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The Tromsø heart study: alcoholic beverages and coronary risk factors*

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SUMMARY Frequency of beer, wine, and spirits drinking and inebriation by alcohol were associated with serum lipids and blood pressure in 14 667 free-living men and women aged 20 to 54 years. Regression analysis including several background variables revealed that alcohol was more "favourably" associated with coronary risk factors than previously reported, due to the small consumption of alchohol in the population (only 2·0% of men and 0·3% of women reported drinking every day) or to unknown confounding factors: wine ($p < 0·05$) and inebriation ($p < 0·01$) were inversely related with total cholesterol in women; the strong positive relation with HDL-cholesterol in both sexes previously reported was confirmed; beer ($p < 0·05$) and inebriation p($< 0·05$) in men and spirits ($p < 0·01$) in women seemed to decrease triglycerides; and a new observation may be the negative association between wine and blood pressure (systolic $p < 0·01$ in both sexes) as opposed to the positive relation with beer ($p < 0·01$ both pressures in men) and spirits ($p < 0·05$ systolic pressure and $p < 0·01$ diastolic pressure in men and $p < 0·05$ diastolic pressure in women). Women showed more "favourable effects" of alcohol than men, and one reason may be that they drank less often. Wine gave lower risk factor readings than beer, and especially lower than spirits.

Several studies have dealt with the association between alcohol intake and the levels of serum lipids[1–16] and blood pressure.[5–8 17–27] While a positive relation between alcohol and high-density-lipoprotein (HDL) cholesterol has been consistently reported,[1–3 8–16] there are conflicting reports on how alcohol consumption associates with total cholesterol,[1–8] triglycerides,[1–6 9] and blood pressure.[5–8 17–27]

Most population studies investigating the relation between use of alchohol and coronary risk factors are performed on middle-aged men of whom about 20% are daily drinkers. In contrast, the present study deals with men and women from 20 to 54 years of age of whom only 2·0% of the men and 0·3% of the women reported daily drinking.

Whether or not the risk factor levels[1 12 14 17] and the incidence of coronary heart disease[28–34] vary with type of beverage has for long been debated. Because beer, wine, and spirits were all important sources of alcohol in this population, each beverage type as well as the frequency of alchohol inebriation were analysed separately to investigate their individual associations with the risk factors.

This report describes the drinking habits and their associations with total cholesterol, HDL-cholesterol, triglycerides, and systolic and diastolic blood pressure in each sex. Beer, wine, spirits, and inebriation were treated separately in univariate and regression analyses, the latter including the four alcohol variables and a number of possible confounders.

Materials and methods

In 1979–80, all men aged 20 to 54 years and all women aged 20 to 49 living in the municipality of Tromsø were invited to be screened for coronary risk factors. Altogether 16 621 subjects, 78% of those invited, attended the screening. The examination comprised administration of a questionnaire identical with that used in the former study in Tromsø[35] and the cardiovascular studies in Norwegian counties;[36] collection of venous nonfasting blood samples for measurement of lipids and glucose levels; and weight, height, and blood pressure measurements. In addition, all participants were given a second questionnaire on dietary habits, alcohol and coffee consumption, and previous diseases. They were instructed to fill in this questionnaire at home and to return it by mail. The 14 667 participants who returned the second questionnaire are the subjects of the present analysis.

*The survey was carried out in cooperation with the National Health Screening Service, Oslo, Norway, and the study was granted by the Norwegian Research Council for Science and the Humanities.

Total cholesterol was measured directly by the enzymatic oxidase method, using a commercial kit (Boehringer). HDL-cholesterol was assayed by the same procedure after precipitation of lower-density lipoproteins with heparin and manganese chloride. Triglycerides were enzymatically determined as glycerol (Boehringer). The laboratory assessments were performed by the Division of Clinical Chemistry, University Teaching Hospital of Tromsø. Blood pressure was measured twice with a sphygmomanometer on the right upper arm in a sitting position and read to the nearest even number. In this study the lowest measured pressures were used. The systolic blood pressure was measured when the first Korotkoff sound appeared (phase 1) and the diastolic pressure at the disappearance phase of the Korotkoff sound (phase 5). If there was no phase 5, the pressure at phase 4 was recorded.

Information on drinking habits was obtained from five questions. In the first, the subject was asked whether he/she was a teetotaller. If not, one proceeded to the other questions and reported how often (never or a few times a year, once or twice a month, about once a week, two or three times a week, about daily) each of the types of beverage beer, wine, and spirits were usually drunk and, finally, roughly how often (never, a few times a year, once or twice a month, once or twice a week, more than twice a week) during the past 12 months the participant had drunk so much alcohol that he/she had become inebriated. In the present analyses teetotallers were included with those who drank beer, wine, and spirits never or a few times a year and were never inebriated.

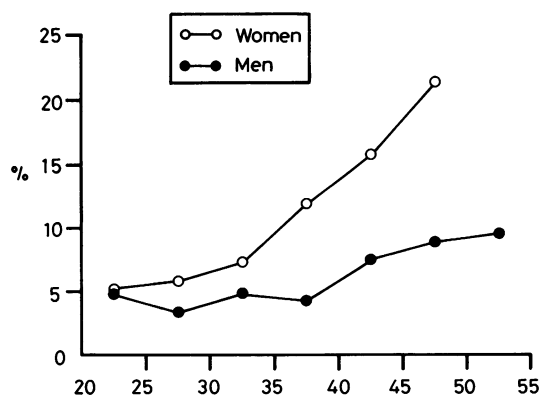
How the risk factor levels varied with the responses to each alcohol variable were investigated using analysis of covariance adjusting for age (and for triglycerides also for time since last meal). For wine in men and all alcohol variables in women, less than 30 subjects had answered in the most frequent alcohol category, and these were included with those in the nearest group. Consequently, the direct comparison between the situations where five categories were used and those with four categories was complicated. For each alcohol variable, the adjusted group means were tested for equality and linear trend. Linear trends were tested by using the contrasts $(-2,-1,0,1,2)$ for five categories and $(-3,-1,1,3)$ for four categories.

To adjust each alcohol variable for the contribution of the other alcohol variables and non-alcoholic characteristics, stepwise multiple regression analyses were performed. Backward elimination was used with the 5% level of significance as exclusion criteria. Serum lipids and blood pressure were used as dependent variable, and the beer, wine, and spirits variables were forced to stay in the regression equation where the following variables were also included when the stepping was started: alcohol inebriation, age (in years), body mass index (weight/height^2), physical activity at leisure (graded 1–4), number of cigarettes a day, time since last meal (graded 1–5), minced meat frequency (graded 1–5), fish dinner frequency (graded 1–5), dark bread (no, yes), bread consumption (graded 1–4), amount of margarine per slice of bread (graded 1–5), soft/plant margarine (no, yes), fruit/vegetables frequency (graded 1–5), cups of coffee a day (graded 1–4), amount of milk fat (graded 1–3), years of education, and poverty during childhood (graded 1–4). For females also use of oral contraceptives (no, yes), menopause started (no or pregnant, uncertain, yes), and current pregnancy (no, yes) were included. The BMDP statistical software[37] was used to perform the analyses.

Results

Figure 1 shows the age and sex-specific responses to the teetotaller question. The proportion of selfreported abstainers was larger among women than men and increased with age, more rapidly among women.

Table 1 shows the responses to each of the other alcohol questions. Noticeable differences in the beverage preference by sex and age were observed. Among men, 35·0% drank beer, 69·3% wine and 33.0% spirits less often than once a month. Men consumed beer more frequently than spirits, and younger men seemed to favour beer and older men spirits. Among women, 62·1% drank beer, 65·7% wine and 58·5% spirits less often than once a month. Women drank beer and spirits less frequently than



Total No of							
Men	- 839	1276	1491	1229	874	788	779
Women	- 1220	1515	1565	1175	865	733	-

Fig 1 *Percentage distribution of teetotallers in total population according to age and sex.*

Table 1 *Percentage distribution of beer, wine, and spirits drinking and alcohol inebriation according to age and sex*

	Men					*Women*				
Age	*Never or a few times a year* 1	*1–2 times a month* 2	*About once a week* 3	*2–3 times a week* 4	*About daily* 5	*Never or a few times a year* 1	*1–2 times a month* 2	*About once a week* 3	*2–3 times a week* 4	*About daily* 5
Beer										
20–29	22·2	36·5	29·6	10·7	0·9	50·8	34·0	12·5	2·6	0·0
30–39	32·5	32·1	22·6	11·3	1·5	66·0	21·5	10·0	2·1	0·4
40–49	47·2	25·0	17·6	7·7	2·5	75·0	15·5	7·4	2·0	0·1
50–54	52·0	22·4	16·7	7·0	1·9	—	—	—	—	—
Total	35·0	30·7	22·8	9·8	1·6	62·1	25·0	10·4	2·3	0·2
Wine										
20–29	69·7	24·1	5·4	0·7	0·1	63·0	29·6	6·7	0·6	0·0
30–39	64·8	24·3	8·4	2·5	0	63·3	26·5	7·9	2·3	0·1
40–49	72·4	19·7	6·1	1·5	0·3	74·5	17·5	6·1	1·6	0·3
50–54	77·9	12·9	7·7	1·5	0	—	—	—	—	—
Total	69·3	22·0	6·9	1·6	0·1	65·7	25·7	7·0	1·5	0·1
Spirits										
20–29	30·4	46·9	20·6	1·9	0·3	55·2	36·7	7·5	0·6	0
30–39	29·7	40·8	23·4	5·7	0·4	57·9	32·5	8·9	0·8	0
40–49	37·7	34·1	20·9	6·3	0·9	65·1	24·4	9·1	1·2	0·2
50–54	41·2	31·3	19·7	6·3	1·5	—	—	—	—	—
Total	33·0	40·0	21·6	4·8	0·6	58·5	32·3	8·4	0·8	0·0

	Men					*Women*				
	Never 1	*A few times a year* 2	*1–2 times a month* 3	*1–2 times a week* 4	*More than twice a week* 5	*Never* 1	*A few times a year* 2	*1–2 times a month* 3	*1–2 times a week* 4	*More than twice a week* 5
Inebriation										
20–29	11·6	42·7	35·6	9·5	0·6	32·6	52·3	13·1	1·9	0·0
30–39	18·2	54·3	23·0	4·1	0·4	54·0	40·6	4·7	0·6	0·0
40–49	32·2	50·9	13·2	3·0	0·7	73·3	24·5	1·7	0·5	0
50–54	39·4	44·8	12·2	3·1	0·5	—	—	—	—	—
Total	21·8	49·1	23·3	5·3	0·5	50·0	41·5	7·3	1·1	0·0

men, but wine was consumed in a pattern similar to that of men. As many as 70·9% of the men and 91·5% of the women claimed to be inebriated by beer, wine or spirits less often than once a month.

Figures 2 (men) and 3 (women) show the mean levels of the risk factors of the beer, wine, spirits, and inebriation classes. Total cholesterol varied significantly with use of beer and wine as well as inebriation in both sexes. In women, a negative relation was evident through significant linear trends for beer and wine. HDL-cholesterol showed a clear positive linear trend for all four alcohol variables in both sexes. The picture painted for triglycerides in men was similar to that of total cholesterol. In women, all alcohol variables were significantly associated with triclycerides, and those who drank beer or spirits at least twice a week or those who were inebriated at least once a week had the highest means, whereas those who drank wine at least twice a week had the lowest mean. In men, the systolic blood pressure increased with inebriation, and both pressures increased with consumption of beer and spirits. On the other hand, the systolic pressure showed a non-significant decrease with wine. The alcohol blood pressure association was generally less pronounced in women, and the diastolic pressure was insignificantly related to alcohol except for inebriation which was positively associated. The means of the systolic pressure differed significantly except for spirits, and for wine there was a strong negative relation.

When analysing all alcohol variables and several possible confounders simultaneously, table 2 reveals results for the alcohol variables that could be expected on the basis of the univariate analysis displayed in figures 2 and 3. None of the alcohol variables was a dominant predictor of the risk factors. Total cholesterol decreased significantly with inebriation, and this was the case also with wine in women whereas the reverse association with spirits occurred in men. For HDL-cholesterol all coefficients were positive, and whereas beer, spirits, and inebriation were significant in men, beer, wine, and spirits were significant in women. For triglycerides, all significant coefficients were negative, but whereas beer and

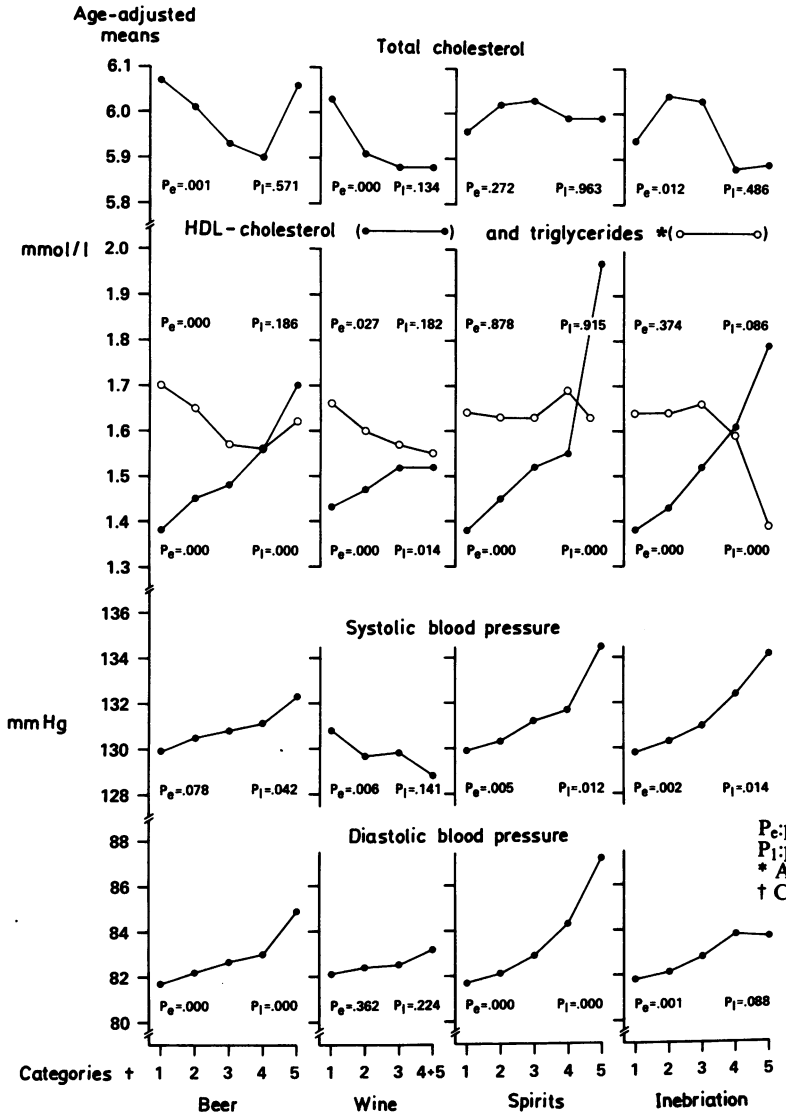


Fig 2 *Mean levels of risk factors in men according to alcohol class.*

inebriation came out as significant in men, only spirits was significant in women. The most striking feature regarding systolic blood pressure was the negative association with wine in both sexes. Beer and spirits were positively related to both pressures in men and spirits to diastolic pressure in women.

As shown in table 2, interesting results occurred for several of the non-alcoholic background variables. The association between the risk factors and body mass and dietary items, the strong contribution of the female specific variables as well as the positive association between diastolic blood pressure and time since last meal will be dealt with in forthcoming papers.

Discussion

As teetotallers had lipid and blood pressure means that were similar to those of subjects who drank less often than once a month or were never inebriated, these were grouped together in the analyses.

To take into account the total frequency of drinking for each subject we analysed the data including an alcohol score adapted from Kozarevic *et al.*[28] For each

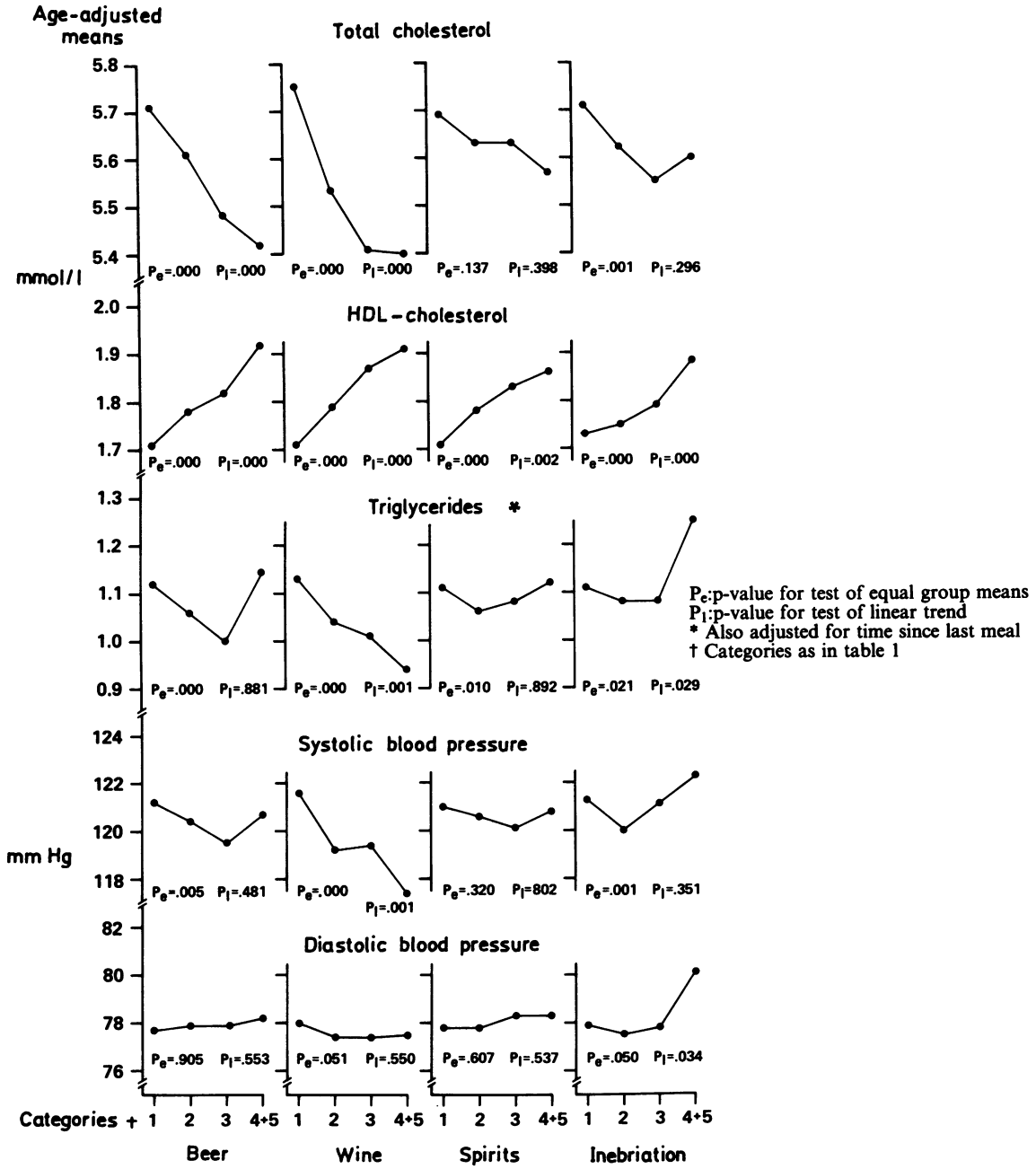


Fig 3 *Mean levels of risk factors in women according to alcohol class.*

subject, the answers to the beer, wine, and spirits questions were converted into drinking frequency per month and then added together to form the single summary score. Similar alcohol scores based on the amount of pure alcohol contained in each beverage were also tried out. When beer, wine, and spirits were kept in the regression equation, the scores played only a marginal role and were thus excluded in the

Table 2 *t values for regression coefficients of the variables in the model at the end of backward elimination*

	Cholesterol						*Blood pressure*			
	Total		*HDL*		*Triglycerides*		*Systolic*		*Diastolic*	
Variables in model at start	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Drinking frequency:										
Beer†	−1·68*	−·36*	4·15	3·52	−2·15	−·08*	4·24	·99*	3·58	1·80*
Wine†	−·56*	−2·26	1·15*	4·98	·57*	−1·30*	−4·58	−2·74	−1·82*	−·89*
Spirits†	2·22	−·10*	5·95	7·13	·52*	−2·84	2·04	·82*	3·20	2·01
Inebriation frequency	−2·50	−4·22	3·95		−2·52					
Age	25·97	20·77	8·80	14·52			7·88	12·42	22·03	15·49
Body mass index	12·98	11·23	−13·58	−13·12	22·03	17·20	14·89	17·53	20·30	16·46
Physical activity at leisure	−4·24		2·97	3·18	−4·03	−2·82			−2·87	
Number of cigarettes		4·95	−6·52	−13·54	5·08	7·55		−3·49	−3·65	−3·61
Time since last meal	3·89		2·59		−10·82	−9·56			10·04	7·00
Minced meat frequency					3·51	2·61				
Fish dinner frequency					−2·87					
Dark bread						−2·18				
Bread consumption	−5·68	−2·41			2·19		3·76			
Amount of margarine per slice of bread					2·14	4·25				
Soft/plant margarine	−8·62	−8·71	−3·31	−3·11						
Fruit/vegatables frequency		−2·66	−2·28					−2·71		
Cups of coffee	11·53	7·65				2·24				
Amount of milk fat		3·05				4·44				
Years of education	−5·85	−5·15	−4·12		−3·49	−2·02		−5·71	2·25	−2·00
Poverty during childhood							−2·12	−2·63	−2·24	
Use of oral contraceptives	—		—	−5·16	—	6·22	—	5·08	—	2·61
Menopause started	—	5·79	—		—	5·43	—	2·51	—	5·09
Current pregnancy	—	5·28	—	4·34	—	7·22	—		—	−5·19
Multiple R-square (%)	25·7	23·8	7·0	11·2	10·9	10·9	5·6	13·2	17·8	15·1

* Not significant at the 5% level
† Forced into the equation
— Not included

presentation of the results.

The low consumption in Norway, which was less than 6 litres pure alcohol per capita per annum at 15 years and above at the time of screening,[38] was reflected through the answers shown in table 1. In population studies, drinking habits are usually measured by selfreporting either the amount of alcohol consumed (24, 48 hour or last week recall) or the frequency of drinking (average, last month, etc). In this study the frequency approach was chosen, but, although the rather vague term inebriation was used in the questionnaire, the answers to this question were assumed to reflect something about the amount of alcohol consumed each time. In the analyses, inebriation seemed to carry some separate information in addition to the beverage variables. The age-adjusted means of inebriation generally differed only slightly from those of the other alcohol variables, but when beer, wine, and spirits were forced to stay in the regression equation, inebriation came out as a significant contributor in four of the 10 regression analyses compared to five for beer, four for wine, and seven for spirits.

The actual frequency of drinking is usually regarded as inaccurate[34] and may blur true associations also in this study. Studies on alcohol seldom use methods that are directly comparable, but this study seems to paint a more "favourable" picture of the relation between alcohol and coronary risk factors. Total cholesterol has usually been found to increase with increased use of alcohol.[1-8] This study showed the reverse pattern in women and no clear trend in men. Similarly, contrary to the discrepant but generally positive associations reported between alcohol and triglycerides,[1-6 9] all significant regression coefficients were negative in this study. Heavy alcohol drinking has generally been associated with elevated blood pressure, whereas the influence of light drinking on blood pressure is weak and disputed.[5-8 17-27] Except for wine, this study revealed a positive linear relation between alcohol and blood pressure in men but no strong or consistent association in women. The difference between heavy drinkers and abstainers was smaller than 8 mmHg (systolic) and 4 mmHg (diastolic), which typically have been reported from other studies. The more "favourable" findings for total cholesterol, triglycerides, and blood pressure are most likely due to the small consumption of alcohol in this population but may also be due to unknown confounders.

Women showed a stronger negative association between total cholesterol and alcohol than men whereas the significant positive association between blood pressure and beer and spirits in men did not appear in women. Sex differences have also previously

been reported[2 9 25 26] and are probably due to women consuming less alcohol and drinking less frequently than men.[1 12 25 39]

Whether or not a moderate intake of alcohol tends to decrease the levels of total cholesterol, triglycerides, and blood pressure and protects against coronary heart disease have for long been debated.[2 28–34] In the univariate analysis, where the means varied significantly (figs 2 and 3), men and women who drank less often than once a month, had higher total cholesterol and triglyceride means for all beverages than those drinking once or twice a month or about once a week. The pattern for inebriation was similar, but the lowest total cholesterol means in men occurred for those who were inebriated at least once a week. The blood pressure means in men, however, were lowest for beer, spirits, and inebriation for those drinking less often than once a month or those never inebriated, but this group had the highest systolic pressure for wine. Women who drank less often than once a month or never were inebriated had higher blood pressure means for all alcohol variables than those consuming beverages or those who were inebriated a few times a year or once or twice a month. The findings of this study, therefore, partly support the hypothesis of a protective effect of alcohol on coronary risk factors, but the biochemical reason why this is so is not elucidated.

Does the risk of coronary heart disease vary with the type of alcoholic beverage? Use of beer, wine, and spirits has been related to lipids[1 12 14] and coronary heart disease incidence[28–34] but seldom to blood pressure.[17] In North America, where wine was a trivial source of alcohol, only small differences were found between beer, wine, and spirits and their associations with the lipids.[1 12 14] Correlating alcohol consumption with coronary heart deaths in 18[29] and 20[30] countries gave a strong negative association only for wine. However, among Japanese men in Hawaii[31] beer was the principal source of alcohol and the only beverage type that correlated significantly with a decreased incidence of coronary heart disease. In Yugoslavia,[28] no significant difference was found between beer, wine, and weak and strong rakija. In matched case-control studies of men[32] and women,[33] reduction in risk was most pronounced in women who drank wine. A problem when comparing different types of alcohol in a population is that drinking is restricted mainly to one or two of the beverages. This study gave an opportunity to investigate the matter because even if men drank wine less often than beer and spirits, women consumed all beverage types at a similar frequency. How clearly both the analysis of covariance and the regression analysis gave more "favourable" results on the risk factors for wine than for beer and spirits came as a surprise. Also, beer seemed to be more "favourable" than spirits. The literature offers many possible explanations as to why the coronary risk factors seem to respond differently to beer, wine, and spirits. The data were analysed further to investigate whether or not wine drinkers had social habits that differed from the rest of the population, but no consistent pattern was evident.

Finally, generalisations on the basis of the potential benefits of alcohol on the health related characteristics that this study dealt with must be drawn with care. One must always bear in mind the undoubtedly overall nett harmful effects of alcohol on health.

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