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## Prevalence and Predictors of Risky and Heavy Alcohol Consumption Among Adult Siblings of Childhood Cancer Survivors

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### Abstract

**Objective**—To describe alcohol consumption patterns and risk factors for heavy alcohol use among siblings of childhood cancer survivors compared to survivors and national controls.

**Methods**—Secondary analysis of prospectively collected data from two national surveys was performed including a cohort of 3,034 adult siblings of childhood cancer survivors (age 18-56 years) and 10,398 adult childhood cancer survivors both from the Childhood Cancer Survivor Study, plus 5,712 adult participants from the population-based National Alcohol Survey. Cancer-related experiences, self-reported current health and mental health were examined in relation to alcohol consumption patterns including heavy and risky drinking.

**Results**—Adult siblings of childhood cancer survivors were more likely to be heavy drinkers ( $OR_{adj}=1.3$ ; 1.0-1.6) and risky drinkers ( $OR_{adj}=1.3$ ; 1.1-1.6) compared to controls from a national sample. Siblings were also more likely to drink at these two levels compared to survivors. Factors associated with heavy drinking among siblings include being 18-21 years old ( $OR_{adj}=2.9$ ; 2.0-4.4), male ( $OR_{adj}=2.3$ ; 1.7-3.0), having a high school education or less ( $OR_{adj}=2.4$ ; 1.7-3.5), and drinking initiation at a young age ( $OR_{adj}=5.1$ ; 2.5-10.3). Symptoms of depression, ( $OR_{adj}=2.1$ ; 1.3-3.2), anxiety ( $OR_{adj}=1.9$ ; 1.1-3.3) and global psychiatric distress ( $OR_{adj}=2.5$ ; 1.5-4.3) were significantly associated with heavy alcohol use.

**Conclusions**—Siblings of children with cancer are more likely to be heavy drinkers as adults compared to childhood cancer survivors or national controls. Early initiation of drinking and symptoms of psychological distress should be identified during early adolescence and effective

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sibling-specific interventions should be developed and made available for siblings of children with cancer.

### Keywords

alcohol; childhood cancer; heavy drinking; risky drinking; siblings; cancer; alcohol/drug use; mental health; psychological impact

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### Introduction

Current treatments for childhood cancer typically include multiple regimens, close monitoring, repeated medical procedures and lengthy in- and out-patient visits. Significant challenges to family functioning [1], marital quality and parenting [2] are described [3-5] [3-5]. These intensive treatments affect the whole family including the siblings of the ill child [6, 7]. Siblings typically experience increased separation from parents, decreased parental monitoring [8], worries that their brother or sister might die [9], disruptions in family functioning [10] and they witness parental distress [8, 11-14]. At the same time, some siblings report increased maturity and family closeness [15-17].

Distress among siblings of children with cancer is widely documented [18-20][21] with higher rates of posttraumatic stress symptoms, [9] anxiety, academic and social problems [3, 22, 23] though other studies describe normative behavior and perceptions in siblings[24]. Risk factors for negative emotions in siblings include older age at the time of the cancer [25, 26], proximity to time of diagnosis [27] and family disruption [26].

**Childhood adversity is associated with increased risk for problem drinking** in general populations [28, 29]. Trauma and chronic stressors such as physical or sexual child abuse [30-32], child neglect [33], and parental alcoholism [34] are consistent predictors of adolescent and adult alcohol dependence and drinking at a young age [35]. Childhood adversity can increase the use of alcohol to relieve painful or intrusive memories, reduce tension or decrease distress [36] though alternately stress can promote alcohol abstinence in an attempt to cope productively with challenges [37, 38]. Cumulative childhood stressors show a dose-response relationship with risk for adult substance abuse [39].

Disruptions in a child's development can increase psychological distress, [32] early age of alcohol use [40] and all types of substance abuse [31, 41, 42]. Early initiation of alcohol use [40] is a risk factor for sustained adult heavy alcohol use [43-45]. Other general risk factors for alcoholism include young adult age, being male, low education [46] and family alcoholism [47-49]. Family disruptions during childhood cancer may accentuate these general risk factors for heavy drinking. For instance, early drinking may be more common in the presence of parent or sibling distress, decreased parental monitoring and family disruption. Norms that typically support male heavy drinking coincide with gender norms that inhibit emotional expression at a time when young men may have added stresses or increased sense of loss. Low education is often associated with decreased resources made more acute in the face of childhood cancer. Finally, family alcoholism will likely exaggerate cancer-related stresses and model avoidant coping. It is unclear whether adversity related to having a sister or brother with cancer increases siblings' risk for adult heavy alcohol use and no large scale studies have described alcohol use among siblings of children with cancer.

A previous study of alcohol use focusing on childhood cancer survivors reported greater frequency of heavy drinking among the siblings. Because that study was focused on survivors little information was available on the siblings' drinking pattern or predictors [50]. Childhood cancer often precedes or overlaps siblings' adolescent and young adult years corresponding to times of initial and peak alcohol use [51]. It is important to monitor alcohol

consumption, among siblings since they have an elevated risk for the development of cancer compared to the general population, even when accounting for increased genetic risks [52-57]. Each year an estimated 17,000 siblings [58, Table 4] of the 12,500 [59] children newly diagnosed with cancer in the U.S. [59] are exposed to new stresses related to childhood cancer.

This study aims to describe alcohol consumption patterns including: current drinking; daily quantity; frequency of drinking; drinking that is considered to be risky for your health and heavy drinking among adult siblings of children who had cancer compared to survivors and controls from a national population sample. Next the study examines general risk factors for adult risky and heavy drinking in all three populations testing the hypotheses that older age, male gender, low education and early drinking are associated with increased adult heavy drinking in siblings. Finally, the study identifies childhood and current risk factors associated with risky and heavy drinking that are specific to the sibling experience. Here the study tests whether type of cancer, older sibling age at the time of the cancer diagnosis, survivor drinking, birth order and poor mental or physical health among siblings or survivors predicts risky and heavy drinking among siblings.

## Patients and Methods

This study employed data from two sources, the Childhood Cancer Survivor Study (CCSS) and the National Alcohol Study (NAS). The CCSS was a National Cancer Institute funded cohort study of childhood cancer survivors diagnosed between 1970 and 1986 and who have survived five or more years after diagnosis (data on deceased participants (and live siblings) were included). The CCSS was conducted at 26 institutions in the United States and Canada and included a retrospectively ascertained cohort of individuals who were under the age of 21 years with a confirmed diagnosis of leukemia, brain cancer, lymphoma, neuroblastoma, Wilms tumor, soft tissue sarcoma or bone tumor. Details of the study sample and procedures have been described elsewhere.[60, 61] The CCSS data in this study were from a 24-page baseline mailed questionnaire completed by self-report or by telephone with a trained interviewer, collected predominantly between 1995 and 1996. The survivor response rate was 82% and included 10,398 adults ages 18-48 along with a comparison group of 3,034 nearest in age siblings who were randomly selected from the list of participating survivors. The sibling response rate was 80.4% and they were aged 18 to 56.

The NAS was a nationally representative survey focusing on alcohol consumption patterns. Data was collected during 1999 to 2001 from U.S. households using random digit dial techniques and computer-assisted telephone interviewing in English or Spanish, taking an average of 45 minutes. NAS data are weighted to reflect the nation according to age, gender and ethnicity. Details on NAS sampling and methods are provided elsewhere. [62, 63] NAS participants who matched the CCSS sibling age range of 18-56 (N=5,712) were selected for the current study and served as national controls. NAS had a 58% completion rate. All participants provided informed consent and CCSS participants included release of information for medical records.

Compared to the national sample, siblings were older, less diverse racially and socio-economically, more likely to be employed and college graduates (Table 1). Compared to survivors, siblings were more likely to be female, white, older, currently employed and college graduates. To address the sample differences national data were weighted to reflect the distribution of siblings by age, race and gender.

Childhood and current factors affecting siblings were described in Table 2. Siblings had a median age of 29 ranging from ages 18-56, with an average of 17 years from the diagnosis.

Fifty percent were aged 0-10 at diagnosis, 71% were older than the survivor and 32% had a brother or sister with leukemia. Over a quarter of these adult siblings had a brother or sister with severe or life threatening health problems or who had died.

## Measures

The two primary dependent variables for these analyses were risky drinking and heavy drinking. Risky drinking is defined by the National Institute for Alcohol Abuse and Alcoholism (NIAAA) [64] as >3 drinks daily among women and >4 drinks daily among men at least once per week; or >7 drinks weekly for women and >14 drinks weekly for men [65]. Risky drinking has high sensitivity and specificity for predicting poor health outcomes [28, 65]. Heavy drinking is defined as having 5 or more drinks daily for women and 6 or more drinks daily for men occurring at least once a month. This amount represents the largest quantity of usual daily drinking measured in the CCSS at baseline and is consistent with the amount it takes to feel intoxicated [66]. Both measures were based on usual daily quantity. Current drinking was assessed to increase comparability to previous studies. Using parallel questions in each survey, alcohol average daily quantity, frequency of consumption and age of initiation of drinking was recorded (See Appendix A). Age of initiation of drinking occurred when the participant first reported drinking alcohol and are categorized into four age groups, < 14, 15-16, 17-20 or 21+.

Independent variables include childhood factors such as siblings' age when the survivor was diagnosed, survivor's cancer diagnosis and birth order (which we examined separately by gender). To assess shared genetic and environmental influences on drinking we used data about the sister/brother survivor's alcohol consumption. Current factors include siblings' past week mental health distress and current physical health status for both siblings and survivors. Survivors were categorized as having mild, moderate, severe, life-threatening and fatal health problems [67] based on the Common Terminology Criteria for Adverse Events developed by the National Cancer Institute [68]. The effect of bereavement was examined in separate analyses.

Mental health for siblings is measured using the 18 item Brief Symptom Inventory (BSI) which assesses symptoms of depression, anxiety and somatization and an overall Global Severity Index (GSI). Item responses range from 0 (not at all) to 4 (extremely). Raw scores are converted to standardized T-scores where 63 or higher are considered clinical cases and are equivalent to the upper 10% of scores in a community sample.[69-71] Commonly identified risk factors for heavy drinking were also explored including siblings' age, race/ethnicity, gender and age of drinking initiation.

## Analysis

Data were analyzed from the 3,034 siblings and 10,398 childhood cancer survivors from the CCSS and 5,712 controls from the NAS. SPSS was used throughout except where noted below.[72] Sample characteristics were described for each population using frequencies and chi square statistics. The NAS data was weighted to reflect the age, race and gender of the sibling sample and were shown in weighted and unweighted forms. Childhood and current characteristics were described for siblings. Alcohol consumption patterns were described for each sample showing frequencies, percent and chi-square statistics noting significant differences between samples. Adjusted odds ratios ( $OR_{adj}$ ) were constructed and 95% confidence intervals were calculated for the dichotomous drinking outcomes using Stata [73]. Statistical procedures involving comparisons between siblings and survivors used logistic regression with generalized estimating equations to account for intra-family correlation. Weighted NAS data were used for all comparisons between samples. Multivariate logistic regression models were formed to simultaneously assess the role of

age, race/ethnicity, gender, education and age of drinking initiation in predicting heavy and risky drinking in each population. Finally, adjusted ORs are presented for siblings for each risk factor separately (childhood and current) while controlling for age, race and gender. Risky drinking was examined using parallel models for heavy drinking.

## Results

Siblings were more likely to drink in the highest quantity categories and to drink more frequently compared to both survivors and national controls (Table 3). In analyses using weighted data, siblings were significantly more likely to initiate drinking between ages 15 and 16 (27.9%), compared to survivors (26.6%) and national controls (23.8%) ( $p < .001$ ).

In multivariate models (Table 3), siblings were more likely to be current drinkers, ( $OR_{adj}=2.0$ ; CI 1.7-2.3), risky drinkers ( $OR_{adj}=1.3$ ; CI 1.1-1.6) and heavy drinkers ( $OR_{adj}=1.3$ ; CI 1.0-1.6) compared to national controls. Compared to survivors, siblings were also more likely to be current ( $OR_{adj}=1.7$ ; CI 1.5-1.9), risky ( $OR_{adj}=1.5$ ; CI 1.3-1.6) and heavy drinkers ( $OR_{adj}=1.5$ ; CI 1.3-1.8).

Risk factors for sibling heavy drinking mirror that of the general population, including being a young adult (age 18-21 and age 22-26), being male, having high school or less education and early initiation of drinking (Table 4). Siblings who initiated drinking at age 14 or younger were more likely to be heavy drinkers as adults compared to the two oldest age groups. Interaction between drinking initiation and data set showed that siblings who initiated drinking at ages 15 or 16 were more likely to become heavy drinkers as adults compared to national controls who started drinking at the same age ( $OR_{adj}=2.1$ ; CI 1.0-4.6,  $p=.053$ ) though results were not statistically significant. Findings for risky drinking were consistent with those for heavy drinking, but with slightly reduced (but still significant) adjusted odds ratios (data not shown).

Some childhood factors related to the cancer experience increased risk for heavy drinking (Table 5). Family (survivor) heavy drinking history was supported as a risk factor showing an association between survivor and sibling heavy drinking ( $OR_{adj}=2.0$ ; CI 1.3-3.2). Birth order of the sibling was unrelated to risk for heavy drinking. Gender specific analyses showed that male siblings who were older than the survivor were less likely to be heavy drinkers (14.0% vs 19.8%  $p=.027$ ) compared to younger male siblings. Siblings who were age 0-10 years old at the time of the cancer diagnosis were 1.7 times more likely to be heavy drinkers, but results were not significant, ( $p=.08$ ).

Current health and mental health factors were assessed. Siblings who described their own health as fair or poor were more likely to be heavy drinkers compared to healthy siblings ( $OR_{adj}=2.2$ ; CI 1.4-3.6). Sibling mental health distress was associated with heavy drinking in multivariate analyses, where siblings with global psychiatric distress ( $OR_{adj}=2.5$ ; CI 1.5-4.3), symptoms of depression ( $OR_{adj}=2.1$ ; CI 1.3-3.2) or anxiety ( $OR_{adj}=1.9$ ; CI 1.1-3.3) were more likely to be heavy drinkers. The current health status of the survivor did not influence heavy drinking in the siblings nor were bereaved siblings more likely to drink heavily. Consistent with heavy drinking analyses, risky drinking was associated with poor general health, depression, anxiety and overall distress and survivor health status was not associated (data not shown).

## Discussion

Findings from the current study indicate that adult siblings of childhood cancer survivors show an overall pattern of greater alcohol consumption. They are more likely to engage in current drinking, risky and heavy drinking, to drink daily, and to drink at higher average

daily quantities compared to both childhood cancer survivors and controls from a national population-based survey.

General background risk factors for heavy drinking were consistent with our hypotheses. Young age, being male and lower education showed similar odds ratios of heavy drinking in siblings and national controls with one exception. While early age of drinking initiation (ages 15-16) placed both populations at risk for adult heavy drinking, siblings who started drinking at a young age were (marginally) more likely to engage in adult heavy drinking compared to national controls who initiated drinking at that same age. In general, early age of first drink is an independent predictor for later alcohol problems, even while controlling for other explanations including family adversity, parental alcohol use, genetic susceptibility or psychopathology [74]. Heavy alcohol use at young ages often establishes a longer term pattern of alcohol use and is strongly associated with lifetime alcohol disorders [75, 76]. For young drinkers family environment, including low parental monitoring or family closeness, plays a critical role in the initiation of drinking but genetics may play a stronger role in continued drinking once it has started [77].

As a result, interventions should involve whole families to prevent the initiation of alcohol use and to minimize continued alcohol use by helping to decrease isolation and loneliness in siblings and supporting use of wider family and social structures to improve oversight during the busiest treatment times.

Current risk factors, including siblings' depression, anxiety and general psychological distress, were associated with increased risk for risky and heavy drinking. This pattern is consistent with previous research in general [78, 79] and clinical populations [80], as well as among childhood cancer survivors [50]. Hardships stemming from the cancer period or from the survivor's ongoing health problems may increase worry, caretaking responsibilities or psychological distress in adult siblings. Longitudinal research is needed to better identify siblings at risk for long term distress.

While siblings' poor health was associated with heavy alcohol use ( $OR_{adj}=2.2$ ) the causal direction between these factors should be tested in future longitudinal studies since this relationship is likely bidirectional. In the current study poorer health did not significantly mediate or moderate the relationship between distress and heavy drinking. Current survivor health characteristics did not influence sibling drinking despite the fact that survivors' chronic poor health could be associated with increased sibling responsibilities, stress or guilt.

While childhood adversity generally increases risk for adult heavy drinking [30-32] this study did not identify particular factors during the siblings' childhood that predicted heavy drinking. Three sibling populations, bone marrow donors, siblings of children who received a bone marrow transplant and bereaved siblings, bear further examination since these sub-groups may experience more intensive therapy and possibly higher levels of distress [81, 82].

Information on whether the sibling was a bone marrow donor was not available. Bereaved siblings were identified and were not significantly more likely to be heavy drinkers. However, bereaved siblings are likely underrepresented since the sample was chosen to study late health effects among those who survived cancer for at least 5 years. Fuller inclusion of these three sub-groups of siblings and families in future research is recommended.

Our results did not support two hypotheses. Older sibling age at the time of the survivor's diagnosis was not associated with heavy drinking but instead, younger age at diagnosis

showed a trend towards heavy drinking. The older age group was also less distressed. It may be that older siblings felt increased responsibility and thus had lower alcohol consumption in the face of family stresses. Siblings' older birth order was not a risk for heavy drinking. This group also reported lower rates of depression [21]. Findings from previous studies on birth order are ambiguous where some studies describe no relationship between birth order and emotional distress [83], another where the older sibling reported more behavioral, social and academic problems [84] and finally a CCSS study described reduced distress in the sibling who is older than the survivor [21]. Reduced heavy alcohol use for older male siblings may be due to increased maturity and responsibility in the face of hardship [37]. It is important to note that the CCSS chose the "nearest in age" sibling, thus "older sibling" is not necessarily the eldest in the family, merely older than the survivor. Future studies may want to examine sibling birth order more broadly by including all siblings.

This study has some limitations. While the current study benefited from strong measures of psychological distress, it is likely that cancer related stressors combine with other unmeasured family or contextual risk and protective factors to influence siblings' distress. In particular, the CCSS underrepresents non-white siblings due to the original recruitment strategy for survivors. Use of a cross sectional design makes it more difficult to identify childhood factors or temporal ordering of predictors for alcohol use. Future research would benefit from a longitudinal design with measurement of siblings' emotional adjustment, family dynamics, other risky health behaviors (such as tobacco use) and family and social context during and just after treatment. It is recommended that future research collect more detailed information on siblings' subjective and objective experience related to alcohol initiation, level of parental supervision during adolescence, academic and social issues and severity and duration of mental health distress over time.

Data from the CCSS reflect treatment conditions between 1970 and 1986. Treatments have changed over this time and thus, findings from the current study may need to be replicated using more recent treatment protocols.

Inclusion of a representative sample of bereaved and transplanted siblings, (with and without sibling donors) would provide additional information on alcohol use among three sibling populations with potentially higher intensity treatment and greater family stress. Given the late health effects focus of the CCSS, inclusion of families where a child died early in treatment was not the focus of the study. Future studies of health behaviors among siblings would benefit from use of a sample drawn to be representative of all siblings of children with cancer by treatment and by race/ethnicity. Finally, future studies may want to include siblings of children with other chronic health problems who may suffer similar adversities during the peak time for alcohol initiation.

The two primary outcomes, risky drinking and heavy drinking, are based on usual daily drinking and thus are likely to be underestimates of actual risky and heavy drinking measures which are designed to be formulated based on a question about maximum drinking [85, 86]. Since the rates of risky drinking in the CCSS and NAS are based on closely comparable questions, the use of this variable should be valid for comparisons between siblings, survivors and peers. Possible biases should be minor and are unlikely to change results.

In general use of odds ratios may overestimate relative risks when the prevalence of a condition is high (such as current drinking). Odds ratios were used because the focus of the study is on the more rare condition of risky and heavy drinking and the desire to facilitate comparisons to previous published work on survivors' alcohol consumption patterns [50]. Serious childhood illness was not assessed in the NAS, so calculated odds ratios comparing

siblings to controls would be conservative, though rates of childhood cancer are so low as to be unlikely to greatly bias the findings. Despite these limitations, this study has provided entirely new information on drinking patterns and risk factors among adult siblings of childhood cancer survivors.

Findings from this study support the need to screen for alcohol use among adolescent siblings. Primary care providers who interact with children and adolescents whose brother or sister has cancer should have heightened awareness of psychological and social stressors and possible alcohol use. Adult primary care providers may want to screen for heavy alcohol use in adult siblings of childhood cancer survivors. Finally, national organizations and camps that serve the needs of siblings are encouraged to have heightened awareness of alcohol use and address risk factors such as psychological distress. Effective interventions targeted to address stressors specific to families with cancer need to be developed to prevent and treat heavy and risky drinking, early initiation and continued drinking. The present findings are likely to be applicable to families who have a child with other chronic serious illnesses. Future studies should be inclusive of these other families.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Appendix A: Question Comparability

Drinking Measure	CCSS, survivors and siblings	NAS, peer comparisons
Any current drinking	Have you had at least one drink of beer, wine, or liquor during the past year?  No Yes	<i>See frequency question below. For those who answered, less than once a month, supplementary question: Think back over the last year, since (current date last year). Did you have a whole drink of any alcoholic beverage like wine, beer, or liquor in these last twelve months?</i>
Usual Daily drinking amount	On the days that you drink, on average, how many drinks do you usually have?  No drinks in past 2 years One drink/day Two drinks/day Three drinks/day Four drinks/day Five drinks/day Six or more drinks/day	On the days when you drink alcohol, how many drinks did you have per day? ___ # drinks
Frequency of drinking/monthly	During the past 2 years, on the average, how many times per month did you drink the	How often do you usually have any kind of beverage containing alcohol, whether it is wine, beer, whiskey, or any other drink?



Drinking Measure	CCSS, survivors and siblings	NAS, peer comparisons
	following: Wine, beer and mixed drinks. Response options for each ranged from 0 to 999.	3 or more times/day Two times/day Once/day Nearly every day 3-4 times/week Once or twice a week Two or three times a month Once a month Less than once a month Less than once a year Have you never had any beverage containing alcohol
NIAAA Risk Drinking:	Combines Usual daily drinking and weekly volume. If usual daily drinking is >3/>4 for women/men and weekly drinking is >7/>14 for women/men.	Combines Usual daily drinking with weekly volume limits If usual daily drinking is >3/>4 for women/men and weekly drinking is >7/>14 for women/men.
Heavy Drinking	Usual daily drinking that is >5/>6 for women/men	Usual daily drinking that is >5/>6 for women/men
Age of first drink	How old were you when you started drinking? _____ Years old	About how old were you when you first started drinking alcoholic beverages, not including small tastes? _____ age

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### Abbreviations used in this manuscript

<b>CCSS</b>	Childhood Cancer Survivor Study
<b>NAS</b>	National Alcohol Survey
<b>OR</b>	odds ratios
<b>NIAAA</b>	National Institute for Alcohol Abuse and Alcoholism
<b>BSI</b>	Brief Symptom Inventory
<b>GSI</b>	Global Severity Index

Table 1

Sample description including siblings, survivors and the national sample

Variable	Siblings	Survivors	National	Actual %
	N=3,034	N=10,398	N=5,712	% wted <sup>c</sup> to Sibling sample
Gender <sup>a</sup>				
Female	1605	4804	2957	52.9
Male	1429	5594	2755	47.1
Race/ethnicity <sup>a</sup>				
White and Other	2765	9362	3797	94.4
Black	68	464	1048	2.3
Hispanic	97	537	867	3.3
Age at interview <sup>a</sup>				
18-21	535	2508	538	17.6
22-26	677	3124	683	22.3
27-31	704	2422	745	23.2
32-48	1108	2344	2808	22.5
49-56	17	0	938	0.6
Household Income <sup>a, b</sup>				
lt 10K	131	825	660	12.6
10-20K	222	1238	761	13.8
20-40K	682	2706	1496	30.2
40-60K	686	1974	944	17.7
gt 60K	1029	2255	1291	25.8
Current employ <sup>a, b</sup>				
No	238	1451	1173	21.8
Yes	2768	8286	4513	78.2
Education <sup>a, b</sup>				

Variable	Siblings	Survivors	National	Actual %
	N=3,034	N=10,398	N=5,712	
Grades 0-12	724	3357	2368	41.6
Some post HS	1059	3682	1662	29.2
College grad	1123	2795	1666	29.2
Marital Status <sup>a, b</sup>				
Married or living as	1597	3877	3275	57.7
Sep/div/widow	262	815	862	15.2
Never married	1001	5287	1534	27.0

<sup>a</sup>Differences are significant for chi square models comparing siblings to survivors.

<sup>b</sup>Differences are significant for chi square models comparing siblings to NAS controls.

<sup>c</sup>These percents have been weighted to match the sibling sample by age, gender and race/ethnicity.

**Table 2**

## Childhood and current characteristics for siblings

Total Population	Siblings N=3,034	Percent
Childhood factors: related to cancer diagnosis or treatment		
Sibling Age at sister/brother's cancer diagnosis, median age 29, range 18-56		
Before birth (-6 to -1 years)	89	2.9
0-10	1501	49.5
11-18	967	31.9
19-36	477	15.7
Was Sibling Younger or Older than Survivor?		
Younger	740	29.3
Older	1782	70.7
Cancer Diagnosis of their brother/sister		
Leukemia	969	31.9
Central Nervous System	375	12.4
Hodgkin disease	489	16.1
Non-Hodgkin Lymphoma	258	8.5
Wilms Tumor	226	7.4
Neuroblastoma	146	4.8
Sarcoma	288	9.5
Bone	283	9.3
Family drinking		
Was the sister/brother survivor a heavy drinker?		
No	2089	92.4
Yes	172	7.6
Current factors: Siblings' current health and mental health		
General Health		
Excellent/Very Good/Good	2853	94.0
Fair/Poor	151	5.0
Depression		
No	2645	93.7
Yes	179	6.3
Anxiety		
No	2720	96.3
Yes	104	3.7
Somatization		
No	2707	95.8



Total Population	Siblings N=3,034	Percent
Yes	119	4.2
Global Severity Index (GSI)		
No	2714	96.1
Yes	109	3.9
Current factors: Survivor Current Physical Health		
Survivor Health Status		
No condition	1135	37.4
Grade 1-mild	556	18.3
Grade 2-moderate	517	17.0
Grade 3-severe	573	18.9
Grade 4-life-threatening	200	6.6
Grade 5-fatal	52	1.7

\* missing data for some variables means that all cells do not sum to 3,034.

Table 3

Drinking patterns for siblings, survivors and national controls including numbers and percents, and adjusted odds ratios

Drinking Measure	Siblings N=3,034	Survivors N=10,398	National N=5,712	Sibling vs. Survivor Chi square, p value		Sibling vs. National chi square, p value	
	%	%	% wted <sup>c</sup> to sibling sample	Actual %			
Usual # drinks/day <sup>a b</sup>							
0	15.7	25.7	30.1	34.5	X <sup>2</sup> =137.43, p<.001	X <sup>2</sup> =251.24, p<.001	
1	25.1	22.7	25.6	27.1			
2	26.2	20.9	20.0	19.9			
3	12.5	12.6	9.8	7.7			
4	7.4	7.5	4.4	3.6			
5	4.3	3.5	2.6	2.0			
6+	8.7	7.0	7.4	5.1			
Drinking frequency <sup>a b</sup>							
Less than monthly	31.4	39.6	46.4	50.5	X <sup>2</sup> =72.11, p<.001	X <sup>2</sup> =187.86, p<.001	
1-3 x/mo	25.2	23.4	21.9	20.2			
1-2 x/wk	23.7	21.3	17.1	15.0			
3-4 x/wk	11.5	9.5	8.1	7.6			
Daily	8.3	6.2	6.8	6.6			
Age of first drink <sup>a b</sup>							
Age 14	13.2	10.8	17.0	13.7	X <sup>2</sup> =18.30, p<.001	X <sup>2</sup> =42.17, p<.001	
Age 15-16	27.9	26.6	23.8	20.8			
Age 17-20	47.0	48.9	44.1	45.8			
Age 21+	11.9	13.7	15.1	19.7			
<b>Composite Drinking Measures</b>							
				<b>Sibling vs. Survivor OR<sub>adj</sub> (95% CI)</b>		<b>Sibling vs. National OR<sub>adj</sub> (95% CI)</b>	
Current Drinker							
No	17.2	26.7	29.6	26.7	Ref	Ref	
Yes	82.8	73.3	70.4	73.3	1.7 (1.5-1.9)***	2.0 (1.7-2.3)***	

Drinking Measure	Siblings N=3,034	Survivors N=10,398	National N=5,712		Sibling vs. Survivor Chi square, p value	Sibling vs. National chi square, p value
	%	%	% wted <sup>c</sup> to sibling sample	Actual %		
Risky Drinking, NIAAA						
No	79.7	83.8	83.8	83.8	Ref	Ref
Yes	20.3	16.2	16.2	16.2	1.5 (1.3-1.6)***	1.3 (1.1-1.6)***
Heavy drinking, 5+/6+						
No	89.6	91.7	91.5	91.7	Ref	Ref
Yes	10.4	8.3	8.5	8.3	1.5 (1.3-1.8)***	1.3 (1.0-1.6)*

<sup>a</sup>Differences are significant for each value of drinking comparing siblings to survivors.

<sup>b</sup>Differences are significant for each value of drinking comparing siblings to NAS controls.

<sup>c</sup>Percents have been weighted to match the sibling sample by age, gender and race/ethnicity. Some numbers do not equal total for each sample due to missing data.

\* p .05

\*\* p < .01

\*\*\* p < .001

Odds ratios are adjusted for age, ethnicity and sex.

**Table 4**

Multivariate models examining commonly known risk factors associated with heavy drinking (5+ women/6+ men) and drinking that is risky to health in each population

	Factors predicting heavy drinking				Factors Predicting risky drinking							
	CCSS Siblings N=3,034		CCSS Survivors N= 10,398		National N = 5,712		CCSS Siblings N=3,034		CCSS Survivors N= 10,398		National N = 5,712	
	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR	Adjusted OR
<b>Total Population</b>												
Age at interview												
18-21	2.9 (2.0-4.4)***	2.0 (1.5-2.6)***	2.6 (1.9-3.5)***	2.4 (1.8-3.3)***	1.4 (1.2-1.7)***	1.9 (1.5-2.3)***	2.4 (1.8-3.3)***	1.4 (1.2-1.7)***	1.4 (1.2-1.7)***	1.9 (1.5-2.3)***	1.4 (1.2-1.7)***	1.9 (1.5-2.3)***
22-26	2.8 (2.0-4.1)***	1.9 (1.5-2.4)***	2.4 (1.8-3.2)***	2.3 (1.7-3.0)***	1.5 (1.2-1.7)***	1.7 (1.5-2.3)***	2.3 (1.7-3.0)***	1.5 (1.2-1.7)***	1.5 (1.2-1.7)***	1.7 (1.5-2.3)***	1.5 (1.2-1.7)***	1.7 (1.5-2.3)***
27-31	1.7 (1.1-2.5)*	1.3 (1.0-1.7)	1.4 (1.1-2.0)*	1.3 (0.9-1.7)	1.0 (0.8-1.2)	1.1 (0.9-1.4)	1.3 (0.9-1.7)	1.0 (0.8-1.2)	1.0 (0.8-1.2)	1.1 (0.9-1.4)	1.0 (0.8-1.2)	1.1 (0.9-1.4)
32-56	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Race/ethnicity												
White and other	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Black, non-Hispanic	0.4 (0.1-1.7)	0.6 (0.4-1.1)	0.7 (0.3-1.6)	0.6 (0.2-1.5)	0.5 (0.3-0.8)***	0.8 (0.4-1.4)	0.6 (0.2-1.5)	0.5 (0.3-0.8)***	0.5 (0.3-0.8)***	0.8 (0.4-1.4)	0.5 (0.3-0.8)***	0.8 (0.4-1.4)
Hispanic	1.0 (0.5-2.1)	1.0 (0.7-1.4)	1.1 (0.6-1.9)	1.0 (0.6-1.8)	1.0 (0.7-1.3)	1.0 (0.7-1.6)	1.0 (0.6-1.8)	1.0 (0.7-1.3)	1.0 (0.7-1.3)	1.0 (0.7-1.6)	1.0 (0.7-1.3)	1.0 (0.7-1.6)
Gender												
Female	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Male	2.3 (1.7-3.0)***	2.1 (1.8-2.6)***	1.8 (1.4-2.2)***	1.4 (1.2-1.7)***	1.3 (1.1-1.4)***	1.5 (1.3-1.7)***	1.4 (1.2-1.7)***	1.3 (1.1-1.4)***	1.3 (1.1-1.4)***	1.5 (1.3-1.7)***	1.3 (1.1-1.4)***	1.5 (1.3-1.7)***
Education												
High school or less	2.4 (1.7-3.5)***	3.4 (2.7-4.4)***	3.1 (2.4-4.3)***	1.6 (1.2-2.1)***	2.0 (1.7-2.4)***	2.0 (1.7-2.5)***	1.6 (1.2-2.1)***	2.0 (1.7-2.4)***	2.0 (1.7-2.4)***	2.0 (1.7-2.5)***	2.0 (1.7-2.4)***	2.0 (1.7-2.5)***
Some college/vocational	1.7 (1.2-2.4)**	2.2 (1.7-2.8)***	1.9 (1.4-2.7)***	1.2 (1.0-1.6)	1.7 (1.5-2.0)***	1.5 (1.2-1.9)***	1.2 (1.0-1.6)	1.7 (1.5-2.0)***	1.7 (1.5-2.0)***	1.5 (1.2-1.9)***	1.7 (1.5-2.0)***	1.5 (1.2-1.9)***
College+	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Age of first drink												
Le 14	5.1 (2.5-10.3)***	6.9 (4.4-10.8)***	3.1 (2.2-4.6)***	4.1 (2.6-6.6)***	5.0 (3.7-6.6)***	4.0 (2.9-5.4)***	4.1 (2.6-6.6)***	5.0 (3.7-6.6)***	5.0 (3.7-6.6)***	4.0 (2.9-5.4)***	5.0 (3.7-6.6)***	4.0 (2.9-5.4)***
15-16	3.5 (1.8-6.9)***	5.3 (3.5-8.1)***	1.7 (1.1-2.4)**	3.0 (1.9-4.6)***	3.7 (2.9-4.8)***	3.1 (2.3-4.2)***	3.0 (1.9-4.6)***	3.7 (2.9-4.8)***	3.7 (2.9-4.8)***	3.1 (2.3-4.2)***	3.7 (2.9-4.8)***	3.1 (2.3-4.2)***
17-20	2.1 (1.1-4.2)*	2.9 (1.9-4.4)***	1.2 (0.8-1.7)	1.8 (1.2-2.7)**	2.1 (1.6-2.6)***	1.7 (1.3-2.3)***	1.8 (1.2-2.7)**	2.1 (1.6-2.6)***	2.1 (1.6-2.6)***	1.7 (1.3-2.3)***	2.1 (1.6-2.6)***	1.7 (1.3-2.3)***
21+	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref

100' > .001  
\*\*\*  
p < .01  
\*\*  
50' p  
\*

**Table 5**

Childhood, family and current risk factors for heavy drinking among siblings

Total Population N=2,261	Sibling Heavy Drinking <sup>a</sup> OR <sub>adj</sub> (95% CI) <sup>a</sup>
Childhood factors: related to cancer diagnosis or treatment	
Sibling Age at sister/brother's cancer diagnosis	
Before birth (-6 to -1 years)	1.1 (0.5-2.8)
0-10	1.7 (0.9-2.9)
11-18	1.3 (0.7-2.2)
19-36 (ref)	--
Older vs. Younger than Survivor	1.1 (0.8-1.5)
Cancer Diagnosis	
Hodgkin disease (ref)	--
Leukemia	1.3 (0.8-2.1)
Central Nervous System/Brain	1.3 (0.8-2.2)
Non-Hodgkin Lymphoma	1.5 (0.8-2.6)
Wilms Tumor	0.8 (0.4-1.4)
Neuroblastoma	1.4 (0.8-2.7)
Sarcoma	0.9 (0.5-1.7)
Bone	1.2 (0.7-2.2)
Family drinking	
Was the sister/brother survivor a heavy drinker?	
Yes vs. No	2.0 (1.3-3.2) **
Current factors: Siblings' health and mental health	
General Self-Assessed Health	
Fair/Poor vs. Excellent/Very Good/Good	2.2 (1.4- 3.6) **
Depression	
Abnormal vs. Normal	2.1 (1.3-3.2) ***
Anxiety	
Abnormal vs. Normal	1.9 (1.1-3.3) *
Somatization	
Abnormal vs. Normal	1.1 (0.6-2.0)
GSI Score	
Abnormal vs. Normal	2.5 (1.5-4.3) ***
Current factors: Survivors' Current Physical Health	

Total Population N=2,261	Sibling Heavy Drinking <sup>a</sup> OR <sub>adj</sub> (95% CI) <sup>a</sup>
Survivor Health Status	
No condition (ref)	
Grade 1-mild	1.0 (0.7-1.5)
Grade 2-moderate	1.0 (0.7-1.4)
Grade 3-severe	0.9 (0.6-1.3)
Grade 4-life-threatening	1.1 (0.7-1.8)
Grade 5-fatal	1.8 (0.8-4.1)

\*  
p < .05

\*\*  
p < .01

\*\*\*  
p < .001

<sup>a</sup>Each cell controls for age, race, and gender.