

Alcohol consumption and risk of common cancers: evidence from a cohort of adults from the United Kingdom

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ABSTRACT

Background: Recent guidelines from the United Kingdom recommend that men and women should drink no more than 14 units of alcohol per week. This recommendation takes into account the link between alcohol and several cancers; however, there is a dearth of high quality evidence from the UK to support this.

Methods: Alcohol consumption using a detailed diary was obtained from 8,670 adults representative of the UK population in 1984/5, with follow-up data from cancer registries until 2009. Hazard ratios (HR) adjusted for several variables including cigarette smoking were calculated for cancers of the breast, lung, colorectum and prostate separately using Cox regression.

Results: Units per week on a typical basis, fitted as a linear term, was associated with breast cancer in women (HR=1.27 per 10 units/week; 95% CI 1.03-1.58) and lung cancer in men (HR=1.16; 1.06-1.27). Increased risks of lung (HR=2.23; 1.18-4.24) and colorectal (HR = 2.28; 1.13-4.57) cancer were seen in men at 15-28 units/week along with higher levels of consumption. Some findings differed by alcohol type.

Conclusions: Overall, alcohol consumption of 15-28 units/week may be harmful in men with respect to common cancers. A linear association between alcohol consumption and risk of breast cancer was observed in women.

INTRODUCTION

In January 2016, the United Kingdom's (UK) Chief Medical Officer advised that men should consume 14 units of alcohol per week or less, reduced from 21 units, in line with women. These guidelines were influenced in part by evidence that the risk of a number of cancers increases from any level of regular drinking, and that the risk of dying from alcohol is less than 1% when consumption is kept below 14 units per week.(1)

The majority of the evidence that influenced updates to the alcohol guidelines was from outside of the UK. Also, a previous report from the International Agency for Research on Cancer (IARC) indicated there might be genetic differences in alcohol metabolism which could indicate the possibility of geographical variations in the relationship between alcohol and cancer.(2) Most studies concur that alcohol is a risk factor for cancers of the oral cavity, pharynx, larynx, oesophagus, liver and colorectum, and alcohol is listed as a carcinogen for these sites by IARC.(2) However, over half of the cancers diagnosed in the UK are of the breast, lung, prostate or colorectum, and so it is these cancers that pose the largest burden on society.(3) The evidence as to whether alcohol affects incidence of lung cancer is conflicting (4-8). For prostate cancer, the evidence is also unclear,(9, 10) with Bagnardi et al reporting raised risks at low and moderate consumption in a recent meta-analysis.(4) Although alcohol is classed as a carcinogen for colorectal cancer, one UK study found no association,(11) whilst others were conducted only in one gender(8, 12) or only assessed a high level of consumption.(13) A previous meta-analysis has established a link between alcohol and breast cancer,(4) although whether there is a level of alcohol consumption that can be considered to be safe is still a debated topic, and data from the UK are sparse.

This study aimed to establish the long term risk of developing one of the four most common cancers based on self-reported alcohol consumption from a sample representative of the UK adult population with a follow-up of 25 years.

METHODS

Data source and participants

The Health and Lifestyle Survey (HALS1) was conducted in 1984/5 to describe the health beliefs, attitudes and behaviours of a representative sample of the population of England, Wales and Scotland, and how these related to physiological measurements of health.(14) The survey randomly sampled 9,003 people aged 18 or over from England, Wales and Scotland. Stages of the survey included an hour-long structured interview and a nurse visit to record physiological measures and cognitive function. Full details of the survey have been reported elsewhere.(15) In 1991/2 a follow-up survey (HALS2) was conducted where equivalent information was collected from 5,290 people who took part in the original survey.

Exposure measures

During the interview participants were asked to complete an alcohol diary for the week prior to interview, if they had consumed at least one alcoholic drink in the preceding seven days. Participants were asked to state the type of drink and quantity in pub measures which was in the form of pints (568 millilitres, ml), glasses (typically 175 ml) and measures (typically 25 ml) for beer, wine and spirits respectively. Participants were asked whether the consumption declared in the diary was 'typical' of their normal consumption (coded as "less than usual", "usual/typical" or "more than usual"). Using these diaries, two exposure measures were created: a continuous variable for units consumed per week and a categorical variable for the number of units consumed per week ('0', '1-14' '15-28' and '>28' units/week based on the revised UK alcohol guidelines). These variables were created both for total alcohol consumption and for each type of alcoholic drink. Self-report alcohol measures have been shown to be both valid and reliable by various studies and retrospective drink diaries have frequently been cited as being more accurate than quantity-frequency methods.(16-18)

Outcome measures

Cancer data in the UK are collated using the comprehensive reporting systems of the National Cancer Registration Schemes in England, Wales, Scotland and Northern Ireland. This information is sent to the Office of National Statistics (ONS), and was available until June 2009.⁽¹⁹⁾ From these cancer records six outcome variables were created: breast cancer in women, prostate cancer in men, as well as lung cancer and colorectal cancer for both men and women.

Covariates

Relevant covariates used in the analysis were identified from previous studies.^(13, 20, 21) Variables included in the model regardless of significance were ethnicity, income (12 categories), self-reported health, smoking status (ex-smoker, non-smoker, <20 a day, ≥ 20 a day), body mass index (BMI) and exercise. We assessed exercise on the basis of the question "Overall do you think you get enough exercise?" ("yes", "no" or "don't know"). Other covariates considered were age at baseline, family history of cancer, job type (non-manual, manual or other), diet and vitamin supplement taking. As none of these variables changed the hazard ratio by more than 10% in any of the reported analyses, they were not included in the adjusted models.

For each covariate that contained less than 1% missing data, the missing values were set to the mode (ethnicity, self-reported health, smoking status and exercise), thus ensuring all participants were included in the analysis. BMI was missing for 18.8% of participants; therefore a separate category was created containing missing values to preserve the overall sample size. Income was missing for 20.1% of participants; as this was fitted as a linear term, the sample size was preserved by also fitting a separate binary variable indicating if the respondent had missing income data.

Statistical Analyses

Cox proportional hazards regression was used to analyse the association between the alcohol exposures and the incidence of breast, lung, prostate and colorectal cancer in men

and women individually, with the person's age rather than time from the HALS 1 survey as the time component. The follow-up period started on the date of the HALS1 survey and ended at the date of cancer under investigation, date of death or June 2009; whichever was earliest. Alcohol consumption was examined in relation to each of the six outcomes separately. This meant only people who had the cancer of interest prior to the start of follow-up were excluded from each analysis; therefore the number of participants in each analysis varied.

The primary analysis was conducted using all participants from HALS1 who declared their previous week's alcohol consumption to be "typical" (analysis 1 in table 2). A secondary analysis was performed using all participants, but with their exposure measure adjusted if they reported their consumption in the week of the diary was "atypical" (analysis 2 in table 2). Those who reported their alcohol consumption was 'more than usual' were moved down a category (e.g. from 15-28 units to 1-14 units), and those who reported 'less than usual' were moved up a category. To address concerns that such an adjustment would be more necessary for someone whose consumption was close to the threshold, we also presented results from an analysis where participants in the three drinking categories (>0 units) only changed category if their consumption was within 5 units of the threshold (i.e. someone would only be promoted into the 15-28 unit/week category if they consumed between 10 and 14 units/week, analysis 3 presented in the supplementary material for online only publication).

For analyses of individual type of alcohol, only those who completed HALS2 were included. This is because for these participants, the alcohol diaries from the HALS1 survey were re-analysed retrospectively to calculate the number of units of each type of alcohol consumed of beer, wine and spirits separately in addition to a figure for the total units. Participants who did not take part in HALS2 did not had their diaries from HALS1 re-analysed in this way. All analysis was carried out using Stata version 14.

RESULTS

Study participants

The HALS1 sample comprised 9,003 participants, of whom 8,670 (3,763 men and 4,907 women) contributed valid cancer follow-up data. Of these, 6,721 (2,780 men and 3,941 women) declared their previous week alcohol consumption to be “typical” and contributed to the primary analysis. The total sample were an average of 45 years old, were predominantly (>96%) of white ethnicity and 70% rated their health as good or excellent (table 1).

Cancer risk by total alcohol consumption

For the categorical exposure measure, alcohol consumption at fewer than 14 units per week was not associated with increased cancer risk in any of the analyses (table 2). However, some increases in cancer risk were found at higher levels of consumption. Men who consumed over 14 units per week had an increased risk of lung cancer with adjusted HRs of 2.23 (CI: 1.18-4.24) when consuming ‘15-28 units’ and 2.68 (CI: 1.42-5.07) when consuming ‘>28 units’. There was also an increased risk of colorectal cancer in men as their consumption increased, however, once adjusted for covariates, this association was only statistically significant for ‘15-28 units’ category in the secondary analysis (HR=2.28, CI: 1.13-4.57). There were no significantly raised risks for any specific categories of alcohol consumption in terms of lung, breast and colorectal cancer in women and for prostate cancer in men.

For the continuous exposure measure, a statistically significant relationship was observed between total alcohol per 10 units per week and breast cancer (HR=1.27, CI: 1.03-1.58) and lung cancer in men (HR= 1.16, CI: 1.06-1.27). There was also a positive relationship between alcohol consumption and colorectal cancer in men, however, this did not reach statistical significance (HR=1.10; CI: 0.96-1.27). There was no evidence of a linear trend for any of the other three outcomes.

Cancer risk stratified by alcohol type (primary analysis only)

Results for beer consumption and lung cancer in men were similar to total consumption with HRs of 3.08 and 4.25 (CI: 1.21-7.84 and 1.79-10.1) for the '15-28' and '>28' units per week respectively, reflecting the fact that beer was the type of alcohol most often consumed (table 3). A similar trend was seen with beer and colorectal cancer in men.

Small numbers of drinkers in the higher alcohol consumption categories (see table 1) meant that consistent patterns with respect to wine and spirit consumption were more difficult to discern. Among men for colorectal cancer, there was a suggestion of an increase in risk at moderate consumption levels (15-28 units) for spirits (HR=6.91; 95% CI 1.86-25.6) with evidence of a linear trend, and for wine even at low levels (1-14 units) (HR= 4.94, CIs: 2.17-11.3). An association between wine consumption and lung cancer in women was also observed (HR= 19.9, CI: 1.93-206), however this is based on one cancer out of only three women who consumed alcohol at this level. The only statistically significant linear association was between consumption of spirits and breast cancer, with an HR of 2.06 per 10 units (CI: 1.30-2.38).

DISCUSSION

Main Finding of this Study

We used data from a cohort of UK adults with 25 years of follow-up to explore whether recent changes to the UK alcohol guidelines are supported with respect to the risk of the most common cancers. Where associations with cancer were found, these occurred in men at moderate levels of consumption (15-28 units), supporting changes to reduce the recommended weekly intake in men to 14 units a week. Insufficient numbers of women drinking at high levels during the time of the initial survey meant we were unable to determine whether drinking at this level was associated with a similar degree of increased risk in women; however, an association between total alcohol consumption and breast cancer was found when alcohol was treated continuously. There was a suggestion that type of alcohol may be important, indicating an important area for future research.

What is already known on the topic?

Overall, our findings support the view of the IARC that alcohol consumption is linked to cancers of the breast and colorectum. (2) They also concur with findings from a meta-analysis conducted by Bagnardi et al in 2015 which reported associations between alcohol consumption and lung and colorectal cancers in men, yet not women.(4) The previous meta-analysis along with a prominent paper by Cao et al (20) also supports our finding of a dose response relationship between alcohol and breast cancer. However, the latter paper found this effect from low consumption levels below 13 units per week, in contrast with our conclusion that there was no evidence of harm at low levels. A similar result was found in the UK million women study which observed a 13% higher risk of breast cancer among women who drank 7-14 units/week than those who drank ≤ 2 units/week (8), this equated to a similar effect size to that reported by Cao (20). The discrepancy between our results and those of these other cohorts could be due to smaller size of the present study. Whilst a 13% increase in risk with 1-2 drinks/day would be considered to be a small effect size, from a population health perspective this could be significant given the large portion of the UK

population who consume alcohol at this level (40% of men and women in the HALS survey and 40% of the million women cohort who drank 3-14 units/week).

What this study adds

A key strength of our study is the relevance to UK public health at this time, just one year after new alcohol guidelines have been issued for the first time since 1995. Whilst data have been published on this topic from larger cohorts of individuals in recent years from Europe and the US,(8, 20, 22) participants from these were older on average at the time of recruitment or followed up for much shorter periods of time. Our study in contrast provides data on a population of both men and women most of whom are still alive and at an average age where they are likely to be making demands on the NHS currently. This makes the research appropriate to today's population who may be affected by cancer. Also, by quantifying the effect alcohol has on the risk of the four most common cancers in the UK when consuming above and below the new recommended limits and by doing so separately for men and women from the same population we provide evidence to directly support the recent change in UK guidance. The four cancer types under investigation account for over 50% of new cancer diagnoses in the UK, therefore in terms of the overall burden of cancer attributable to alcohol use these findings are of high relevance.

Whilst alcohol is considered a carcinogen for colorectal cancer by IARC in men and women, we found some evidence of a raised risk when consuming ≥ 15 units/week in men but not in women. Rather than being caused by biological differences, this could be due to insufficient numbers of women drinking at high levels to establish an effect. For instance, we reported only 3,325 person-years of follow-up in women (2 cancers) consuming ≥ 15 units per week compared with 16,709 person-years of follow-up in men (18 cancers). However, in a larger study by Allen et al.(8) comprising women only, no association was found for colon cancer whilst a modest 25% increase was seen when consuming ≥ 15 units/week for rectal cancer providing further indication of a possible gender difference for this cancer type.

Limitations of this study

The main limitation of this study is the lack of statistical power for some analyses due to a relatively small cohort size especially when alcohol levels were categorised. In particular, the small numbers of women in higher alcohol consumption categories meant that we were unable to assess the risk of cancer in women who consumed high levels of alcohol due to insufficient events. An analysis presented in the recent guideline update reported a 16% increase in risk of breast cancer at 14 units of alcohol per week and 40% at 35 units.(1) Our study sample had insufficient statistical power to detect differences of this size. However, with the continuous exposure measure, we observed a 27% increase in breast cancer risk per 10 units/week, an effect size which was larger than the 10% increase in breast cancer per 10 units/week in an earlier meta-analysis of 53 studies.(23) Another consequence of the lack of statistical power was our inability to assess the risk in people consuming 15 to 21 units. This is the group who among men consumed alcohol quantities under the old recommended upper limit, yet over the new one.

Another limitation is that our results for lung cancer are liable to be influenced by residual confounding by smoking as we were only able to consider cigarette smoking in 4 categories rather than quantifying actual cigarette consumption. The potential for residual confounding could account for why a meta-analysis on this topic found no association between alcohol and lung cancer when confined to never smokers.(24) Third, alcohol was only assessed at one time point (1984/5) so these may not represent alcohol levels 20-years later at the time when many of our cohort were still at risk of cancer. However, as we are primarily interested in how someone's alcohol drinking influences their health longer term rather than the risk immediately following a change in alcohol consumption this would not be considered a major concern. Finally, there is a recognised problem in alcohol research of mixing abstainers and former drinkers in studies of alcohol consumption. This is problematic given that many of the latter group could contain people who gave up drinking due to ill health. However, we anticipate that only a small portion of our non-drinkers would come into this

category as our study population were younger on average than those in previous studies. Furthermore, adjustment for self-reported health in our regression analysis would have removed much of the resulting confounding.

Conclusion

We found that alcohol consumption between 15-28 units per week was associated with an increased risk of lung and colorectal cancers in men, thus supporting recent changes to the UK alcohol guidelines. Before the next guideline update, more data are needed evaluating the risk of cancer in women who consume high levels of alcohol to enable us to state with confidence whether it is appropriate for recommended intakes to be the same in men and women. We also highlighted some potentially important differences based on alcohol type. Whilst this would suggest the need for future studies to stratify by alcohol type, it must also be recognised that future public health messages would be more challenging to convey if it was to be established that cancer risks were notably influenced by the type of alcohol consumed.

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Table 1: Comparison of baseline characteristics between analytical populations

Characteristic		HALS1 initial participants (n=9,003)		Analytical sample 1 (n=6,721)		Analytical sample 2 (n=8,670)	
		Men (n=3,905)	Women (n=5,098)	Men (n=2,780)	Women (n=3,941)	Men (n=3,763)	Women (n=4,907)
Age	Mean (SD)	45.57 (17.61)	46.08 (17.81)	47.90 (17.90)	48.00 (18.02)	45.75 (17.65)	46.33 (17.78)
Ethnicity	White	96.59%	96.96%	96.22%	96.90%	96.76%	97.25%
	Non-white	3.41%	3.04%	3.78%	3.10%	3.24%	2.75%
Self-reported health	Excellent	21.59%	19.75%	21.40%	19.18%	21.61%	19.69%
	Good	50.09%	51.77%	49.03%	51.13%	50.01%	51.70%
	Fair	23.30%	22.87%	24.32%	23.70%	23.39%	22.97%
	Poor	5.02%	5.61%	5.25%	5.99%	5.00%	5.64%
Smoking status	Non	33.67%	49.08%	31.62%	49.96%	33.62%	48.89%
	Ex	31.81%	19.65%	33.85%	19.31%	32.02%	19.85%
	<20 a day	17.26%	19.64%	17.01%	19.31%	17.17%	19.50%
	>20 a day	17.26%	11.63%	17.52%	11.42%	17.19%	11.76%
BMI	Mean (SD)	24.80 (3.68)	24.33 (4.39)	24.83 (3.69)	24.41 (4.49)	24.81 (3.70)	24.36 (4.39)
Exercise	Enough	54.57%	52.59%	56.62%	54.88%	54.77%	52.91%
	Not Enough	45.43%	47.41%	43.38%	45.12%	45.23%	47.09%
Total number of units consumed	Median (IQR)	7 (0-20)	0 (0-5)	6 (0-18)	0 (0-3)	7 (0-20)	0 (0-5)
	0	29.52%	52.47%	35.22%	60.29%	29.43%	52.52%
	1-14	37.03%	41.94%	34.71%	35.65%	37.06%	41.96%
	15-28	16.81%	4.85%	15.22%	3.40%	16.78%	4.77%
	>28	16.63%	0.75%	14.86%	0.66%	16.42%	0.75%
Units of beer consumed	Median (IQR)	4 (0-17)	0 (0-0)	2 (0-16)	0 (0-0)	4 (0-17)	0 (0-0)
	0	38.41%	80.73%	43.59%	83.26%	38.43%	80.79%
	1-14	33.84%	17.67%	30.82%	15.43%	33.64%	17.62%

	15-28	14.48%	1.38%	12.89%	1.14%	14.60%	1.36%
	>28	13.27%	0.23%	12.71%	0.17%	13.32%	0.23%
Units of wine consumed	Median (IQR)	0 (0-0)	0 (0-2)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-2)
	0	76.38%	67.85%	79.94%	74.10%	76.34%	67.92%
	1-14	22.44%	30.58%	19.09%	24.73%	22.47%	30.52%
	15-28	1.00%	1.47%	0.79%	1.05%	1.01%	1.46%
	>28	0.17%	0.10%	0.18%	0.13%	0.18%	0.10%
Units of spirits consumed	Median (IQR)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	0	76.99%	78.76%	80.67%	83.26%	76.91%	78.83%
	1-14	21.01%	20.32%	17.39%	16.06%	21.06%	20.24%
	15-28	1.48%	0.92%	1.40%	0.67%	1.50%	0.93%
	>28	0.52%	0.00%	0.55%	0.00%	0.53%	0.00%

Table 2: Cancer risk by category of alcohol consumption (total consumption)

	Analysis 1 – Typical alcohol consumers only (n=6,721)					Analysis 2 – Analysis with imputed alcohol categories (n=8,670)				
	Events	Person-years	Incidence/ 1000 p-ys	Crude hazard ratio (95% CI)	Adjusted hazard ratio* (95% CI)	Events	Person-years	Incidence/ 1000 p-ys	Crude hazard ratio (95% CI)	Adjusted hazard ratio* (95% CI)
Breast cancer										
0	90	43,977	2.0	1.00	1.00	105	54,465	1.9	1.00	1.00
1-14	49	28,588	1.7	0.93 (0.65-1.32)	0.91 (0.63-1.30)	59	34,792	1.7	0.97 (0.71-1.34)	0.95 (0.69-1.32)
15-28	9	2,667	3.4	1.86 (0.94-3.69)	1.80 (0.89-3.63)	16	6,674	2.4	1.57 (0.92-2.67)	1.47 (0.86-2.52)
>28	2	557	3.6	2.32 (0.57-9.46)	2.22 (0.53-9.20)	2	825	2.4	1.79 (0.44-7.28)	1.86 (0.42-7.13)
Continuous (10 units/week)				1.27 (1.03-1.56)	1.27 (1.03 – 1.58)					
Lung cancer (men)										
0	23	16,827	1.4	1.00	1.00	25	22,235	1.1	1.00	1.00
1-14	20	17,821	1.1	0.85 (0.47-1.55)	0.93 (0.50-1.69)	28	23,564	1.2	1.09 (0.63-1.87)	1.19 (0.69-2.05)
15-28	17	8,519	2.0	2.26 (1.20-4.24)	2.23 (1.18-4.24)	22	16,004	1.4	2.08 (1.17-3.69)	2.09 (1.16-3.75)
>28	20	8,154	2.5	3.16 (1.71-5.81)	2.68 (1.42-5.07)	21	10,205	2.1	3.36 (1.87-6.06)	2.91 (1.58-5.34)
Continuous (10 units/week)				1.21 (1.11-1.32)	1.16 (1.06-1.27)					
Lung cancer (women)										
0	42	44,729	0.9	1.00	1.00	43	55,340	0.8	1.00	1.00
1-14	26	29,049	0.9	1.29 (0.79-2.12)	1.21 (0.72-2.03)	27	35,351	0.8	1.32 (0.81-2.15)	1.26 (0.77-2.08)
15-28	0	2,784	0.0	NE	NE	0	6,809	0.0	NE	NE
>28	1	577	1.7	2.91 (0.40-21.2)	1.72 (0.23-12.9)	1	845	1.2	2.87 (0.40-21.0)	1.64 (0.22-12.2)
Continuous (10 units/week)				1.07 (0.69-1.67)	0.84 (0.52-1.34)					
Colorectal cancer (men)										
0	14	16,860	0.8	1.00	1.00	17	22,268	0.8	1.00	1.00
1-14	24	17,853	1.3	1.73 (0.90-3.36)	1.68 (0.86-3.28)	28	23,599	1.2	1.64 (0.89-2.99)	1.58 (0.86-2.91)
15-28	10	8,539	1.2	2.34 (1.04-5.29)	2.26 (0.99-5.17)	16	16,025	1.0	2.41 (1.21-4.80)	2.28 (1.13-4.57)
>28	8	8,170	1.0	2.54 (1.04-6.10)	2.22 (0.89-5.53)	8	10,221	0.8	2.21 (0.94-5.19)	2.01 (0.84-4.82)
Continuous (10 units/week)				1.12 (0.98-1.28)	1.10 (0.96-1.27)					
Colorectal cancer (women)										
0	38	44,813	0.8	1.00	1.00	42	55,424	0.8	1.00	1.00

1-14	21	29,077	0.7	1.31 (0.77-2.25)	1.20 (0.69-2.12)	24	35,388	0.7	1.34 (0.81-2.22)	0.82 (0.56-1.19)
15-28	2	2,748	0.7	1.28 (0.31-5.31)	1.22 (0.29-5.14)	4	6,809	0.6	1.52 (0.54-4.25)	1.23 (0.73-2.06)
>28	0	577	0.0	NE	NE	0	855	0.0	NE	NE
Continuous (10 units/week)				1.07 (0.65-1.77)	0.98 (0.65-1.77)					
Prostate cancer										
0	34	16,712	2.0	1.00	1.00	43	22,075	1.9	1.00	1.00
1-14	33	17,222	1.9	0.94 (0.58-1.52)	0.86 (0.53-1.41)	24	23,432	1.8	0.94 (0.61-1.43)	0.85 (0.55-1.30)
15-28	12	848	1.4	1.14 (0.59-2.20)	1.04 (0.53-2.04)	19	15,917	1.2	1.09 (0.63-1.87)	0.99 (0.57-1.71)
>28	5	812	0.6	0.58 (0.22-1.50)	0.51 (0.20-1.34)	6	10,712	0.6	0.58 (0.24-1.37)	0.51 (0.22-1.23)
Continuous (10 units/week)				0.92 (0.78-1.09)	0.91 (0.76-1.07)					

NE Not estimable, CI confidence interval

* Adjusted for ethnicity (white/non-white), income, self-rated health (excellent/good/fair/poor), smoking status (4 categories), body mass index (underweight/normal/overweight/obese/severely obese/unknown), exercise (self-rated, enough vs. not enough)

As age of the participant was the unit of time in the above survival analysis (with age at the time of the HALS 1 survey the value at start of follow-up) the crude hazard ratios presented above are intrinsically adjusted for age. For this reason division of the raw incidence rates in the above table by the incidence rate in the reference group will often give very different values to the crude HR.

Table 3: Cancer risk by category of alcohol consumption (stratification by alcohol type): Typical consumption only

	Beers			Wines			Spirits		
	Events	Crude hazard ratio (95% CI)	Adjusted hazard ratio* (95% CI)	Events	Crude hazard ratio (95% CI)	Adjusted hazard ratio* (95% CI)	Events	Crude hazard ratio (95% CI)	Adjusted hazard ratio* (95% CI)
Breast cancer									
0	101	1.00	1.00	79	1.00	1.00	91	1.00	1.00
1-14	11	0.67 (0.36-1.26)	0.66 (0.35-1.30)	32	1.20 (0.79-1.82)	1.18 (0.77-1.82)	20	1.14 (0.70-1.85)	1.12 (0.69-1.84)
15-28	1	0.82 (0.11-5.91)	0.85 (0.12-6.21)	2	1.99 (0.49-8.10)	1.97 (0.48-8.17)	2	2.52 (0.62-10.2)	2.26 (0.55-9.30)
>28	0	NE	NE	0	NE	NE	0	NE	NE
per 10 units/week		0.61 (0.24-1.55)	0.60 (0.23-1.53)		1.40 (0.87-2.24)	1.38 (0.84-2.26)		2.14 (1.35-3.38)	2.06 (1.30-3.28)
Lung cancer (men)									
0	12	1.00	1.00	39	1.00	1.00	35	1.00	1.00
1-14	13	1.85 (0.84-4.06)	1.80 (0.81-3.97)	6	0.56 (0.24-1.33)	0.94 (0.38-2.35)	9	1.00 (0.48-2.08)	1.25 (0.58-2.70)
15-28	8	3.87 (1.57-9.56)	3.08 (1.21-7.84)	0	NE	NE	1	1.39 (0.19-10.2)	1.80 (0.89-3.63)
>28	12	6.93 (3.02-15.9)	4.25 (1.79-10.1)	0	NE	NE	0	NE	NE
per 10 units/week		1.29 (1.15-1.44)	1.18 (1.03-1.33)		0.49 (0.11-2.20)	1.03 (0.28-3.71)		1.00 (0.59-1.72)	1.14 (0.66-1.96)
Lung cancer (women)									
0	38	1.00	1.00	37	1.00	1.00	37	1.00	1.00
1-14	6	1.35 (0.57-3.23)	1.30 (0.54-3.14)	6	0.59 (0.25-1.40)	0.75 (0.30-1.85)	7	1.04 (0.46-2.34)	0.91 (0.40-2.08)
15-28	0	NE	NE	0	NE	NE	0	NE	NE
>28	0	NE	NE	1	10.6 (1.45-77.5)	19.9 (1.93-206)	0	NE	NE
per 10 units/week		1.32 (0.57-3.09)	0.92 (0.36-2.31)		1.12 (0.46-2.68)	1.37 (0.55-3.42)		0.53 (0.10-3.00)	0.40 (0.06-2.42)
Colorectal cancer (men)									
0	14	1.00	1.00	17	1.00	1.00	21	1.00	1.00
1-14	11	1.46 (0.66-3.22)	1.21 (0.54-2.71)	15	3.21 (1.59-6.42)	4.94 (2.17-11.3)	7	1.30 (0.55-3.07)	1.30 (0.54-3.15)
15-28	3	1.50 (0.43-5.26)	1.37 (0.38-4.94)	0	NE	NE	3	8.69 (2.55-29.5)	6.91 (1.86-25.6)
>28	2	3.38 (1.05-10.9)	2.91 (0.82-10.3)	0	NE	NE	1	5.30 (0.71-39.8)	3.27 (0.38-28.4)
10 units/week		1.09 (0.86-1.37)	1.05 (0.81-1.35)		1.92 (0.84-4.41)	2.05 (0.85-4.96)		1.38 (1.04-1.83)	1.26 (0.92-1.74)
Colorectal cancer (women)									

0	26	1.00	1.00	20	1.00	1.00	24	1.00	1.00
1-14	2	0.82 (0.19-3.50)	0.76 (0.18-3.23)	7	1.46 (0.61-3.49)	1.29 (0.52-3.22)	4	0.99 (0.34-2.85)	0.90 (0.30-2.72)
15-28	0	NE	NE	1	5.28 (0.70-39.7)	5.93 (0.70-50.1)	0	NE	NE
>28	0	NE	NE	0	NE	NE	0	NE	NE
10 units/week		0.09 (<0.01-26.74)	0.08 (<0.01-29.87)		1.32 (0.50-3.52)	1.17 (0.40-3.46)		0.56 (0.07-4.39)	0.49 (0.06-4.38)
Prostate cancer									
0	33	1.00	1.00	49	1.00	1.00	47	1.00	1.00
1-14	24	1.26 (0.74-2.13)	1.25 (0.73-2.13)	14	1.06 (0.58-1.92)	1.02 (0.53-1.95)	15	1.23 (0.69-2.19)	1.13 (0.62-1.30)
15-28	4	0.71 (0.25-2.01)	0.73 (0.25-2.08)	1	2.21 (0.30-16.1)	1.96 (0.24-15.7)	2	2.18 (0.53-8.99)	2.09 (0.49-8.87)
>28	3	0.69 (0.20-2.25)	0.59 (0.18-1.98)	0	NE	NE	0	NE	NE
10 units/week		0.91 (0.74-1.13)	0.90 (0.73-1.11)		0.75 (0.27-2.04)	0.68 (0.23-2.02)			

NE Not estimable, CI confidence interval

* Adjusted for ethnicity (white/non-white), income, self-rated health (excellent/good/fair/poor), smoking status (4 categories), body mass index (underweight/normal/overweight/obese/severely obese/unknown), exercise (self-rated, enough vs. not enough)

Percent of people in each alcohol consumption category for people who contributed to the above analysis (those who participated in the HALS 2 survey and reported that their alcohol intake during the week of the diary was typical). Men (n=1,645): Beer (0 units 43.4%; 1-14 units 30.8%, 15-28 units 12.9%, >28 units 12.7%), Wine (0 units 79.9%, 1-14 units 19.1%, 15-28 units 0.8%, >28 units 0.2%, n=3), Spirits (0 units 80.7%; 1-14 units 17.4%; 15-28 units 1.4%; >28 units 0.6%, n=9). Women (n=2,378: Beer (0 units 83.3%; 1-14 units 15.4%, 15-28 units 1.1%; >28 units 0.2%, n=4), Wine (0 units 74.1%, 1-14 units 24.7%, 15-28 units 1.1%, >28 units 0.1%, n=3), Spirits (0 units 83.3%; 1-14 units 16.1%; 15-28 units 0.7%; >28 units 0.0%, n=0).