in untreated subjects. Dietary data were missing for 125 subjects, and blood samples were missing for 23 subjects. A total of 1052 participants remained for the present analysis.

2.2. Assessment of alcohol intake and diet

Alcohol consumption was assessed by means of a 203-item semiquantitative food frequency questionnaire that included separate questions for intake of beer, wine, and liquor. Data were also collected on intake of total energy, macronutrients, fiber, fruit, vegetables, and fish. All dietary questionnaires were checked by trained dieticians who obtained additional information about unclear or missing data from the participants by telephone. Food data were converted into nutrient intakes by multiplying the frequency of use of each food by the portion size and the nutrient content per gram. Values for nutrient contents of food were obtained from the NEVO food consumption database 2001 [26]. Participants reported the number of alcoholic beverages they consumed on a daily or weekly basis in each of 3 categories: wine (white, rose, red, fortified), liquor (eg, rum, gin, cognac, whisky, liqueur), and beer (alcohol and alcohol-free). In the category of beer drinkers, alcohol-free beer and regular beer consumers were combined because the total number of alcohol-free beer drinkers was low and most of them also consumed regular beer. Daily intake of total ethanol was calculated, which was divided into 4 categories: (1) 0 g, (2) 0.01 to 4.99 g, (3) 5 to 14.99 g, and (4) ≥15 g. Because of small sample sizes in women, categories 3 and 4 of the daily intake of ethanol were combined. In addition, daily intake of beer was categorized as (1) 0 g, (2) 0.01 to 99.99 g, and (3) ≥100 g; wine intake as (1) 0 g, (2) 0.01 to 74.99 g, and (3) ≥75 g; and liquor intake as (1) 0 g, (2) 0.01 to 20.99 g, and (3) ≥21 g. Upper categories correspond to approximately half a glass of the specific alcoholic beverage [26].

2.3. Assessment of lifestyle and health

Data on lifestyle and health were collected by a self-administered questionnaire. Subjects were categorized as current, former, or never smokers. Information about the highest attained level of education was used as an indicator of socioeconomic status, which was categorized as low (primary education or less), intermediate (secondary general or vocational education), and high (higher vocational education, university). We considered subjects to be physically active when they reported 30 minutes of moderate or heavy exercise per day. Information about lipid-lowering drugs, blood pressure–lowering drugs, and antidiabetes drugs was obtained by self-report during the baseline interview. After 1 year of participation, subjects reported by telephone when they experienced their (most recent) myocardial infarction.

2.4. Physical examination

Physical examination was carried out at baseline by a trained research nurse at the hospital's cardiology unit or at the subjects' home. Height and weight were measured, and body mass index (BMI) was calculated as weight (in kilograms) divided by height squared (in square meters). Blood pressure was measured twice with an interval of 15 seconds on the left upper arm using an automatic device (Omron HEM, Hamburg, Germany) with the participant in a sitting position. The average value of 2 measurements was used in the analysis. In case of 3 measurements, the third measurement was left out of this study. Hypertension was considered present when the subject had either a systolic blood pressure of 140 mm Hg or higher, or a diastolic blood pressure of 90 mm Hg or higher, or when blood pressure–lowering drugs were used [27].

Three tubes of fasting blood were collected if the appointment was before 10:30 AM. After 10:30 AM, participants were permitted to consume a light meal; but they were asked to abstain from smoking and drinking coffee at least up to 1 hour before venipuncture and blood pressure measurements. The blood samples were stored at −80°C within 24 hours. Standard kits (Roche Diagnostics, Basel, Switzerland) were used to determine levels of total cholesterol (no. 1489232), HDLC (no. 3038661), triglycerides (no. 1488872), and glucose (no. 1448668) on an autoanalyzer (Hitachi 912, Roche Diagnostics). The LDLC was calculated according to the Friedewald formula, as follows: LDLC = total cholesterol − HDLC − (triglycerides/2.2) [28]. Hypercholesterolemia was

considered present when serum cholesterol was ≥5.0 mmol/L or when lipid-lowering medication was used [27]. *Diabetes mellitus* was defined by using antidiabetes drugs or fasting plasma glucose level of ≥6.1 mmol/L. In nonfasting participants, a glucose level higher than 7.8 mmol/L (2-hour postload glucose) was used as a cutoff value for diabetes mellitus [27].

2.5. Statistical analysis

Subject characteristics were analyzed in categories of alcoholic beverages, using analysis of variance. Means and standard deviations (SDs) or percentages were obtained for continuous and categorical variables, respectively. Skewed data are presented as median with interquartile range (Q1-Q3). The analyses were conducted separately for men and women because of large differences in total ethanol intake and preferred alcoholic beverages. Because the distribution of triglycerides was skewed, a natural log transformation was used in statistical analysis. Partial correlations, adjusted for age, sex, and total energy intake, were computed between alcohol consumption and blood lipids to identify potential confounders.

The association between categories of total ethanol intake and blood lipids was studied in a linear regression model with adjustment for age and energy (model 1). The blood lipid levels (total cholesterol, LDLC, HDLC, and triglycerides) in each category of total ethanol intake were compared with lipid levels in abstainers (reference group). In the second model, lifestyle factors and CHD risk factors were added, namely, BMI, smoking status, socioeconomic status, use of lipid-lowering medication, presence of diabetes, presence of hypertension, and level of physical activity. Finally, analyses were repeated after adjustment for dietary intake of total fat, saturated fat, fiber, carbohydrates, cholesterol, fruit, vegetables, and fish (model 3). We examined whether there was a linear trend in the relation of total ethanol intake with serum lipids by entering the median ethanol values within the categories into the multivariate model. Similarly, the association of specific types of alcoholic beverages (beer/wine/liquor) with blood lipids was analyzed in relation to blood lipids. In these analyses, additional adjustment was made for the other types of alcoholic beverages but not for total ethanol intake. Because of possible effect modification by using lipid-lowering medication, the analyses were stratified by lipid-lowering treatment. The associations are expressed as regression coefficients with standard errors. P values ≤ .05 were considered statistically significant. The statistical analysis of the data was performed using the statistical software program SPSS 12.0.1 (SPSS, Chicago, IL).

3. Results

Baseline characteristics of the study population are presented in Table 1. The study comprised 817 men (78%) with a mean age of 68.6 years (SD 5.7) and 235 women with a mean age of 70.3 (5.7) years. The percentage of drinkers was higher among men (83%) than among women (62%). Thirty-five percent of men consumed 15 g ethanol or more per day, whereas this was 11% in women. The average daily amount of alcohol consumed by drinkers was also higher in men than in women (14.3 vs 6.2 g, respectively). Men predominantly consumed beer (53%), followed by liquor (51%) and wine (49%), whereas women mainly consumed wine (49%). Around half of the participants had a total cholesterol level of 5 mmol/L or higher. The HDLC was lower in men than in women (1.23 vs 1.43 mmol/L, respectively). Serum triglycerides and LDLC did not differ between men and women. Seventy percent of the population

Table 1
Characteristics of 1052 Dutch subjects aged 60 to 80 years [a] with a history of myocardial infarction

	Men (n = 817)	Women (n = 235)
Age (y)	68.6 ± 5.7	70.3 ± 5.7
BMI (kg/m^2)	27.7 ± 3.4	28.7 ± 4.8
Time since last MI (y)	5.4 ± 4.1	4.4 ± 2.7
Smoking status (%)		
Current	20.0	17.9
Former	69.2	46.2
Never	10.8	35.9
Educational level (%) [b]		
Low	55.5	61.6
Intermediate	29.2	32.8
High	15.3	5.6
Ethanol consumption per day (%)		
Abstainer	16.8	37.9
0-4.99 g	21.9	30.6
5-14.99 g	26.8	20.9
≥15 g	34.5	10.6
Use of alcoholic beverages (%)		
Beer	52.6	8.9
Wine	48.7	49.4
Liquor	50.7	25.5
Hypertension (%) [c]	90.1	93.2
Blood pressure (mm Hg)		
Systolic	145 ± 21	144 ± 24
Diastolic	83 ± 11	80 ± 11
Physically active (%) [d]	31.9	19.0
Diabetes mellitus (%) [e]	19.6	20.6
Hypercholesterolemia (%) [f]	92.3	96.6
Use of lipid-lowering medication	70.4	69.8
Serum lipids (mmol/L)		
Total cholesterol	5.05 ± 0.94	5.47 ± 1.02
HDLC	1.23 ± 0.32	1.43 ± 0.38
LDLC	2.94 ± 0.86	3.07 ± 0.92
Triglycerides	1.93 ± 1.00	2.14 ± 1.32

Values are mean ± SD, percentage, or median (Q1-Q3). MI indicates myocardial infarction.

[a] Including the 151 oversampled subjects.

[b] Low: primary education or less; intermediate: secondary general or vocational education; high: higher vocational education, university.

[c] Self-reported hypertension, blood pressure level ≥140/90 mm Hg, or use of blood pressure–lowering medication.

[d] Defined as ≥30 minutes a day of moderate or heavy physical activity.

[e] Self-reported diabetes mellitus, fasting glucose concentrations ≥6.1 mmol/L or nonfasting glucose concentrations ≥7.8 mmol/L (2-hour postload glucose), or use of antidiabetes medication.

[f] Serum total cholesterol concentration ≥5.0 mmol/L or use of lipid-lowering medication.

used lipid-lowering medication, whereas in the population without oversampling, 78% used lipid-lowering medication. Treated subjects had lower levels of total cholesterol (5.2 mmol/L) and LDLC (3.0 mmol/L) than untreated subjects (5.8 and 3.6 mmol/L, respectively).

General characteristics of the cohort by type of alcoholic beverage are presented in Table 2. Drinkers of beer, wine, and liquor did not largely differ from abstainers. However, drinking wine seemed to be associated with a healthier dietary pattern reflected by a slightly higher intake of fruit, vegetables, and fish and a slightly lower intake of saturated fat. Abstainers had lower serum HDLC and higher serum triglycerides than alcohol drinkers.

Table 3 (men) and Table 4 (women) present regression coefficients for total ethanol intake in relation to blood lipids, adjusted for confounders. The relation of total ethanol intake with blood lipids was generally more pronounced in women than in men after multivariable adjustment, but estimates for HDLC and LDLC in women were not statistically significant. In HDLC, an increase of 0.094 mmol/L was observed for male alcohol drinkers who consumed ≥15 g ethanol per day compared with abstainers after controlling for dietary, lifestyle, and CHD risk factors. In women, ethanol intake was positively associated with HDLC; but the association disappeared in the fully adjusted model. After adjustment for age and energy, an inverse association was observed between total ethanol intake and triglycerides in men. Further adjustment (model 2 and model 3) for lifestyle factors, CHD risk factors, and dietary factors attenuated this association. Women who consumed ≥15 g ethanol per day had significantly lower LDLC (−0.145 mmol/L), higher HDLC (0.212 mmol/L), and higher total cholesterol (0.152 mmol/L) (data not shown) than men (0.090, 0.094, and 0.111 mmol/L, respectively).

The associations of specific alcoholic beverages with HDLC in men are shown in Table 5. Wine consumption was positively associated with total cholesterol, LDLC, and triglycerides after age and energy adjustment; but no associations were found after further adjustment (data not shown). After controlling for the dietary, lifestyle, and CHD risk factors, a weak positive association with HDLC was observed for men who consumed ≥21 g of liquor per day compared with abstainers (difference of 0.058 mmol/L for ≥21 g/d vs 0 g/d, $P = .045$). In the fully adjusted model, beer consumption in men showed a positive, borderline-significant association with HDLC (difference of 0.073 mmol/L for ≥100 g/d vs 0 g/d, $P = .066$). In women, wine consumption appeared to be positively associated with HDLC, although this association did not reach statistical significance and was strongly attenuated after controlling for nutritional confounders (data not shown). No associations between beer or liquor intake and blood lipids were found in women.

Stratified analysis by use of lipid-lowering medication showed that differences in blood lipid levels over the categories of alcohol consumption were present in both treated (n = 739) and untreated subjects (n = 313) (data not shown). In linear regression analysis adjusted for age; BMI; and lifestyle, dietary, and CHD risk factors, the difference in

Table 2
Selected characteristics of 817 male coronary patients aged 60 to 80 years[a], according to intake of different alcoholic beverages

	Abstainers (n = 137)	Drinkers (n = 680)[b]		
		Beer (n = 430)	Wine (n = 398)	Liquor (n = 414)
Age (y)	69.4 ± 5.8	68.1 ± 5.4	68.3 ± 5.5	68.6 ± 5.5
BMI (kg/m^2)	27.9 ± 3.7	27.7 ± 3.4	27.2 ± 3.2	27.7 ± 3.3
Current smoking (%)	26	18	13	20
Higher education (%)[c]	7	18	23	16
Dietary intake				
Total energy (kJ/d)	7541 ± 1992	8426 ± 1994	8438 ± 2011	8385 ± 1988
Carbohydrates (g/d)	218 ± 67	228 ± 64	231 ± 63	225 ± 63
Protein (g/d)	68 ± 19	71 ± 18	71 ± 17	71 ± 18
Fat (g/d)	72 ± 28	76 ± 26	74 ± 25	76 ± 25
Saturated fat (g/d)	29 ± 14	29 ± 11	27 ± 10	28 ± 11
Monounsaturated fat (g/d)	22 ± 8	24 ± 9	24 ± 9	24 ± 8
Polyunsaturated fat (g/d)	15 ± 7	16 ± 7	16 ± 7	16 ± 7
Cholesterol (mg/d)	162 ± 66	179 ± 63	173 ± 60	179 ± 63
Fruit and vegetables (g/d)	260 ± 169	261 ± 177	288 ± 170	269 ± 163
Fish (g/d)	15 ± 18	16 ± 14	18 ± 14	16 ± 13
Fiber (g/d)	20 ± 7	20 ± 7	21 ± 7	20 ± 6
Blood lipids (mmol/L)				
Total cholesterol	4.94 ± 1.03	5.13 ± 0.91	4.99 ± 0.86	5.08 ± 0.91
HDLC	1.14 ± 0.29	1.27 ± 0.33	1.26 ± 0.31	1.27 ± 0.33
LDLC	2.85 ± 0.93	3.01 ± 0.86	2.91 ± 0.79	2.96 ± 0.84
Triglycerides	2.10 ± 1.14	1.89 ± 0.95	1.81 ± 0.91	1.87 ± 0.91

Values are mean ± SD, percentage, or median (Q1-Q3).

[a] Including the oversampled subjects.

[b] Drinking categories show overlap because one subject may consume different types of alcohol.

[c] Higher vocational education, university.

Table 3
Regression coefficients[a] for the association between total ethanol intake and serum blood lipids in 817 male coronary patients[b]

	Total ethanol intake (g/d)				*P* for trend[f]
	0 (n = 137)	0.01-4.99 (n = 179)	5-14.99 (n = 219)	≥15 (n = 282)	
Total cholesterol (mmol/L)					
Model 1[c]	Ref	0.040 (0.114)	0.095 (0.109)	0.133 (0.107)	.21
Model 2[d]	Ref	−0.014 (0.104)	0.120 (0.101)	0.142 (0.099)	.09
Model 3[e]	Ref	−0.010 (0.106)	0.123 (0.107)	0.111 (0.144)	.43
HDLC (mmol/L)					
Model 1[c]	Ref	−0.024 (0.038)	0.112 (0.037)	0.172 (0.036)	<.001
Model 2[d]	Ref	−0.039 (0.038)	0.087 (0.036)	0.150 (0.036)	<.001
Model 3[e]	Ref	−0.036 (0.038)	0.072 (0.038)	0.094 (0.052)	.024
LDLC (mmol/L)					
Model 1[c]	Ref	0.082 (0.104)	0.139 (0.100)	0.076 (0.097)	.84
Model 2[d]	Ref	0.020 (0.094)	0.145 (0.090)	0.065 (0.089)	.66
Model 3[e]	Ref	0.031 (0.095)	0.167 (0.096)	0.090 (0.129)	.67
Triglycerides (mmol/L)					
Model 1[c]	Ref	−0.006 (0.024)	−0.063 (0.023)	−0.050 (0.022)	.04
Model 2[d]	Ref	0.006 (0.023)	−0.042 (0.022)	−0.030 (0.022)	.14
Model 3[e]	Ref	0.002 (0.023)	−0.042 (0.023)	−0.025 (0.031)	.50

Ref indicates reference category (abstinence).

[a] Regression coefficients denote the adjusted difference in serum blood lipids (in millimoles per liter) compared with abstainers (reference group).

[b] Including the oversampled subjects.

[c] Adjusted for age and total energy intake.

[d] Adjusted for age, total energy intake, smoking, socioeconomic status, use of lipid-lowering medication, diabetes mellitus, hypertension, and physical activity.

[e] As model 2, with additional adjustment for dietary intake of total fat, saturated fat, fiber, carbohydrates, cholesterol, fruit, vegetables, and fish.

[f] *P* for trend refers to a linear trend in regression coefficients across increasing categories of total ethanol intake by treating the median of each category as a categorical variable.

HDLC between increasing categories of total ethanol intake and abstainers was higher among untreated subjects than among treated subjects. In untreated subjects who consumed ≥15 g ethanol per day, an increase of 0.212 mmol/L was observed compared with abstinence (test for trend, $P = .026$).

4. Discussion

In this analysis of (mainly treated) coronary patients, we found a positive and significant association between total ethanol intake and HDLC in men. The HDLC was 0.094 mmol/L higher in men who consumed more than 15 g of ethanol per day compared with abstainers. A weak but positive association was found between liquor intake and HDLC in men. Beer consumption in men and wine consumption in women were also positively associated with HDLC, but these associations did not reach statistical significance in the fully adjusted model. There was no association between alcohol consumption and total cholesterol, LDLC, and triglycerides.

To the best of our knowledge, data on the relationship between alcohol intake and cardiovascular risk factors in coronary patients are scanty. Using the extensive data set of the Alpha Omega Trial, we were able to examine habitual alcohol use in relation to blood lipids in post–myocardial infarction patients, with adjustment for a large number of potential confounders. Associations between specific types of alcoholic beverages and blood lipids were simultaneously adjusted for intake of other types of alcoholic beverages, which is considered an appropriate method [29]. Our study also had limitations. The cross-sectional design does not allow inference on causal associations. Coronary patients may have changed their drinking habits after they experienced a myocardial infarction. If they decided to consume less alcohol, this would have attenuated the association with HDLC and biased the effect toward the null. However, these participants had their last myocardial infarction approximately 4 to 5 years ago and are considered as stable patients. An alteration in drinking habits would change HDLC levels in approximately 4 weeks [5]. We relied on alcohol consumption by self-reporting; and heavy drinkers may have underreported their drinking habits, which could also have weakened the associations. In this study, a food frequency questionnaire was used in which participants reported consumption of alcohol during the previous month. Drinking habits among older subjects are considered to be generally stable over time [1]. We examined the effect of mean alcohol consumption in this study, as detailed information on drinking patterns was not available. Therefore, we could not make a distinction between regular use, occasional use, and binge drinking. The number of binge drinkers however is likely to be small in our study because patients who drank more than 6 glasses per day were excluded from the Alpha Omega Trial. Therefore, in this study, the association of heavy alcohol use with blood lipids could not be studied. In addition, it should be noted that abstainers may contain “sick quitters,” that is, people who stopped drinking because of illness or interaction with the

Table 4
Regression coefficients[a] for the association between total ethanol intake and serum blood lipids in 235 female coronary patients[b]

	Total ethanol intake (g/d)			*P* for trend[f]
	0 (n = 89)	0.01-4.99 (n = 72)	≥5 (n = 74)	
Total cholesterol (mmol/L)				
Model 1[c]	Ref	0.232 (0.167)	0.320 (0.168)	.092
Model 2[d]	Ref	0.203 (0.153)	0.434 (0.156)	.008
Model 3[e]	Ref	0.174 (0.158)	0.270 (0.204)	.224
HDLC (mmol/L)				
Model 1[c]	Ref	0.109 (0.062)	0.233 (0.062)	<.001
Model 2[d]	Ref	0.096 (0.062)	0.211 (0.063)	.002
Model 3[e]	Ref	0.076 (0.062)	0.060 (0.080)	.560
LDLC (mmol/L)				
Model 1[c]	Ref	0.028 (0.152)	0.149 (0.153)	.311
Model 2[d]	Ref	−0.024 (0.137)	0.201 (0.139)	.102
Model 3[e]	Ref	−0.020 (0.140)	0.157 (0.180)	.342
Triglycerides (mmol/L)				
Model 1[c]	Ref	0.014 (0.035)	−0.027 (0.035)	.333
Model 2[d]	Ref	0.030 (0.035)	0.004 (0.035)	.897
Model 3[e]	Ref	0.031 (0.036)	0.017 (0.046)	.798

Ref indicates reference category (abstinence).

[a] Regression coefficients denote the adjusted difference in serum blood lipids (in millimoles per liter) compared with abstainers (reference group).

[b] Including the oversampled subjects.

[c] Adjusted for age and total energy intake.

[d] Adjusted for age, total energy intake, smoking, socioeconomic status, use of lipid-lowering medication, diabetes mellitus, hypertension, and physical activity.

[e] As model 2, with additional adjustment for dietary intake of total fat, saturated fat, fiber, carbohydrates, cholesterol, fruit, vegetables, and fish.

[f] *P* for trend refers to a linear trend in regression coefficients across increasing categories of total ethanol intake by treating the median of each category as a categorical variable.

prescribed medication [4]. This may also have diluted the associations toward the null in this study. Alcohol consumption is likely to be related to other lifestyle factors that affect blood lipids, such as physical activity. Adjustment for self-reported physical activity did not modify the observed relation between ethanol intake and HDLC. However, we used a relatively crude way to assess physical activity; and therefore, we cannot fully exclude residual confounding due to this factor. With regard to our findings in women, it should be emphasized that the sample size was relatively small (n = 235); and therefore, the associations need to be interpreted with caution.

The results of our study are consistent with other epidemiologic studies describing a positive relation between light-to-moderate alcohol consumption and HDLC [5,15-17,30-32]. In a study among 340 coronary patients (78% men) younger than 76 years [13], alcohol consumption was positively associated with HDLC, whereas there was no relation with total cholesterol, LDLC, or triglycerides. Similar results were found in subjects who were on lipid-lowering medication, indicating that alcohol intake increased HDLC also in adjunct to treatment. A meta-analysis showed that consumption of 30 g of ethanol per day increased HDLC more than gemfibrozil, a medication used to treat people with low HDLC [5]. The beneficial effect of moderate alcohol consumption on HDLC was most apparent among older coronary patients. In middle-aged men who are moderate drinkers, the inverse association between alcohol consumption and CHD mortality can largely be explained by effects on HDLC [33]. In the Physicians' Health Study, middle-aged men (mean age, 63 years) with a history of myocardial infarction who consumed moderate amounts of alcohol had a lower all-cause mortality. We found a significant association between liquor consumption and HDLC in men [10]. This is in line with the Health Professionals Follow-up study among 38 077 men aged 40 to 75 years who were free of CVD. In these subjects, who mainly consumed liquor and beer, alcohol consumption was inversely associated with risk of myocardial infarction [25]. These findings and our result support the hypothesis that the beverage most widely consumed by a given population is the one most likely to be positively associated with HDLC simply because of the maximum variation in alcohol consumption from specific types of drinks [34].

Several mechanisms have been proposed to explain the beneficial effect of alcohol consumption on HDLC. Some previous studies suggested that alcohol increased the subfractions HDL_2 and HDL_3 [13,35]. Both subfractions have been inversely related to risk of myocardial infarction [13]. Alcohol may also affect hemostasis [5,18,19] and insulin resistance [36].

Table 5
Regression coefficients[a] for the association between intake of alcoholic beverages and HDLC in 817 male coronary patients[b]

	Categories of intake (g/d)			*P* for trend[f]
Beer	0	0.01-99.99	≥100	
n	387	297	133	
Model 1[c]	Ref	0.050 (0.026)	0.127 (0.035)	.001
Model 2[d]	Ref	0.044 (0.026)	0.135 (0.034)	<.001
Model 3[e]	Ref	0.030 (0.026)	0.073 (0.038)	.066
Wine	0	0.01-74.99	≥75	
n	419	214	184	
Model 1[c]	Ref	0.033 (0.029)	0.056 (0.031)	.077
Model 2[d]	Ref	0.009 (0.029)	0.033 (0.032)	.294
Model 3[e]	Ref	−0.003 (0.029)	−0.043 (0.038)	.248
Liquor	0	0.01-20.99	≥21	
n	403	184	230	
Model 1[c]	Ref	0.011 (0.030)	0.109 (0.028)	<.001
Model 2[d]	Ref	0.003 (0.030)	0.108 (0.028)	<.001
Model 3[e]	Ref	−0.010 (0.030)	0.058 (0.032)	.045

Ref indicates reference category (zero use of specific alcoholic beverage).

[a] Regression coefficients denote the adjusted difference in serum HDLC level (in millimoles per liter) compared with the level in abstainers (reference group).

[b] Including the oversampled subjects.

[c] Adjusted for age and total energy intake.

[d] Adjusted for age, total energy intake, smoking, socioeconomic status, use of lipid-lowering medication, diabetes mellitus, hypertension, and physical activity.

[e] As model 2, with additional adjustment for dietary intake of total fat, saturated fat, fiber, carbohydrates, cholesterol, fruit, vegetables, and fish.

[f] *P* for trend refers to a linear trend in regression coefficients across categories of alcoholic beverages by entering the median value within each category into the multivariable model.

In summary, we found a positive relationship of ethanol intake with HDLC levels in male coronary patients, most of whom were on lipid-lowering treatment. With regard to specific types of alcohol, we found a weak and positive relationship between liquor and beer consumption and HDLC in men and wine consumption and HDLC in women. These results suggest that the beneficial effect of alcohol consumption on HDLC may be explained by ethanol and not by other beneficial substances in specific types of alcoholic beverages. Based on this finding, further research needs to be done to examine the effects of the residual substances from different types of alcoholic beverages on HDLC.

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References

[1] Doll R, Peto R, Wheatley K, et al. Mortality in relation to consumption of alcohol: 13 years' observations on male British doctors. BMJ 1994; 309:911-8.
[2] Rimm EB, Klatsky A, Grobbee D, Stampfer MJ. Review of moderate alcohol consumption and reduced risk of coronary heart disease: is the effect due to beer, wine, or spirits? BMJ 1996;312:731-6.
[3] Camargo Jr CA, Stampfer MJ, Glynn RJ, et al. Moderate alcohol consumption and risk for angina pectoris or myocardial infarction in U.S. male physicians. Ann Intern Med 1997;126:372-5.
[4] Shaper AG, Wannamethee G, Walker M. Alcohol and mortality in British men: explaining the U-shaped curve. Lancet 1988;2:1267-73.
[5] Rimm EB, Williams P, Fosher K, et al. Moderate alcohol intake and lower risk of coronary heart disease: meta-analysis of effects on lipids and haemostatic factors. BMJ 1999;319:1523-8.
[6] Maclure M. Demonstration of deductive meta-analysis: ethanol intake and risk of myocardial infarction. Epidemiol Rev 1993;15:328-51.
[7] Stampfer MJ, Colditz GA, Willett WC, et al. A prospective study of moderate alcohol consumption and the risk of coronary disease and stroke in women. N Engl J Med 1988;319:267-73.
[8] Fuchs CS, Stampfer MJ, Colditz GA, et al. Alcohol consumption and mortality among women. N Engl J Med 1995;332:1245-50.
[9] Klatsky AL, Armstrong MA, Friedman GD. Risk of cardiovascular mortality in alcohol drinkers, ex-drinkers and nondrinkers. Am J Cardiol 1990;66:1237-42.
[10] Muntwyler J, Hennekens CH, Buring JE, et al. Mortality and light to moderate alcohol consumption after myocardial infarction. Lancet 1998;352:1882-5.
[11] Thun MJ, Peto R, Lopez AD, et al. Alcohol consumption and mortality among middle-aged and elderly U.S adults. N Engl J Med 1997;337: 1705-14.
[12] Mukamal KJ. Alcohol use and prognosis in patients with coronary heart disease. Prev Cardiol 2003;6:93-8.
[13] Gaziano JM, Buring JE, Breslow JL, et al. Moderate alcohol intake, increased levels of high-density lipoprotein and its subfractions, and decreased risk of myocardial infarction. N Engl J Med 1993;329: 1829-34.
[14] Sierksma A, Gaag van der S, Tol van A, et al. Kinetics of HDL cholesterol and paraoxonase activity in moderate alcohol consumers. Alcohol Clin Exp Res 2002;26:1430-5.
[15] Parker DR, McPhilips JB, Derby CA, et al. High-density-lipoprotein cholesterol and types of alcoholic beverages consumed among men and women. Am J Public Health 1996;86:1022-7.
[16] Langer RD, Criqui MH, Reed DM. Lipoproteins and blood pressure as biological pathways for effect of moderate alcohol consumption on coronary heart disease. Circulation 1992;85:910-5.
[17] Schröder H, Ferrández O, Jimenez Conde J, et al. Cardiovascular risk profile and type of alcohol beverage consumption: a population-based study. Ann Nutr Metab 2005;49:100-6.
[18] Mukamal KJ, Jensen MK, Gronbaek M, et al. Drinking frequency, mediating biomarkers, and risk of myocardial infarction in women and men. Circulation 2005;112:1406-13.
[19] Sierksma A, Gaag van der MS, Kluft C, et al. Moderate alcohol consumption reduces plasma C-reactive protein and fibrinogen levels: a randomized, diet-controlled intervention study. Eur J Clin Nutr 2002; 56:1130-6.
[20] Di Castelnuovo A, Rotondo S, Iacoviello L, et al. Meta-analysis of wine and beer consumption in relation to vascular risk. Circulation 2002;105:2836-44.
[21] Contaldo F, Pasanisi F, Mancini M. Beyond the traditional interpretation of Mediterranean diet. Nutr Metab Cardiovasc Dis 2003;13:117-9.
[22] Gronbaek M, Deis A, Sorensen TI, et al. Mortality associated with moderate intakes of wine, beer, or spirits. BMJ 1995;310:1165-9.
[23] Renaud S, De Lorgeril M. Wine, alcohol, platelets, and the French paradox for coronary heart disease. Lancet 1992;339:1523-6.
[24] Criqui MH, Rigel BL. Does diet or alcohol explain the French paradox? Lancet 1994;344:1719-23.
[25] Mukamal KJ, Conigrave KM, Mittleman MA, et al. Roles of drinking pattern and type of alcohol consumed in coronary heart disease in men. N Eng J Med 2003;348:109-18.
[26] Stichting NEVO. NEVO tabel. Nederlands Voedingsstoffenbestand 2001. (NEVO table. Dutch Nutrient Database 2001) Den Haag: Voorlichtingsbureau voor de Voeding; 2001 (in Dutch).
[27] Chobanian AV, Bakris GL, Black HR. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension 2003;42:1206-52.
[28] Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of LDL cholesterol in plasma without use of preparative ultracentrifuge. Clin Chem 1972;18:499-502.
[29] Rimm EB. Review of moderate alcohol consumption and reduced risk of coronary heart disease: is the effect due to beer, wine, or spirits? Authors' reply. BMJ 1996;313:365.
[30] Ruidavets JB, Ducimetiere P, Arveiler D, et al. Types of alcoholic beverages and blood lipids in a French population. J Epidemiol Community Health 2002;56:24-8.
[31] Hines LM, Stampfer MJ, Ma J, et al. Genetic variation in alcohol dehydrogenase and the beneficial effect of moderate alcohol consumption on myocardial infarction. N Engl J Med 2001;344: 549-55.
[32] Kabagambe EK, Baylin A, Ruiz-Narvaez E, et al. Alcohol intake, drinking patterns, and risk of nonfatal acute myocardial infarction in Costa Rica. Am J Clin Nutr 2005;82:1336-45.
[33] Suh I, Shaten BJ, Cutler JA, et al. Alcohol use and mortality from coronary heart disease: the role of high-density lipoprotein cholesterol. The Multiple Risk Factor Intervention Trial Research Group. Ann Intern Med 1992;116:881-7.
[34] Rimm EB, Stampfer MJ. Wine, beer, and spirits. Are they really horses of a different color? Circulation 2002;105:2806-7.
[35] Clevidence BA, Reichman ME, Judd JT, et al. Effects of alcohol consumption of lipoproteins of premenopausal women: a controlled diet study. Arterioscler Thromb Vasc Biol 1995;15:179-84.
[36] Lazarus R, Sparrow D, Weiss ST. Alcohol intake and insulin levels. The Normative Aging Study. Am J Epidemiol 1997;145:907-16.