Research Article

Cancer Epidemiology, Biomarkers & Prevention

Extent of Alcohol Consumption among Adult Survivors of Childhood Cancer: The British Childhood Cancer Survivor Study

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Abstract

Background: This study aimed to identify subgroups of childhood cancer survivors at highest risk of consuming alcohol, consuming above recommended weekly levels, and consuming potentially harmful amounts and compare survivor risks with those expected from the general population.

Methods: Using the British Childhood Cancer Survivor Study, a population-based cohort of 17,981 individuals diagnosed with childhood cancer (1940-1991) and surviving ≥5 years, 14,836 were eligible for a questionnaire that ascertained drinking behavior, as previously ascertained in the 2002 General Household Survey throughout Britain.

Results: Of 10,389 survivors who responded, 77.2% were alcohol drinkers, 23.8% consumed over weekly recommendations, and 3.9% consumed potentially harmful amounts. Survivors were less likely than the general population to be a current drinker {odds ratio [OR; 99% confidence interval (CI)]: 0.52 (0.46-0.60)}, consume over weekly recommended levels [OR (99% CI): 0.65 (0.58-0.73)], and consume harmful amounts [OR (99% CI): 0.40 (0.32-0.49)]. Survivors of a central nervous system neoplasm or leukemia, particularly those treated with brain irradiation, were the least likely to have adverse drinking behaviors when compared with the general population. However, survivors of Hodgkin's lymphoma, non–Hodgkin's lymphoma, Wilms' tumor, bone sarcoma, and soft tissue sarcoma had adverse drinking behaviors at levels expected from the general population.

Conclusion: Overall adverse drinking behaviors were less frequent in survivors than expected from the general population, but subgroups with adverse drinking behaviors were identified, and it is these subgroups who are most in need of intervention.

Impact: UK clinical follow-up guidelines for childhood cancer survivors need strengthening in relation to alcohol consumption. *Cancer Epidemiol Biomarkers Prev; 19(5); 1174–84. ©2010 AACR.*

Introduction

In the United Kingdom, alcohol consumption is part of modern culture (1), and at moderate levels of intake, it has been associated with a beneficial effect on cardiovascular risk in the general population (2). However, it has been shown to increase the risk of cancer of the mouth, pharynx and larynx, esophagus, colorectum, liver, and breast (3). Childhood cancer survivors are likely to be particularly susceptible to the harmful effects of alcohol, as they are at a 3- to 6-fold increased risk of a second primary neoplasm resulting largely from their exposure to anticancer therapy (4). Alcohol consumption could exacerbate other late consequences of childhood cancer treatment, including increased risks of cardiovascular dysfunction, osteoporosis, and liver damage (5, 6).

Alcohol consumption has been investigated among childhood cancer survivors (7), but comparisons between studies are difficult because of many confounding influences. No previous large-scale investigation of the drinking behaviors among childhood cancer survivors in Britain has been undertaken. Therefore, we aimed to determine the prevalence of those currently drinking alcohol, consuming over national recommended weekly amounts, and consuming potentially harmful weekly amounts of alcohol. Each measure of prevalence was compared with that expected from the general population.

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Materials and Methods

Participants

The British Childhood Cancer Survivor Study (BCCSS) comprises 17,981 individuals who were diagnosed with cancer before their 15th birthday between 1940 and 1991 and who survived at least 5 years. The population-based cohort was identified using the National Registry of Childhood Tumours. Of 14,836 individuals within the cohort who were alive and aged at least 16 years, a questionnaire was forwarded onto 13,211 (89.0%) survivors via their general practitioner. The questionnaires used for this analysis were completed by the survivors from March 1, 2001 to December 20, 2006; 50.4% were completed in 2002, 35.8% in 2001, 9.3% in 2003, 2.6% in 2004, 1.3% in 2005, and 0.6% in 2006. More details on the BCCSS, such as objectives, methods, and responses rates, are available elsewhere (8). Survivors who were impaired, such that they could not complete the questionnaire, were asked to seek assistance of a third party to complete the form. Ethical approval for the study was obtained from a Multi-centre Research Ethics Committee and every Local Research Ethics Committee in Britain (212 in total).

Measures of current alcohol drinking status and amount drunk

Current alcohol drinkers were identified as those who answered "yes" to "Do you ever drink alcohol nowadays including drinks you brew or make at home?" Current alcohol drinkers were asked to estimate their average weekly consumption in units (1 unit = 8 g/10 mL pure alcohol) in the last 12 months for beer, spirits/liqueurs, fortified wine, wine, and alcopops. Total units/week were used to group individuals in two ways: if they were consuming above recommended levels and whether they drank at levels identified as harmful.

Recommended and harmful drinking levels used

The Department of Health has published recommended weekly drinking limits for England considered unlikely to damage health: specifically ≤21 units/week for men and ≤14 units/week for women (9). These recommendations have support from the Royal College of Physicians (10) and the British Medical Association (11).

Harmful weekly amounts of alcohol have been identified as being >50 units/week for men and >35 units/week for women because hypertension, stroke, coronary heart disease, pancreatitis, and liver disease have been reported by the Department of Health (12) to be significantly higher in those drinking such quantities in the general population.

Explanatory factors investigated in relation to survivors' drinking behavior

Demographic, cancer, and treatment-related factors. Survivors were categorized by age at questionnaire completion; gender; childhood cancer type; age at diagnosis; whether receiving long-term regular hospital follow-up; and whether their cancer was initially treated with chemotherapy, radiotherapy, or surgery (defined in the Results tables).

Social and economic factors. From the completed questionnaires, we obtained legal marital status, highest level of educational attainment, socio-economic classification (SEC), region of residence within Britain, and whether a third party completed the questionnaire (defined in Results tables).

Quality of life measures. The SF-36 survey questionnaire was used to determine health status (13). The specific measures used were physical function, general health perception, social functioning, mental health, pain, and energy/vitality. Using the individual scores for each of these measures, with the exception of mental health, survivors were grouped as scoring low (≤10th percentile of the score distribution), moderate (between 10th percentile of the score distribution and median), or high (≥median; footnotes to Tables 1, 2, and 3 show some of these "cut" points). For mental health, a score of ≤52 was defined as the low category because this range of scores has been suggested to represent emotional limitations as seen from psychiatric disorder studies (13). The moderate group for mental health was classified as above the low cutoff point to the median, and the high group was at the median or greater.

General population data

These data were obtained from the General Household Survey (GHS) in Britain in 2002, which sampled 8,620 households, resulting in a sample size of 20,149 people of all ages (0-99 y); the average response rate was 69% (14, 15). The general population data set was restricted to those aged 16 to 69 years because for one of the factors that we adjust for in the analysis (educational attainment) was obtained only in those aged 69 years or younger in the GHS. This reduced the GHS sample to 12,618. Further details on the GHS can be obtained from their 2002 report and Web site (14, 15). The BCCSS cohort was also subsequently restricted to those aged 16 to 69 years for the population comparison, and this age range incorporates the majority of the BCCSS cohort (see Results: survivor characteristics for age range).

Individuals from the GHS were classified as current drinkers based on their responses to a question identical to that used in the BCCSS. The estimated total alcohol units for individuals sampled in the GHS were used to group them as in the BCCSS.

Statistical analysis

Two types of analyses were undertaken. An internal analysis consisted of estimating the prevalences of being a current drinker, drinking over weekly recommendations, consuming harmful amounts of alcohol, and also investigating explanatory factors associated with each of these three outcomes within survivors. An external analysis comprised comparing the survivors' prevalences for the three outcomes with that expected from the general population of Britain. All analyse were carried out using Stata statistical software (version 10.1; Stata Corp.). Statistical

Table 1. Frequency of current drinkers and corresponding ORs (99% CIs) from multivariable logistic regression for the significant or borderline significant explanatory factors for being a current drinker

Factor	Total no. survivors	% Current drinker	ORs for being a current drinker (99% CI)	$P_{heterogeneity}$*	P_{trend} ($P_{nonlinearity}$)†
Overall	10,389	77.2%			
Gender					
Males	5,307	79.6%	1.00		
Females	5,082	74.8%	0.70 (0.57-0.87)	<0.001	
Radiotherapy					
No	2,209‡	82.5%	1.00		
Radiotherapy to non (abdominal/pelvic/brain) site	1,281‡	86.3%	1.21 (0.82-1.78)		
Radiotherapy to abdominal and pelvic region	983‡	84.1%	0.93 (0.61-1.41)		
Radiotherapy to brain	2,941‡	73.8%	0.70 (0.49-0.99)	0.022	
SEC§					
Managerial and professional occupations	2,320‡	90.3%	1.00		
Intermediate occupations	1,828‡	84.6%	0.88 (0.63-1.21)		
Routine and manual occupations	3,173‡	81.4%	0.83 (0.61-1.13)		0.071 (0.775)‖
Never worked and unemployed	606‡	64.0%	0.49 (0.31-0.76)		
Student	1,732‡	59.0%	0.34 (0.22-0.52)	<0.001	
Legal marital status					
Single	6,823‡	73.8%	1.00		
Married	2,715‡	84.5%	1.17 (0.90-1.52)		
Separated/widowed/divorced	622‡	83.9%	1.63 (1.05-2.54)	0.012	
Region¶					
England					
London	952‡	72.4%	1.00		
North East	477‡	78.2%	1.95 (1.10-3.46)		
North West	1,246‡	77.1%	1.51 (1.00-2.29)		
Yorkshire and the Humber	889‡	78.0%	1.75 (1.10-2.79)		
East Midlands	794‡	77.0%	1.88 (1.17-3.03)		
West Midlands	952‡	74.1%	1.41 (0.91-2.19)		
East of England	1,105‡	78.5%	1.59 (1.06-2.39)		
South East	1,509‡	79.9%	1.75 (1.18-2.58)		
South West	1,045‡	79.2%	1.62 (1.05-2.48)		
Wales	515‡	79.4%	2.51 (1.40-4.51)		
Scotland	894‡	75.3%	1.61 (1.02-2.52)	0.003	
Level of educational attainment**					
No qualifications	1,545‡	55.0%	1.00		
Level 1	4,191‡	77.4%	1.63 (1.20-2.21)		
Level 2	2,879‡	84.9%	2.20 (1.56-3.11)		
Level 3	1,430‡	90.2%	2.28 (1.49-3.52)	<0.001	<0.001 (0.045)
Third party completed the questionnaire					
No	9,091	81.2%	1.00		
Yes	1,298	49.8%	0.60 (0.44-0.83)	<0.001	
Physical function score††					
Low	999‡	55.2%	1.00		
Moderate	3,968‡	76.5%	1.30 (0.90-1.88)		
High	5,010‡	83.6%	1.70 (1.11-2.60)	0.002	<0.001 (0.950)

(*Continued on the following page*)

Table 1. Frequency of current drinkers and corresponding ORs (99% CIs) from multivariable logistic regression for the significant or borderline significant explanatory factors for being a current drinker (Cont'd)

Factor	Total no. survivors	% Current drinker	ORs for being a current drinker (99% CI)	$P_{heterogeneity}$*	P_{trend} ($P_{nonlinearity}$)†
Social functioning score††					
Low	1,073‡	58.6%	1.00		
Moderate	3,069‡	76.5%	1.25 (0.86-1.81)		
High	5,994‡	81.9%	1.58 (1.03-2.43)	0.015	0.004 (0.940)

*The *P* value (two-sided) is from the likelihood ratio test for heterogeneity in the probability of being a current alcohol drinker across different levels of the specified explanatory factor with adjustment for all other factors in the multivariable model. The threshold for statistical significance was 0.01.

†The P_{trend} is from the test for trend and the *P* value in parentheses is from the test for departure from a linear trend. Both *P* values are two-sided. The threshold for statistical significance was 0.01.

‡These values do not add up to the total because of exclusion of those with no record of treatment (radiotherapy, *n* = 2,975) and unusable or missing data (SEC: missing data or occupations given were inadequately described or could not be used to classify SEC, *n* = 730; legal marital status: missing data, *n* = 229; region: survivors who lived in Northern Ireland or the Channel Islands, *n* = 11, were excluded from the analysis; educational attainment: missing data, *n* = 344; physical function score: missing data, *n* = 412; social functioning score: missing data, *n* = 253).

§For SEC, the survivor's present or most recent occupation was used to classify survivors into "managerial and professional occupations," "intermediate occupations," or "routine and manual occupations" defined by the 2002 General Household Survey (14); two further categories were added: "student" and "never worked or unemployed" due to the BCCSS population characteristics.

‖For SEC, the tests for trend and for departure from a linear trend were completed using the first three levels of the factor: managerial and professional, intermediate, and routine and manual occupations.

¶Region was based on government office regions in Great Britain (14) and was established using the survivor's address at questionnaire completion or, if not available, the location of their registered general practitioner.

**The different levels for educational attainment relate to formal educational qualifications in Great Britain, which include level 1, which corresponds to a low level of qualification obtained in Great Britain (e.g., General Certificate of Standard Education); level 2, which corresponds to an intermediate level of educational attainment (e.g., Advanced level qualification); and level 3, the highest level of qualification, a first degree or higher.

††The score categories were for physical function (low, 0-45; moderate, 46-99; high, 100) and social functioning (low, 0-44; moderate, 45-99; high, 100); see Materials and Methods for explanation on defining these categories.

significance was taken at the 1% level, with two-sided tests. Multivariable logistic regression models provided odds ratios (OR) and 99% confidence intervals (CI).

Internal analysis

It was decided a priori that all explanatory factors identified above should be investigated in logistic regression as possible explanatory factors for the three drinking outcomes because of their established association with drinking in general population studies (14, 16) or their importance among childhood cancer survivors.

Tests for heterogeneity (based on the likelihood ratio statistic) were used to investigate the influence of each factor on the odds of each of the three outcomes using a multivariable logistic regression model controlling for all factors identified a priori. Tests for linear trend and nonlinearity were undertaken where appropriate.

External analysis

Multivariable logistic regression was undertaken to obtain ORs and 99% CIs for each of the three outcomes compared with that expected from the general population of Britain (15), controlling for key variables known to be associated with alcohol drinking in the general population (14, 16). The comparison with the general population was undertaken initially for all survivors and subsequently for specific subgroups defined in terms of childhood cancer type and treatment. To take account of household clustering within the GHS, a multivariable generalized estimating equations (GEE) logistic regression model was used, and to compensate for nonresponse in the GHS and to match the GHS sample to known population distributions, the weighting factor for the GHS data was also used.

Results

Survivor characteristics

Of 10,493 returned questionnaires (response rate, 70.7%), 10,389 survivors (99.0% of those returned) could be classified according to their current drinking status.

Table 2. Frequency of survivors consuming over the weekly drinking recommendations and corresponding ORs (99% CIs) from multivariable logistic regression for the significant or borderline significant explanatory factors for consuming over recommended levels

Factor	Total no. current drinkers	Percentage consuming over recommended levels*	ORs (99% CI)	$P_{heterogeneity}$[†]	P_{trend} ($P_{nonlinearity}$)[‡]
Overall	7,973[§]	23.8%			
Gender					
Males	4,189	27.7%	1.00		
Females	3,784	19.5%	0.65 (0.53-0.79)	<0.001	
Age at questionnaire completion (y)					
16-24	2,602	26.1%	1.00		
25-34	2,922	22.9%	0.71 (0.53-0.94)		
35-44	1,651	23.1%	0.85 (0.59-1.22)		
45-54	657	21.0%	0.84 (0.52-1.36)		
≥55	141	21.3%	0.81 (0.37-1.77)	0.017	0.057 (0.039)
Radiotherapy					
No	1,810[‖]	24.3%	1.00		
Radiotherapy to non (abdominal/pelvic/brain) site	1,099[‖]	25.5%	1.00 (0.72-1.38)		
Radiotherapy to abdominal and pelvic region	826[‖]	23.9%	0.97 (0.67-1.41)		
Radiotherapy to brain	2,149[‖]	20.4%	0.63 (0.44-0.91)	0.013	
Legal marital status					
Single	4,994[‖]	26.4%	1.00		
Married	2,286[‖]	18.2%	0.54 (0.42-0.70)		
Separated/widowed/divorced	519[‖]	24.3%	0.80 (0.55-1.16)	<0.001	
Third party completed the questionnaire					
No	7,344	24.7%	1.00		
Yes	629	13.2%	0.52 (0.33-0.83)	<0.001	
Whether receiving long-term regular hospital follow-up[¶]					
No	4,992[‖]	24.6%	1.00		
Yes	2,732[‖]	22.6%	0.82 (0.66-1.02)	0.018	
General health perception score**					
Low	681[‖]	23.2%	1.00		
Moderate	2,958[‖]	26.1%	1.09 (0.73-1.63)		
High	4,195[‖]	22.4%	0.83 (0.53-1.30)	0.010	0.019 (0.057)
Mental health score**					
Low	1,218[‖]	26.9%	1.00		
Moderate	2,192[‖]	22.4%	0.63 (0.45-0.86)		
High	4,401[‖]	24.0%	0.63 (0.45-0.90)	<0.001	0.007 (0.007)

*This includes all current drinkers who reported weekly alcohol units of >21 units for men and >14 units for women.

[†]The *P* value (two-sided) is from the likelihood ratio test for heterogeneity in the probability of consuming over the recommended weekly alcohol units across different levels of the specified explanatory factor with adjustment for all other factors in the multivariable model, using only the current drinkers. The threshold for statistical significance was 0.01.

[‡]The P_{trend} is from the test for trend and the *P* value in parentheses is from the test for departure from a linear trend. Both *P* values are two-sided. The threshold for statistical significance was 0.01.

[§]This is not all current drinkers (n = 8,024) due to missing alcohol units for 51 survivors.

[‖]These values do not equal the total because of exclusion of those with no record of treatment (radiotherapy n = 2,089) and unusable or missing data (legal marital status: missing data, n = 174; whether receiving long-term regular hospital follow-up: missing data, n = 249; general health perception score: missing data, n = 139; mental health score: missing data, n = 162).

[¶]Information obtained from the consent form returned from the general practitioner, which asked whether the survivor was receiving long-term regular hospital follow-up in relation to his/her childhood neoplastic disease.

**The score categories were for general health perception (low, 0-32; moderate, 33-76; high, 77-100) and mental health (low, 0-52; moderate, 53-75; high, 76-100).

Table 3. Frequency of survivors consuming harmful amounts of alcohol and corresponding ORs (99% CIs) from multivariable logistic regression for the significant or borderline significant explanatory factors for consuming harmful amounts

Factor	Total no. current drinkers	Percentage consuming harmful amounts of alcohol*	ORs (99% CI)	$P_{heterogeneity}$†	P_{trend} ($P_{nonlinearity}$)‡
Overall	7,973§	3.9%			
Gender					
Males	4,189	5.0%	1.00		
Females	3,784	2.8%	0.39 (0.23-0.66)	<0.001	
Legal marital status					
Single	4,994‖	4.4%	1.00		
Married	2,286‖	2.5%	0.50 (0.26-0.96)		
Separated/widowed/divorced	519‖	5.0%	1.16 (0.52-2.59)	0.004	
Level of educational attainment					
No qualifications	841‖	5.5%	1.00		
Level 1	3,223‖	4.5%	0.77 (0.37-1.60)		
Level 2	2,433‖	3.7%	0.66 (0.30-1.47)		
Level 3	1,288‖	1.5%	0.25 (0.08-0.78)	0.006	0.003 (0.179)

*This includes all current drinkers who reported weekly alcohol units of >50 units for men and >35 units for women.
†The *P* value (two-sided) is from the likelihood ratio test for heterogeneity in the probability of consuming harmful weekly amounts of alcohol, across different levels of the specified explanatory factor with adjustment for all other factors in the multivariable model, using only the current drinkers. The threshold for statistical significance was 0.01.
‡The P_{trend} is from the test for trend and the *P* value in parentheses is from the test for departure from a linear trend. Both *P* values are two-sided. The threshold for statistical significance was 0.01.
§This is not all current drinkers (n = 8,024) due to missing alcohol units for 51 survivors.
‖These values do not equal the total because of unusable or missing data (legal marital status: missing data, n = 174; educational attainment: missing data, n = 188).

The mean age at questionnaire completion for these survivors was 30.1 years (range, 16.0-74.2 y).

Of the 10,389 survivors, 8,024 (77.2%) were classed as a current drinker. A total number of alcohol units could be calculated for 7,973 survivors (99.4% of current drinkers). Among the current drinkers, 1,900 (23.8%) were consuming over the weekly recommendations and 313 (3.9%) were classified as consuming harmful amounts.

Internal analysis

Risk factors in relation to being a current drinker. From potential explanatory factors listed in Materials and Methods, those which were either significant or were of borderline significance for being a current drinker are listed in Table 1. Females [OR (99% CI): 0.70 (0.57-0.87)], survivors who received brain irradiation [0.70 (0.49-0.99)], and those for whom a third party had completed the questionnaire [0.60 (0.44-0.83)] were significantly less likely to be current drinkers than the corresponding referent groups of males, survivors not treated with radiotherapy, and those who self-completed the questionnaire, respectively. For SEC, the lowest levels of current drinking were among students [0.34 (0.22-0.52)] and those who had never worked or were unemployed [0.49 (0.31-0.76)] when compared with survivors in managerial and professional occupations. Relative to single survivors, the highest level of current drinking was observed among those separated, widowed, or divorced [1.63 (1.05-2.54)]. Geographically, the level of current drinking was lowest in London residents (referent group) and highest among those resident in Wales [2.51 (1.40-4.51)]. The ORs for current drinking increased (linearly) with increasing educational attainment, physical function score, and social functioning score.

Risk factors in relation to consuming over weekly drinking recommendations. From all potential explanatory factors examined, those which were either significant or were of borderline significance for consuming over the recommendations are listed in Table 2. Females [OR (99% CI): 0.65 (0.53-0.79)], survivors aged 25 to 34 years [0.71 (0.53-0.94)], survivors who received brain irradiation [0.63 (0.44-0.91)], those currently married [0.54 (0.42-0.70)], and those for whom a third party had completed the questionnaire [0.52 (0.33-0.83)] were all significantly less likely to be drinking over the recommendations than the corresponding referent groups of males, those aged 16 to 24 years, survivors not treated with radiotherapy, single survivors, and self-completers of the questionnaire, respectively. Survivors who scored moderate [0.63 (0.45-0.86)] or high [0.63 (0.45-0.90)] for mental

health were less likely to drink over the recommendations than those who scored low for this measure. There was suggestive evidence that survivors receiving hospital follow-up [0.82 (0.66-1.02)] were less likely to be consuming over the recommendations compared with survivors not receiving follow-up.

Risk factors in relation to consuming harmful amounts of alcohol. The significant explanatory factors for consuming harmful amounts are listed in Table 3. Females [OR (99% CI): 0.39 (0.23-0.66)] and survivors who were currently married [0.50 (0.26-0.96)] were significantly less likely to be consuming harmful amounts of alcohol than the corresponding referent groups of males and single survivors, respectively. The ORs for consuming harmful amounts of alcohol decreased (linearly) with increasing educational attainment.

External analysis

Comparison of survivors' consumption with that expected from the general population of Britain concerning: Being a current drinker. Overall, survivors had approximately half the odds of being a current drinker than the general population [OR (99% CI): 0.52 (0.46-0.60)]. The deficit was greater among survivors receiving brain irradiation [0.46 (0.39-0.55)] than among survivors not so treated [0.71 (0.61-0.83); Table 4].

Table 4. Comparison of the prevalence of current drinkers among survivors and the general population of Britain, overall and for childhood cancer and treatment subgroups, with ORs and 99% CIs from a multivariable GEE logistic regression model

Childhood cancer type group and treatment subgroup where relevant	Numbers used	Percentage of current drinkers*	OR (99% CI)†
GHS (reference)	12,618‡	86.2%‡	1.00
All survivors	10,387§	77.2%	0.52 (0.46-0.60)
Brain irradiated	2,941‖	73.8%	0.46 (0.39-0.55)
Brain not irradiated	4,471‖	84.0%	0.71 (0.61-0.83)
CNS neoplasm	2,182	67.4%	0.34 (0.29-0.41)
Brain irradiated	1,009‖	62.9%	0.29 (0.23-0.37)
Brain not irradiated	704‖	76.4%	0.49 (0.37-0.65)
Leukemia	2,849	75.5%	0.50 (0.42-0.61)
Brain irradiated	1,878‖	79.9%	0.61 (0.49-0.75)
Brain not irradiated	163‖	84.0%	0.68 (0.38-1.23)
Hodgkin's lymphoma	735	86.0%	0.70 (0.51-0.95)
Non–Hodgkin's lymphoma	535	84.9%	0.71 (0.50-1.02)
Neuroblastoma	424	75.9%	0.51 (0.36-0.72)
Wilms' tumor	966	81.2%	0.69 (0.53-0.90)
Bone sarcomas	397	86.6%	0.83 (0.53-1.30)
Soft tissue sarcomas	716	83.2%	0.70 (0.51-0.95)
Retinoblastoma	703	80.5%	0.59 (0.44-0.79)
Other neoplasms¶	880	79.9%	0.58 (0.45-0.75)

*These percentages will be very slightly different to those reported in Table 1 because we used survivors aged ≤69 years for this external comparison.

†From a GEE multivariable logistic regression controlling for age at questionnaire completion (only those aged up to and including 69 years were included because educational attainment was only requested from individuals aged up to and including 69 years in the GHS), gender, legal marital status, SEC, educational attainment, and region, and took into account the GHS weighting factor, for the likelihood of being a current drinker.

‡These are the unweighted values from the GHS. Using the GHS weighting factor, the weighted percentage of current drinkers from the GHS was 86.0%.

§This does not include the total number of survivors for whom we have current drinking data; two survivors were excluded from this analysis due to being aged >69 years at questionnaire completion.

‖These do not sum the total number of survivors used because the category "brain not irradiated" does not include the survivors for whom we have no record of their radiotherapy; this was for all survivors (n = 2,975), for CNS neoplasm survivors (n = 469), and for leukemia survivors (n = 808).

¶Other neoplasms include Burkitt's lymphomas; intracranial and intraspinal germ cell tumors; gonadal germ cell tumors; other and unspecified nongonadal germ cell tumors; thyroid carcinomas; and malignant melanoma, skin carcinoma, and other less frequently occurring carcinomas.

Table 5. Comparison of the prevalence of current drinkers consuming over the weekly drinking recommendations, and consuming harmful weekly amounts of alcohol, among survivors and the general population of Britain, overall and for childhood cancer and treatment subgroups, with ORs and 99% CIs from multivariable GEE logistic regression models

Childhood cancer type group and treatment subgroup where relevant	Numbers used*	Consuming over recommendations		Consuming harmful amounts of alcohol	
		Percentage*	OR (99% CI)†	Percentage*	OR (99% CI)†
GHS (referent)	10,868‡	25.9%‡	1.00	6.0%‡	1.00
All survivors	7,972	23.8%	0.65 (0.58-0.73)	3.9%	0.40 (0.32-0.49)
Brain irradiated	2,149§	20.4%	0.52 (0.43-0.62)	2.6%	0.24 (0.16-0.36)
Brain not irradiated	3,734§	24.6%	0.78 (0.69-0.89)	3.8%	0.47 (0.36-0.61)
CNS neoplasm	1,457	19.1%	0.50 (0.41-0.62)	3.0%	0.33 (0.21-0.51)
Brain irradiated	628§	15.0%	0.38 (0.27-0.53)	1.9%	0.21 (0.09-0.48)
Brain not irradiated	535§	23.9%	0.75 (0.56-1.02)	3.0%	0.37 (0.19-0.74)
Leukemia	2,135	22.3%	0.54 (0.45-0.64)	3.5%	0.30 (0.21-0.43)
Brain irradiated	1,487§	22.9%	0.58 (0.48-0.71)	2.9%	0.26 (0.16-0.41)
Brain not irradiated	136§	19.9%	0.55 (0.29-1.04)	3.7%	0.30 (0.06-1.42)
Hodgkin's lymphoma	629	33.2%	1.10 (0.86-1.40)	4.3%	0.44 (0.25-0.79)
Non–Hodgkin's lymphoma	452	29.0%	0.81 (0.60-1.10)	5.5%	0.52 (0.28-0.94)
Neuroblastoma	319	23.5%	0.59 (0.40-0.87)	3.8%	0.38 (0.17-0.86)
Wilms' tumor	784	27.7%	0.83 (0.66-1.05)	4.3%	0.47 (0.29-0.77)
Bone sarcomas	341	21.7%	0.62 (0.43-0.91)	4.7%	0.61 (0.30-1.24)
Soft tissue sarcomas	592	27.7%	0.78 (0.60-1.03)	6.8%	0.74 (0.46-1.19)
Retinoblastoma	564	21.3%	0.64 (0.48-0.86)	3.2%	0.39 (0.20-0.76)
Other neoplasms	699	22.2%	0.64 (0.49-0.84)	3.3%	0.36 (0.19-0.66)

*The totals and percentages were calculated for survivors aged ≤69 years.
†From a GEE multivariable logistic regression model controlling for age at questionnaire completion (≤69 years), gender, legal marital status, SEC, educational attainment, and region, and took into account the GHS weighting factor, for the likelihood of consuming over the recommendations for weekly alcohol units or consuming harmful weekly amounts of alcohol.
‡These are the unweighted values from the GHS. Using the GHS weighting factor, the weighted percentage of those consuming over recommended levels and consuming harmful weekly amounts of alcohol from the GHS were 26.6% and 6.3%, respectively.
§These do not sum the total number of survivors used because the category brain not irradiated does not include the survivors for whom we have no record of their radiotherapy; this was for all survivors (n = 2,089), for CNS neoplasm survivors (n = 294), and for leukemia survivors (n = 512).

Survivors of a central nervous system (CNS) neoplasm or leukemia were least likely to be a current drinker compared with the general population: OR (99% CI), 0.34 (0.29-0.41) and 0.50 (0.42-0.61), respectively. The deficit among CNS neoplasm survivors receiving brain irradiation was greater [0.29 (0.23-0.37)] than among CNS neoplasm survivors not so treated [0.49 (0.37-0.65)]. Leukemia survivors receiving brain irradiation were less likely to be a current drinker than the general population [0.61 (0.49-0.75)], but this was not the case for leukemics not receiving brain irradiation [0.68 (0.38-1.23)], although the numbers available for the latter comparison were small.

For the remaining childhood cancer types, only survivors of non–Hodgkin's lymphoma or a bone sarcoma were no different to the general population for the odds of being a current drinker.

Consuming over the weekly drinking recommendations. Overall, survivors were less likely to be consuming over recommended levels than the general population [OR (99% CI): 0.65 (0.58-0.73)], and this deficit was again seen to be greater among survivors receiving brain irradiation [0.52 (0.43-0.62)] than among survivors not so treated [0.78 (0.69-0.89); Table 5].

Survivors of a CNS neoplasm [0.50 (0.41-0.62)] or leukemia [0.54 (0.45-0.64)] were least likely to be consuming over recommended levels when compared with the general population, and again, this deficit was greater for those survivors who had received brain irradiation compared with those not so treated.

Of the remaining childhood cancer types, survivors of soft tissue sarcoma, non–Hodgkin's lymphoma, Wilms' tumor, or Hodgkin's lymphoma were no different to the general population for the likelihood of consuming over recommended levels.

Consuming harmful amounts of alcohol. Overall, survivors were less likely to be consuming harmful

amounts of alcohol than the general population [OR (99% CI): 0.40 (0.32-0.49)]. This deficit was again observed to be greater for survivors receiving brain irradiation [0.24 (0.16-0.36)] than among survivors not so treated [0.47 (0.36-0.61); Table 5].

Leukemia or CNS neoplasm survivors were least likely to be consuming harmful amounts of alcohol compared with the general population [0.30 (0.21-0.43) and 0.33 (0.21-0.51), respectively] and even less so among those who received brain irradiation.

Of the remaining childhood cancer types, survivors of bone sarcoma or soft tissue sarcoma were no different to the general population for the odds of consuming harmful amounts of alcohol.

Discussion

This is the largest ever population-based study of alcohol consumption among adult survivors of childhood cancer. After taking into account demographic, social, and economic differences between the BCCSS and the general population, survivors were less likely to be a current drinker [OR (99% CI): 0.52 (0.46-0.60)], drinking over weekly recommendations [0.65 (0.58-0.73)], and consuming harmful amounts of alcohol [0.40 (0.32-0.49)] when compared with levels expected from the general population.

In adolescent survivors of childhood cancer, it has been reported that, compared with peers or population data, they are either less likely to be a current alcohol drinker (17, 18) or binge drinker (17), or no different to comparators for being a current drinker (18, 19). Among 10,398 adult survivors of childhood cancer within the North America treatment centre-based cohort, the Childhood Cancer Survivor Study (CCSS), current drinking was slightly more prevalent in survivors than in a national sample of peers [OR (95% CI): 1.1 (1.0-1.2)] but not when compared with siblings [0.6 (0.5-0.6)]. CCSS survivors were slightly less likely to be involved in both risky drinking [compared with peers: 0.9 (0.8-1.0) and siblings: 0.7 (0.6-0.8)] and heavy drinking [compared with peers: 0.8 (0.7-0.9) and siblings: 0.7 (0.6-0.8); ref. 20]. In a population-based Canadian study of 1,263 adult survivors of childhood cancer, survivors were less likely to be binge drinkers [OR (95% CI): 0.7 (0.6-0.8)] than controls (21).

Current drinkers among survivors of non–Hodgkin's lymphoma, Hodgkin's lymphoma, Wilms' tumor, bone sarcoma, and soft tissue sarcoma were similar to the general population in terms of exceeding weekly recommendations or harmful limits, whereas other survivors were less likely than the general population to indulge in such practices. In the CCSS, cancer type was associated with the drinking outcomes investigated, and survivors of Hodgkin's lymphoma, Wilms' tumor, and bone sarcoma were more likely to be heavy drinkers compared with leukemics (20). Adverse drinking behaviors among these particular childhood cancer survivors could place them at an even higher risk of a variety of late effects, which are known to result from exposure to anthracycline drugs and abdominal/chest irradiation (5, 6). Alcohol could increase already elevated risks for a second cancer (22, 23), particularly of the upper digestive tract and breast (24-27), and it could also increase preexisting elevated risks of cardiac sequelae (28, 29), hepatic dysfunction (30), and osteoporosis (31).

It is of concern that survivors of cancer types (Hodgkin's lymphoma, soft tissue sarcoma, and Wilms' tumor) associated with the highest adverse drinking behaviors, compared with the general population, are those who we previously reported to be more likely to be a current smoker, have greater rates of initiating smoking, and have some of the highest odds of smoking prevalence compared with the general population (32). Drinking and smoking behaviors have been reported to be related (5), and survivors who are moderate to heavy smokers are more likely to drink over alcohol recommendations than light smokers (33). This is of concern because alcohol and tobacco interact in relation to the risk of cancers of the mouth, pharynx and larynx, and esophagus (3). Butterfield et al. (33) suggest that success in changing one harmful health behavior might increase motivation and self-confidence to change another risky behavior.

One treatment factor associated with drinking behavior was radiotherapy, and those receiving brain irradiation were less likely to be a current drinker and less likely to be consuming over recommendations than survivors not treated with radiotherapy. Furthermore, when survivors receiving brain irradiation were compared with the general population, a larger deficit in drinking behavior was seen compared with that for survivors not so treated. Such an association between drinking and brain irradiation has been reported by others (20, 21), and the social effect of the neuro-cognitive deficits associated with brain irradiation may be an influencing factor (21).

Mental health was significantly associated with drinking over that recommended; survivors who had some or no emotional limitations were less likely to be drinking over that recommended than survivors who had considerable emotional limitations. Carswell et al. (21) observed that childhood cancer survivors with substantial stressful life events had odds of being a binge drinker nearly three times that of those who had no stressful life events. In addition, those with lower life satisfaction were more likely to be a binge drinker (21). In the CCSS, survivors with depression, anxiety, somatization, or cancer-related anxiety were all at an increased risk of heavy drinking (20). Feeling more susceptible to the late effects of cancer and worrying more about the effect of cancer treatment have also been seen to predict alcohol use in childhood cancer survivors (5). A significant minority of survivors may experience posttraumatic stress disorder related to their childhood cancer (34). These survivors may be engaging in adverse drinking behaviors to cope with the stresses of life (21). Interventions that help survivors cope with stress and the psychological strain of

their cancer may also encourage adoption of healthy lifestyle choices (35).

The weekly and harmful drinking recommendations used in our study were those intended for the general population, but it is possible that risks to health from alcohol may start to increase from different levels of consumption depending on other health risks (11), and it is suggested that no level of alcohol consumption is risk-free in relation to cancer incidence (36). It is reasonable to suggest that childhood cancer survivors should therefore be made aware that the health risks they may face could be exacerbated by a lower level of alcohol consumption than is recommended for the general population. Guidelines from the Children's Oncology Group in North America explore alcohol use in detail and specify it, for example, as a risk factor in increasing the potential long-term effect of radiation on the gastrointestinal and hepatic system and on the urinary tract (37). These guidelines also refer to risks of drinking alcohol with respect to bone, dental and liver health, and the increased risk of second cancers, particularly breast and oral cancer (37). In published clinical follow-up guidelines concerning survivors of childhood cancer in Britain, there is limited specific guidance on alcohol use in survivors (38, 39), and some survivor information specifies only that alcohol should be drunk in moderation in relation to the risk of second cancers (40). In addition, a recent investigation from one region in Britain found that health behaviors were not frequently discussed during follow-up consultations, although the young adult cancer survivors would have desired it (41). We suggest that UK guidelines should be strengthened in view of these findings.

Previously in adolescent cancer survivors, a brief broad-based counseling approach for multiple health behaviors and a short educational intervention to influence decision making and risk reduction had limited value in achieving long-term changes to lifestyle choices (5, 42, 43), whereas a peer-delivered smoking intervention was found to improve quit rates in adult survivors of childhood cancer compared with self-help (44). Interventions to control drinking behavior are complex (1, 45), but evidence from these interventions should be used when developing alcohol and smoking interventions for BCCSS survivors.

Future survivors of childhood cancer should be advised of the health risks associated with alcohol consumption early in their follow-up care because early initiation of drinking has been associated with heavier drinking later in life (20). For current adult survivors of childhood cancer, help should be given to those who have harmful drinking behaviors: we have identified survivor groups with adverse drinking behaviors to which lifestyle interventions could be targeted in the first instance.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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