RESEARCH REPORT

Increased mortality related to heavy alcohol intake pattern

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Study objective: Although moderate alcohol intake is related to decreased all cause and ischaemic heart disease mortality, intake of large amounts at a time may be harmful.
Design: A cohort study, average follow up time was 7.3 years.
Setting: Finland.
Participants: General population sample of 5092 men, aged from 25 to 64 years, who had consumed alcohol during the 12 months before the baseline examination.
Main results: The main outcome measure was death. After excluding cases with previous myocardial infarction at the baseline examination and after adjustment for age, education, smoking, and average alcohol intake in Cox proportional hazards model, subjects with heavy drinking pattern (six or more drinks at a time) still had higher mortality from all causes than drinkers without heavy drinking occasions (RR 1.57; 95% CI 1.17 to 2.10). Respective analyses showed increased risk also for ischaemic heart disease (1.77; 95% CI 1.01 to 3.08), external causes (2.90; 95% CI 1.47 to 5.72) and alcohol related causes of death (2.73; 95% CI 1.13 to 6.64). The last two risk ratios were not adjusted for smoking. Relative risk point estimates were approximately similar for drinkers with heavy drinking occasions irrespective of beverage type, although those for beer and wine did not reach significance, probably because of the small number of cases. The highest average alcohol intake was found among drinkers who consumed all three types of beverage.
Conclusions: Consuming six or more drinks at a time is related to increased mortality among working age male drinkers. The authors found no clear evidence for beverage specific differences.

Compared with abstainers, average alcohol intake at the moderate level is related to reduced and heavy intake to increased all cause and ischaemic heart disease mortality.[1 2] Studies on problem drinking,[3 4] alcoholism,[5] and inebriation[6] suggest that the increased mortality is influenced not only by high average intake over time but consuming large amounts at a time even if the average intake over time is low. Earlier, Room and Day have found that drinkers consuming five or more drinks a day have higher mortality than all other drinkers among middle aged US adults.[7] Later, mortality among men drinking six or more bottles of beer at a time has been found to be higher than among those restricting their intake to less than three bottles of beer per occasion.[8] It would be surprising, however, if this effect would be limited to beer, as alcohol is the main toxic substance also in wine and spirits. We have therefore studied heavy drinking pattern in a large cohort, with reference to all three types of beverage. As some unknown characteristics of abstainers have been suspected to undermine the validity of abstainers as a reference group,[9] we have compared drinkers with heavy pattern with drinkers without heavy drinking occasions. Heavy drinking occasion was defined as consuming six or more drinks of beer, wine, or spirits at a time. To make the comparison stringent, we adjusted for average alcohol intake in addition to potential confounders.

METHODS

Subjects

In this study, all men studied in the National FINRISK Study in 1987 and 1992 in Finland were followed up until the year 1997.[10] A study population at the baseline survey in the National FINRISK Study was of 25 to 64 years old Finnish men from provinces of North Karelia and Kuopio, south western Finland and from the cities of Helsinki and Vantaa. In 1987, the survey was carried out in North Karelia, Kuopio province and in south western Finland and in 1992 in the same areas and in addition in the cities of Helsinki and Vantaa. For the National FINRISK Study a stratified random sample of study population was drawn in 1987, so that there were, in each 10 year age group, 500 men in North Karelia and 250 in other study areas and in 1992, there were 250 men in each 10 year age group in all study areas. So, the total sample size for this study was 8000 men of whom 5958 participated in the baseline survey. All those who reported that they had consumed any alcohol during the past 12 months (n=5160) were counted as eligible for this study (table 1). The information needed to categorise the subjects to drinkers with a heavy drinking pattern and others was missing from 68 subjects, so the final analyses were done on 5092 men. In some analyses, subjects with previous myocardial infarction (n=213) were excluded, so in these analyses, the number of subjects was 4879.

Baseline survey

The baseline survey was carried out in 1987 and 1992 in all areas during January to March with standardised methods following the WHO MONICA protocol.[11] The survey protocol has been approved in the ethics committee of the National Public Health Institute. The survey included a self administered questionnaire, physical measurements, and laboratory tests. The questionnaire, which was completed at home before the actual examinations, included questions about socioeconomic factors, health behaviour, health status, and use of health services. In the clinical examination, blood pressure, height, and weight were measured.

Average alcohol consumption over time was assessed by a self administered questionnaire inquiring into the usual quantity and frequency of consuming various beverage types during the past 12 months. One drink of wine or spirits was

Table 1 Sample and participating men in the National FINRISK Study in years 1987 and 1992

	1987					1992					
	Age groups					Age groups					
	25–34	35–44	45–54	55–64	Total	25–34	35–44	45–54	55–64	Total	Total
Original sample (n)	1000	1000	1000	1000	4000	1000	1000	1000	1000	4000	8000
Available for contact (n)*	978	994	994	996	3962	981	993	996	995	3965	7927
Participants (n)	692	763	826	828	3109	618	693	758	780	2849	5958
Participation rate (%)	71	77	83	83	78	63	70	76	78	72	75
Number of eligible (n)†	637	695	731	668	2731	562	623	643	601	2429	5160
Final number of subjects (n)‡	632	689	715	634	2670	562	621	642	597	2422	5092

*Those who had died or moved out from the survey area between sampling and survey period were excluded from the original sample. †Men who have consumed alcohol during the past 12 months. ‡Number of subjects with full information on drinking habit.

considered to contain 12 grams of pure alcohol and beer 12.5 grams of pure alcohol. These average alcohol contents were used in estimating the average weekly alcohol intake. Alcohol content figures were based on the average alcohol content of beverage types sold in Finland. Both the questionnaire and the alcohol content figures used in the National FINRISK Study have been described earlier.[12]

A heavy drinking pattern was defined as consuming six or more drinks of the same beverage type, either beer, or wine, or spirits. Thus, the heavy pattern drinkers included heavy beer drinkers, heavy wine drinkers, heavy spirits drinkers, and a mixed group, the last group including cases consuming six or more drinks of more than one beverage type at a time. It should be noted that the questionnaire did not permit to include into the heavy pattern category those drinkers whose consumption reached the level of six or more drinks only if the number of beer, wine, and spirits drinks imbibed at a time were added up.

Blood pressure was measured from the right arm of the subject after 15 minutes of rest in a sitting position. Appearance of the Korotkoff sounds was recorded as the systolic blood pressure and fifth phase as the diastolic blood pressure.

Blood lipids were analysed from fresh serum samples in Helsinki in the National Public Health Institute's laboratory, which is standardised with national and international reference laboratories. Serum total cholesterol and HDL cholesterol were determined using an enzymatic method (CHOD-PAP, Boehringer Mannheim, Monotest). Before analysis, HDL-cholesterol was precipitated from the sample by the PTA precipitation method.

Smoking was assessed by structured questions in the self administered questionnaire. Based on their responses, the participants were classified into two categories. Current smokers were classified as those who had smoked regularly for at least one year and had smoked daily during the previous month. Other respondents were classified as non-smokers (never smokers, occasional smokers, ex-smokers).

Education was assessed with a question asking for the total years in education. Educational categories (low, medium, and high) were calculated using birth year specific tertiles of education years.

Previous myocardial infarctions (MI) were assessed in the baseline survey asking if participants had ever had an MI diagnosed by a physician.

Follow up

The follow up information of participants was achieved through linkage to the national mortality register, which is maintained for all Finnish citizens. The follow up was extended up to 10 years if the baseline survey was carried out in 1987 and up to five years if the baseline survey was carried out in 1992. The end date of the cohort was set as the end of the year 1997. The mean outcome measures were all cause mortality and deaths attributable to cardiovascular diseases, ischaemic heart diseases, malignant neoplasm, external causes, and alcohol related diseases. Causes of deaths were classified using the ICD-9 coding until the end of year 1995, and ICD-10 from the beginning of year 1996 as the codes have been in use in Finland. For cardiovascular disease, ICD-9 codes 390–459 and ICD-10 codes I00-I99 were used. ICD-9 codes used for ischaemic heart disease were 410–414 and ICD-10 codes I20-I25. Malignant neoplasm was classified using ICD-9 codes 140–208 and ICD-10 codes C00-C97. Codes used for external causes according to ICD-9 coding were E800-E999 and according to ICD-10 coding V01-Y99 and X60-X84 with

Table 2 Characteristics of study participants according to drinking pattern

Characteristic	Drinkers with heavy pattern	No heavy drinking occasions	p Value
Number of men	1528	3564	
Age (SD) (y)	42.1 (10.5)	45.5 (11.2)	<0.001*
Alcohol intake (g/week) (%)			
0–95.9	41.3	81.7	
96–199.9	29.9	12.1	
200+	28.8	6.2	0.001†
Mean (SD)	202.0 (261.5)	57.9 (75.9)	<0.001*
Prevalence of smokers % (n)	58.6 (889)	29.3 (1027)	0.001†
Education (%)			
Low	30.9	21.6	
Medium	36.7	31.2	
High	32.3	47.2	0.001†
Mean (SD) cholesterol (mmol/l)	5.95 (1.22)	5.92 (1.16)	0.36*
Mean (SD) high density lipoprotein (mmol/l)	1.30 (0.34)	1.28 (0.31)	0.045*
Mean (SD) systolic blood pressure (mm Hg)	141.3 (17.4)	139.9 (17.7)	0.012*

*t test. †χ^2 test.

Table 3 Amount of alcohol consumed and frequency of inebriation by different groups of drinkers with heavy drinking pattern

	Number	%	Mean alcohol consumption* (g/week)	Frequency of inebriation (times/month)	Intake of spirits at a time (g)†	Intake of beer at a time (g)†	Intake of wine at a time (g)†
Drinkers with heavy spirit drinking pattern	1264	82.7	200.5	2.1	141.2	56.6	57.2
Only spirits	791	51.8	136.8	1.7	136.0	32.8	33.4
Spirits + beer	158	10.3	250.3	2.4	143.6	122.5	39.2
Spirits + wine	172	11.3	225.6	2.5	147.8	41.5	101.5
Spirits + beer + wine	143	9.4	463.7	3.7	159.4	125.2	111.7
Drinkers with heavy beer/wine drinking pattern	264	17.3	209.3	2.5	52.2	81.4	74.0
Only beer	123	8.0	191.9	2.4	52.6	109.8	36.9
Only wine	109	7.1	202.9	2.4	51.5	38.3	97.8
Wine + beer	32	2.1	296.5	3.5	53.0	112.7	99.4
Total	1528	100	202.0	2.2	126.4	61.0	60.4

*Assessed by the quantity-frequency questionnaire. †Usual dose of different beverages imbibed at a time calculated to grams of pure alcohol.

the exception that alcohol induced poisonings (E85) were excluded from this category. Alcohol related diseases (including the poisonings) comprises ICD-9 codes 291, 303, 3575, 4255, 5353, 5710–5713, 5770D-5770F, 5771C-5771D, 607A, 7795A and E85. Respective ICD-10 codes are F10.0-F10.9 (perturbations mentis et modi se gerendi ex usu alcohol), G31.2 (degeneration systematis nervosi ex alcohol), G62.1 (polyneuropathia alcoholica), G72.1 (myopathia alcoholica), I42.6 (cardiomyopathia alcoholica), K29.2 (gastritis acuta alcoholica), K70 (morbus hepatis alcoholicus), K86.0 (pancreatitis acuta et chronica alcoholica), O35.4 (cura matris propter laesionem fetus ex abusu alcohol matris) and X45 (alcohol poisoning).

Characteristics of drinkers with heavy pattern and drinkers without heavy drinking occasions

Drinkers with heavy pattern were slightly younger, less educated, consumed on the average more alcohol, and had slightly higher HDL cholesterol and higher blood pressure than drinkers without heavy drinking occasions. Means and prevalence of background characteristics and other potential confounders are presented in table 2.

Drinking habits and beverage preferences are shown in table 3. Of all drinkers with heavy pattern (consuming six or more drinks at a time), 51.8% reported to drink only spirits, 7.1% only wine, 8.0% only beer, 11.3% both wine and spirits, 10.3% both beer and spirits, 2.1% both beer and wine and 9.4% beer, wine, and spirits. The average alcohol intake among all spirit drinkers with heavy drinking occasions was 200.5 g/week and among beer or wine drinkers with heavy drinking occasions 209.3 grams/week (table 3). Among spirit drinkers, the mean alcohol consumption was the highest among those who reported to imbibe heavily all three types of beverage and among those who reported to imbibe only spirits. The frequency of inebriation was higher among beer and wine drinkers with heavy drinking occasions compared to spirit drinkers. Although the average alcohol intake and the frequency of inebriation were lower among spirit drinkers with heavy drinking pattern than among other heavy drinkers, the amount imbibed at a time was higher among the first group.

Statistical methods

The association between mortality and the heavy drinking pattern was analysed using the Cox proportional hazards model. The analyses were carried out for all cause mortality, and mortality from ischaemic heart disease, external causes of death, and alcohol related causes of death. First analyses included only age as a covariant. Next, potential confounders were added one by one, beginning with the average alcohol intake, and followed by education. Additional covariates included smoking in the case of total mortality, and smoking, total cholesterol, HDL-cholesterol and systolic blood pressure in the case of ischaemic heart disease. We found an interaction on the baseline survey between the previous MI and a heavy drinking pattern. Therefore, separate analyses both including and excluding cases with previous MI at the baseline were made for all cause and ischaemic heart disease mortality. In addition to all drinkers with heavy drinking pattern, beverage specific analyses for drinkers with heavy drinking occasions were also carried out.

RESULTS

The cohort included 3564 drinkers without heavy drinking occasions and 1528 drinkers with heavy pattern. Of the second group, 1264 reported to drink spirits heavily (some drinking also beer or wine) and 264 only beer or wine. A total of 347 deaths were registered between years 1987 and 1997, of these

Table 4 Mortality among men studied in the National FINRISK Study in 1987 and 1992 by drinking pattern

	Drinkers with heavy pattern				No heavy drinking occasions			
Cause of death	n	Person years	Crude mortality rate/100000	Age adjusted mortality rate/100000*	n	Person years	Crude mortality rate/100000	Age adjusted mortality rate/100000*
All causes	128	11205	1142	1301	219	26187	836	730
Cardiovascular diseases	48	11508	417	484	109	26603	409	343
Ischaemic heart diseases	38	11550	329	371	85	26718	318	264
Cerebrovascular diseases	3	11673	25	31	18	27042	66	56
Malignant neoplasms	21	11605	180	206	59	26923	219	186
External causes†	27	11565	233	239	20	27029	73	73
Alcohol related diseases‡	20	11633	171	190	12	27084	44	42

*Standardised to European population. †Alcohol poisonings excluded. ‡Alcohol poisonings included.

Table 5 Relative risk for total mortality and ischaemic heart disease mortality among drinkers with heavy pattern compared with other drinkers. Proportional hazard models are adjusted for potential confounders and other covariates. The previous covariates remain in the model when the new one is added. Previous myocardial infarctions are excluded

	Total mortality		IHD mortality	
Adjustments	Relative risk	95% Confidence intervals	Relative risk	95% Confidence intervals
Age	2.27	(1.78 to 2.88)	2.26	(1.41 to 3.63)
+Average alcohol use*	1.92	(1.45 to 2.53)	2.14	(1.25 to 3.67)
+Smoking	1.63	(1.23 to 2.17)	1.78	(1.03 to 3.07)
+Education	1.57	(1.17 to 2.10)	1.77	(1.01 to 3.08)

*Average alcohol use grouped into three categories. 0–95.9 g/week, 96–199.9 g/week and 200+ g/week.

123 were attributable to ischaemic heart disease, 47 to external causes, and 32 to alcohol related diseases. The age adjusted mortality was higher in the group with heavy drinking occasions than in the group without heavy drinking occasions in all investigated mortality categories (table 4).

After excluding cases with previous myocardial infarction reported at the baseline examination and after adjustment for age, education, smoking, and average alcohol intake in Cox proportional hazards model, drinkers with heavy pattern still had higher mortality from all causes than drinkers without heavy drinking occasions (table 5). Respective analyses showed increased risk also for ischaemic heart disease (table 5), external causes, and alcohol related causes of death (table 6). The last two risk ratios were not adjusted for smoking. Spirit drinkers with heavy pattern had similarly increased risk ratios. Likewise, relative risk point estimates were approximately similar for beer only and wine only drinkers. The confidence intervals were too wide, however, probably because of the small number of cases, to reach significance.

Compared with abstainers, the risk of death among heavy pattern drinkers was not significantly increased, when adjusted with age, smoking and education (RR=1.30 95% CI 0.9 to 1.9). The number of deaths among abstainers was small in the present dataset.

DISCUSSION

We found increased risk of death from all causes, ischaemic heart disease, external causes, and alcohol related causes among drinkers with heavy pattern, compared with drinkers without heavy drinking occasions. The questionnaire permitted us to define persons who used to consume six or more drinks of the same beverage type, beer, wine or spirits, at a time as drinkers with heavy pattern. Unfortunately, if there were subjects who used to consume six or more drinks of different beverage types, these remained unidentified and had to be classified into the group of drinkers with no heavy pattern. This weakness may dilute the observed association and the actual one might thus be stronger.

Reliability and validity

Data on average alcohol intake are usually underestimated.[13–15] As the underestimation has not been found to depend much on the actual intake,[16] it is not likely to distort the observed associations. Under-estimation is mainly attributable to the fact that frequency of drinking is under-reported,[17] probably because people tend to forget light drinking occasions. Amounts of alcohol consumed at a time are reported more accurately. Therefore, we believe that our estimates on the effect of heavy drinking pattern on mortality are not likely to be biased because of errors in self reporting of alcohol consumption.

Although our measure of a heavy drinking pattern was the usual quantity of consuming six or more drinks at a time over the past 12 months, which is likely to give a good estimate on the long term heavy drinking pattern, it is possible that some subjects later changed their drinking pattern to a more moderate one or become non-drinkers. Such changes are likely to dilute the observed association compared with the actual one.

Control of confounding

The risk of death remained higher among drinkers with heavy pattern than drinkers without heavy drinking occasions after adjustment for average alcohol intake and other important confounders. Additional adjustments for total cholesterol, high density lipoprotein, and systolic blood pressure did not influence the risk estimates materially. We also excluded cases with previous myocardial infarction reported at the baseline examination, because they might have changed their drinking patterns after the onset of the disease.

The custom of drinking six or more drinks at a time might be related also to other unhealthy behaviours, such as poor diet, low physical activity, and general tendency to reckless

Table 6 Relative risk for external cause mortality and alcohol related disease mortality among drinkers with heavy pattern compared with other drinkers. Proportional hazard models are adjusted for potential confounders and other covariates. The previous covariates remain in the model when the new one is added

	External cause mortality		Alcohol related disease mortality	
Adjustments	Relative risk	95% Confidence intervals	Relative risk	95% Confidence intervals
Age	3.25	(1.81 to 5.84)	4.58	(2.22 to 9.46)
+Average alcohol use*	3.19	(1.63 to 6.24)	2.87	(1.20 to 6.86)
+Education	2.90	(1.47 to 5.72)	2.73	(1.13 to 6.64)

*Average alcohol use grouped into three categories. 0–95.9 g/week, 96–199.9 g/week and 200+ g/week.

Key points

- Studies on problem drinking suggest that the increased mortality associated with alcohol use is influenced not only by high average intake over time but consuming large amounts at a time even if the average intake over time is low. The aim of this study was to assess the risk of death among drinkers with heavy pattern and drinkers without heavy drinking occasions in a large cohort.
- According to this study, consuming six or more drinks of any alcoholic beverage at a time is related to increased mortality among working age men independent of the total alcohol consumption.

Policy implications

- Heavy drinking occasions are hazardous to health and should be discouraged. In prevention, screening, and counselling, special attention should also be paid to the drinking pattern.

behaviour. We were not able to control all these possible confounders. It is likely that those factors are closely related to education and long term average alcohol intake, which were both controlled. However, some residual confounding may remain and the observed associations between customary heavy amounts of alcohol intake and mortality may be only partly attributable to heavy drinking pattern.

Mechanisms

Some epidemiological studies have found that the risk of ischaemic heart disease decreases by increasing average alcohol intake. When the drinking pattern has been studied, however, high daily amounts (nine or more drinks for men, five or more for women) have been found to associate with increased risk of ischaemic heart disease, compared with both non-drinkers and never drinkers.[18] The major mechanisms behind the ischaemic heart disease risk reduction among moderate drinkers seem to be an increase in HDL-lipoprotein cholesterol and a decrease in blood clotting tendency.[19] These beneficial effects are counteracted by increase in blood pressure.[20 21] There are three other effects of heavy drinking pattern that may at least partly explain the increase in ischaemic heart disease risk. Firstly, angiographic and epidemiological evidence suggests that a heavy drinking pattern accelerates atherosclerosis.[22 23] Secondly, the alcohol withdrawal state that follows heavy drinking occasions increases the risk of cardiac arrhythmias.[24 25] Thirdly, alcohol intake brings about increases in homocysteine levels[26] and this is associated with a higher risk of ischaemic heart disease. As to external causes of death, weakening of sensorimotor coordination is a major mechanism in accidents and alcohol induced depression[27] may play an important part in suicides.

Beverage differences

It is not clear why the earlier Finnish study found an increased risk of death among beer drinkers with a heavy drinking pattern but we did not. Both cohorts consisted of middle aged men and had about eight years of follow up. The drinkers with heavy pattern in the earlier study might have consumed notable amounts of spirits or wine in addition to beer. Although over half of all alcohol in Finland is by beer consumption, according to our data and other surveys heavy drinking in Finland is still strongly dominated by spirit drinking.[15] The traditional drinking pattern, which still continues, has been long periods of abstinence interspersed by intoxicating spirit drinking occasions. Chance may also have played a part; there were only 15 deaths among drinkers with heavy pattern in the earlier study while we had 128. We were not able to find any clear evidence showing differences between beer, wine, and spirits in the risk of death related to heavy drinking occasions.

Conclusions

Our findings suggest that drinking six or more drinks at a time brings about an additional increase in the risk of death in working aged men, surpassing that related to average long term alcohol intake. This can be readily used in counselling men screened by the Alcohol Use Disorders Identification Test (AUDIT), as it includes a question about the frequency of drinking occasions at this level.[28] Men should be advised to avoid heavy drinking occasions and the drinking pattern should be recognised in the recommendations on alcohol use.

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