

Occupational Outcomes of Adult Childhood Cancer Survivors

A Report From the Childhood Cancer Survivor Study

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BACKGROUND: The authors examined whether survivors from the Childhood Cancer Survivor Study were less likely to be in higher-skill occupations than a sibling comparison and whether certain survivors were at higher risk for lower-skill jobs. **METHODS:** The authors created 3 mutually exclusive occupational categories for participants aged ≥ 25 years: Managerial/Professional, Nonphysical Service/Blue Collar, and Physical Service/Blue Collar. The authors examined currently employed survivors (4845) and their siblings (1727) in multivariable generalized linear models to evaluate the likelihood of being in 1 of the 3 occupational categories. Multinomial logistic regression was used among all participants to examine the likelihood of these outcomes compared to being unemployed (survivors, 6671; siblings, 2129). Multivariable linear models were used to assess survivor occupational differences by cancer- and treatment-related variables. Personal income was compared by occupation. **RESULTS:** Employed survivors were less often in higher-skilled Managerial/Professional occupations (relative risk, 0.93; 95% confidence interval 0.89-0.98) than their siblings. Survivors who were black, were diagnosed at a younger age, or had high-dose cranial radiation were less likely to hold Managerial/Professional occupations than other survivors. In multinomial models, female survivors' likelihood of being in full-time Managerial/Professional occupations (27%) was lower than male survivors (42%) and female (41%) and male (50%) siblings. Survivors' personal income was lower than siblings within each of the 3 occupational categories in models adjusted for sociodemographic variables. **CONCLUSIONS:** Adult childhood cancer survivors are employed in lower-skill jobs than siblings. Survivors with certain treatment histories are at higher risk for lower-skill jobs and may require vocational assistance throughout adulthood. *Cancer* 2011;117:3033-44. © 2011 American Cancer Society.

KEYWORDS: neoplasms, occupations, survivors, socioeconomic factors, late effects, female.

There are more than 328,000 childhood cancer survivors (CCS) in the United States.¹ During the past 4 decades, survival from childhood cancers has improved substantially because of new and improved treatments and advancements in supportive care.² Cure, however, is not without consequence. Surgery, chemotherapy, and radiation are associated with late health effects that can affect survivors' physical, psychosocial, and cognitive functioning.³⁻⁶ As a result, researchers have increasingly sought to identify the effect of treatment-related health problems on the social and economic characteristics of adult survivors. Many survivors report education difficulties, unemployment, and lower incomes, and survivors are more likely to have public health insurance coverage in contrast to unaffected populations.⁷⁻¹¹ The impact of childhood cancer on occupational achievement, however, has not been reported.

The assessment of occupations can capture several aspects of socioeconomic status by summarizing the income, education, and skill requirements associated with achievement of specific job types. Studies of other high-risk populations,

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such as employed adults with disabilities, find that even after accounting for educational attainment, these workers are disproportionately employed in entry-level lower-wage jobs.¹² Such jobs are associated with an increased risk of morbidity and mortality^{13,14} and more exposure to workplace hazards and job instability.¹⁵ Employees in lower-skilled jobs, such as the service industry, have fewer opportunities for employer-sponsored health insurance, retirement savings, disability leave, and career advancement than managerial and professional occupations.¹⁶

Certain CCS may be at higher risk for poor occupational outcomes because of their treatment histories. Survivors treated with cranial radiation face cognitive limitations, hearing loss, or other neurosensory problems.^{5,6} Bone tumor and soft-tissue sarcoma survivors may have amputations or limb-sparing surgeries that affect their functional status¹⁷ and limit their ability to perform tasks required for some occupations. Other factors, such as female sex and younger age at diagnosis, have been associated with lower levels of employment in adult survivors¹⁸ and could potentially impact occupational achievement.

The purposes of this study were to 1) assess whether employed CCS are underrepresented in higher-skilled occupations and are disproportionately in jobs that require fewer skills compared with a sibling cohort and 2) determine whether specific risk factors (eg, female sex or a history of cranial radiotherapy) predict survivors' occupational attainment. Because many CCS report physical limitations,¹⁹ we were interested in evaluating whether survivors who were employed in lower-skilled occupations reported that their jobs required physical activity because we hypothesized that physical problems could limit the types of jobs available to survivors with fewer employment skills. We also examined whether personal income differed within occupations for survivors compared with siblings.

MATERIALS AND METHODS

Participants

The Childhood Cancer Survivor Study (CCSS) is a multi-institutional research initiative started in 1994 to investigate health outcomes in childhood and adolescent cancer survivors. The cohort includes survivors diagnosed when younger than age 21 years and a group of randomly selected age-matched siblings.²⁰ Participants were diagnosed between January 1, 1970 and December 31, 1986 and had survived at least 5 years from the time of diagnosis.^{21,22} Eligible diagnoses included leukemia, central nervous system (CNS) malignancies (all histologies), Hodgkin disease,

non-Hodgkin lymphoma (NHL), Wilms tumor, neuroblastoma, soft tissue sarcoma, or malignant bone tumor. The Human Subjects Committees at the 26 participating institutions reviewed and approved the CCSS protocol.

CCSS participants completed a baseline survey (1994-1996) and 4 follow-up surveys. We performed the current cross-sectional analyses using the second follow-up (2003), as detailed information was asked about current occupation at this time. Information on cancer type, treatments received, and clinical characteristics of the survivors was obtained from medical records.

At baseline, there were 14,357 survivors and 4023 siblings. By the second follow-up, 8.2% survivors had refused contact or were lost to follow-up, 11.3% had died, and 10.5% of siblings were no longer being followed. Of the remaining 11,560 survivors and 3601 siblings, the second follow-up was completed by 9289 survivors and 2792 siblings. Because 26% of survivors between ages 20-24 years were still in school, we excluded 2145 survivors and 512 siblings who were <25 years of age at survey completion. Students engaged in postsecondary education likely have jobs that do not reflect their eventual occupational attainment. We used no upper age limit because the oldest eligible survivors and siblings were aged 54 years and 58 years, respectively.

We generated 2 analysis samples from the remaining 7144 survivors and 2280 siblings. First, we excluded the 473 survivors and 151 siblings with missing employment information. Then, because of the high levels of unemployment (survivors 27%, siblings 19%), we performed analyses comparing the occupations of employed to unemployed participants (6671 survivors and 2129 siblings). We also performed analyses limited to participants who were currently employed (4845 survivors and 1727 siblings).

Occupation measures

We asked CCSS participants to list their main job title and tasks. These were coded according to the US Department of Labor Standard Occupational Classification (SOC) System (<http://www.bls.gov/soc/>). The SOC has 23 major occupational groups that include detailed information on occupations requiring similar job duties, skills, education, or experience. We excluded military occupations (10 survivors and 16 siblings) because of potential differences in skill requirements.

The remaining 22 groups were classified into 3 mutually exclusive occupational categories (Fig. 1). First, occupations were coded as "Professional/Managerial" or "Service/Blue Collar". We grouped Professional/

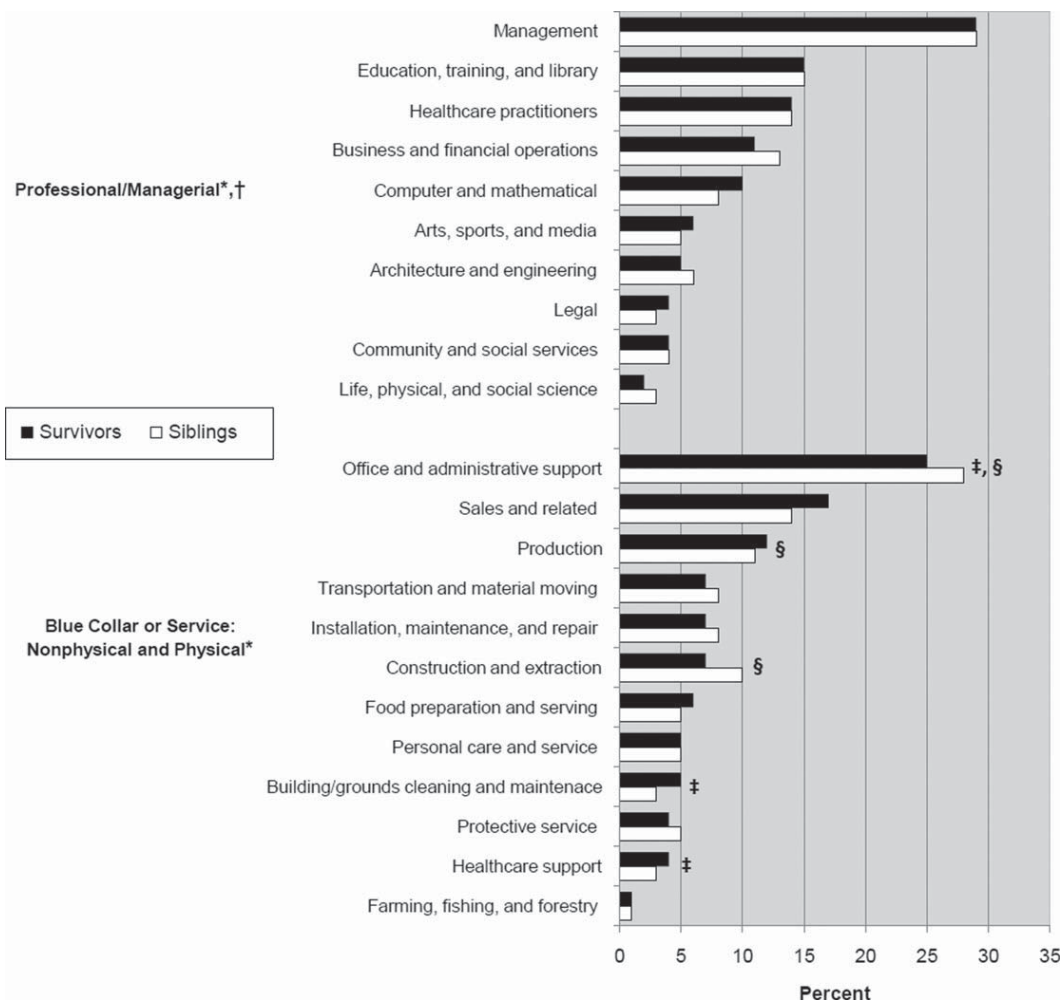


Figure 1. Distribution of jobs among survivors and siblings by occupation is shown. *4845 survivors and 1727 siblings were currently employed; Professional, 2589 survivors and 1026 siblings; Nonphysical, 1787 survivors and 551 siblings; Physical, 469 survivors and 150 siblings. †The proportions reporting specific Professional jobs did not differ significantly between survivors and siblings. ‡The proportion of survivors and siblings reporting Nonphysical work was significantly different for this job. §The proportion of survivors and siblings reporting Physical work was significantly different for this job.

Managerial positions according to assessment of skill levels and/or experience to capture higher-skill and higher-experience jobs. Because of medical conditions that potentially could limit survivors from performing physical labor common to Service/Blue Collar occupations, we coded the remaining occupations as Physical or Nonphysical. Participants reporting mostly heavy labor or physically demanding work were coded as “Physical”. Those reporting primarily sitting, standing, or walking occupations were coded as “Nonphysical”. We used the 5-point Job Zone classification developed by occupational experts from the Occupational Information Network (O*Net) database (<http://onetcenter.org>) to assess agreement with our created occupational categories.²³ Occupations with

higher Job Zone scores require more education, preparation, and training, and the Professional/Managerial average Job Zone scores (3.4-5.0) were higher than those for Service/Blue Collar (1.0-2.7).

Other measures

For survivor-sibling comparisons, we included current age, sex, and race in all models. Full-time employment was considered as working ≥ 30 hours per week and part-time as < 30 hours. Cancer recurrence and secondary cancers (not including nonmelanoma skin cancers) were examined to account for subsequent events. For chemotherapy and radiation treatment, we evaluated whether survivors received any of these therapies as well as the

specific types of chemotherapeutic agents (platinum, alkylating agents, anthracyclines, and bleomycin) and the location of specific radiation regions (brain/head, neck, chest, spine, abdomen, pelvis, arm/leg, or total body irradiation). We hypothesized that cranial radiation would be highly related to occupation and created a 7-level categorical variable to investigate doses. All other cancer-related variables are listed in Table 1.

Statistical Analyses

The proportions of survivors and siblings in each occupational category (including unemployed) were calculated overall and by demographic characteristics. Additional proportions were calculated for survivors by cancer and treatment characteristics.

To compare survivors to siblings, we used multivariable regression with robust variance estimates for survivor-sibling correlations²⁴ with adjustments for age, sex, and race. We limited the analyses to employed participants, comparing survivors in each cancer diagnosis group with siblings, separately for Professional/Managerial, Nonphysical, and Physical occupations. Because of the high proportion of participants in each occupational category, the results are reported as relative risks (RR) with 95% confidence intervals (95% CI).²⁵ Sensitivity analyses examined the impact of excluding the highest and lowest average Job Zone values and were consistent with the overall regression estimates. Next, to assess differences in occupations and unemployment between survivors and siblings, we calculated predicted probabilities from multinomial logistic regressions for the categories of full-time and part-time Professional/Managerial, Nonphysical, and Physical Occupations, and Unemployed²⁴ with an interaction for survivor/sibling status by sex.

To estimate associations of cancer and treatment-related variables with the occupational categories, we next performed multivariable relative risk regressions limited to employed survivors. Cancer diagnosis was not included because of its close relation to treatment. We first examined the 7-category cranial radiation-dose variable with current age, sex, and race. We then investigated the other treatment variables, considering that many of the cancer treatments were related. We also calculated predicted probabilities from ordinal logistic regressions for yearly personal income for the survivors and siblings by occupation. Because of potential endogeneity with occupational status, we examined educational attainment separately for all regressions. Analyses were performed using Stata ver-

sion 11.0 (Stata Corp, College Station, Tex). All reported *P*-values are 2-sided and considered significant at $\alpha = .05$.

RESULTS

Twenty-seven percent of survivors were unemployed compared with 19% of siblings ($P < .001$). Unemployment was due to staying at home to take care of family or children, or being a student or retired (survivors 12%; siblings 14%), not working because of health limitations (survivors, 9.3%; siblings, 1.5%), and being unemployed but currently seeking work (survivors, 5%; siblings, 2.7%). Among survivors, 39% reported a Professional occupation compared with 48% of siblings ($P < .001$), although the distribution of specific jobs within this category did not differ (Fig. 1). The proportions reporting Physical (25% vs 27%) and Nonphysical (7% vs 7%) occupations were similar between survivors and siblings; however, within these categories there were differences in the proportions reporting certain jobs.

Fewer survivors with leukemia or central nervous system (CNS) tumors were in Professional jobs and those with doses of cranial radiation ≥ 35 Gy were less often employed or less likely to be working in Professional jobs (Table 1). Survivors in all occupational categories tended to be younger or male more often than siblings, whereas the proportion working full-time did not differ (Table 2).

Survivor-Sibling Comparisons

In multivariable regression models restricted to currently employed participants (Table 3), survivors were less likely to hold Professional occupations (RR, 0.93; 95% CI, 0.89-0.98) and more likely to be employed in Nonphysical occupations (RR, 1.15; 95% CI, 1.07-1.24) than siblings. Leukemia, CNS tumor, and non-Hodgkin lymphoma (NHL) patients reported fewer Professional positions, whereas bone cancer patients were more likely than siblings to be working in a Professional occupation (RR, 1.12; 95% CI, 1.04-1.21). Leukemia patients were more likely (RR, 1.26; 95% CI, 1.03-1.54) and bone cancer patients less likely (RR, 0.37; 95% CI, 0.23-0.61) to report Physical occupations. The estimates remained similar when adjusted for full-time or part-time employment status and education. Except for neuroblastoma, survivors of all cancer types reported more unemployment compared with siblings.

In our multinomial models, we found differences by sex in the proportion unemployed and for part-time or full-time employment (Fig. 2). Both male and female

Table 1. Cancer and Treatment-Related Characteristics for Survivors by Occupational Status^a

Characteristics	Total No.	Professional or Managerial		Employed		Physical		Unemployed	
		n=2589 (39%)		n=1787 (27%)		n=469 (7%)		n=1826 (23%)	
		No.	%	No.	%	No.	%	No.	%
Diagnosis									
Leukemia	2046	713	35	631	31	196	10	506	25
Central nervous system	829	197	24	221	27	50	6	361	44
Hodgkin disease	1096	512	47	261	24	64	6	259	24
Non-Hodgkin lymphoma	585	231	39	159	27	52	9	143	24
Wilms tumor	482	195	40	130	27	28	6	129	27
Neuroblastoma	287	119	41	78	27	17	6	73	25
Soft tissue sarcoma	650	297	46	155	24	45	7	153	24
Bone cancer	696	325	47	152	22	17	2	202	29
Age at diagnosis, y									
≤4	1782	577	32	536	30	157	9	512	29
5-9	1696	606	36	470	28	134	8	486	29
10-14	1729	727	42	435	25	105	6	462	27
≥15	1464	679	46	346	24	73	5	366	25
Cancer recurrence									
Yes	652	240	37	169	26	40	6	203	31
No	6019	2349	39	1618	27	429	7	1623	27
Secondary cancers									
Yes	335	127	38	79	24	13	4	116	35
No	6336	2462	39	1708	27	456	7	1710	27
Years since diagnosis									
≤20	1547	612	40	394	25	116	8	425	28
21-30	4170	1591	38	1142	27	296	7	1141	27
>30	954	386	40	251	26	57	6	260	27
Treatment era									
1970-1973	1069	425	40	285	27	69	6	290	27
1974-1977	1712	638	37	475	28	113	7	486	28
1978-1981	2006	769	38	536	27	149	7	552	28
1982-1986	1884	757	40	491	26	138	7	498	26
Chemotherapy									
Any chemotherapy	4754	1898	40	1255	26	340	7	1261	27
No chemotherapy	1339	505	38	359	27	74	6	401	30
Missing ^b	578	186	32	173	30	55	9	164	28
Platinum chemotherapy									
Any	237	106	45	60	25	5	2	66	28
No platinum	5856	2297	39	1554	27	409	7	1596	27
Missing ^b	578	186	32	173	30	55	10	164	28
Radiation									
Any	4338	1664	38	1176	27	297	7	1201	28
No radiation	1749	736	42	435	25	118	7	460	26
Missing ^b	584	189	32	176	30	54	9	165	28
Cranial radiation^c									
None	1762	742	42	440	25	118	7	462	26
<i>Cumulative dose</i>									
Scatter low ^d	1887	868	46	470	25	97	5	452	24
Scatter high ^d	189	92	49	40	21	15	8	42	22
<18 Gy	539	208	39	159	30	45	8	127	24
18-24 Gy	742	228	31	247	33	82	11	185	25
25-34 Gy	129	41	32	46	36	8	6	34	26
≥35 Gy	613	134	22	162	26	29	5	288	47
Missing ^b	810	276	34	223	28	75	9	236	29

(Continued)

Table 1. (Continued)

Characteristics	Total No.	Employed				Unemployed			
		Professional or Managerial n=2589 (39%)	Nonphysical n=1787 (27%)		Physical n=469 (7%)		n=1826 (23%)		
N=6671		No.	%	No.	%	No.	%	No.	%
Surgery sites									
Amputation	432	190	44	92	21	14	3	136	31
Limb-sparing	66	20	30	16	24	3	5	27	41
CNS resection	950	244	26	263	28	57	6	386	41

^a Percentages calculated by row.

^b Includes subjects who did not provide consent for release of medical information on detailed treatment exposures.

^c Denominator is the number of patients who received radiation exposure with cranial radiation information (n = 5861).

^d Scatter low indicates no treatment to head or brain, but patient received radiation to some part of the body (dose range ≥ 0 to <1 Gy); Scatter high indicates no direct treatment to segment, but treatment was nearby (≥ 1 to ≤ 5 Gy).

survivors were more likely to be unemployed (males, 17%; females, 38%) than siblings (males, 9%; females, 25%). Twenty-seven percent of female survivors, 42% of male survivors, 41% of female siblings, and 50% of male siblings held a full-time Professional occupation.

Survivor Risk Group Comparisons

When we limited the analyses to only employed survivors, female survivors were actually more likely to hold Professional (RR, 1.13; 95% CI, 1.07-1.19) and Nonphysical (RR, 1.19; 95% CI, 1.10-1.29) occupations than male survivors and less likely to report Physical occupations (RR, 0.19; 95% CI, 0.14-0.25; Table 4). Black survivors were 33% less likely to report Professional occupations, and black, Hispanic, and other race survivors were 33%-36% more likely to be unemployed compared with white survivors. Survivors diagnosed at age ≥ 5 years had an increased likelihood of Professional and decreased likelihood of Nonphysical and Physical occupations.

Employed survivors with cranial radiation doses ≥ 18 Gy were between 22% and 29% less likely to hold Professional positions than survivors without this treatment, and they were more likely to be employed in Nonphysical jobs. For Physical occupations and cranial radiation survivors, there was a parabolic effect in that only midrange doses between 18 and 24 Gy were significant (RR, 1.57; 95% CI, 1.20-2.05). Doses of ≥ 35 Gy were associated with a 1.61 higher risk of unemployment (95% CI, 1.39-1.87). CNS tumor resection imparted a decreased likelihood of Professional (RR, 0.82; 95% CI, 0.73-0.92) but increased Nonphysical (RR, 1.23; 95% CI, 1.09-1.40) occupation. Platinum chemotherapy was associated with a decreased likelihood of Physical employ-

ment (RR, 0.34; 95% CI, 0.14-0.80). No other chemotherapy agents or radiation sites were significant. The estimates remained similar when adjusted for education except the relative risks for cranial radiation attenuated.

Personal Income

Yearly personal income differed by occupation for survivors and siblings in models adjusted for age, sex, marital status, and full-time or part-time employment status (Fig. 3). Survivors were more likely than siblings to make less than \$20,000 per year and were less likely to report incomes greater than \$40,000 per year in each of the occupation categories. The income differences remained similar in magnitude when education was included.

DISCUSSION

Studies of adult CCS have increasingly sought to identify and explain the impact of late effects on their social, economic, and demographic outcomes. We found that adult survivors were less likely to be employed in higher-skill occupations when compared with siblings. Survivors, particularly those with a history of CNS tumors and leukemia, reported jobs that were nonphysical more often than siblings. Because of the physical late effects from cancer, we hypothesized that CCS would be less likely to report occupations that required high levels of physical activity, but this was only significant for bone cancer survivors.

Our results that suggest survivors are more often employed in lower-skill occupations have implications for their economic status throughout their lifetimes. The average median yearly income for 2003 for the major SOC occupational groups in our Professional/Managerial category was approximately \$49,000

Table 2. Demographic Characteristics of Survivors and Siblings by Occupational Status

No. (%)	Full Sample ^a				Employed				Unemployed			
	Survivors n=6671 No.	%	Siblings n=2129 No.	%	Survivors n=2589 No.	%	Siblings n=1026 No.	%	Survivors n=1787 No.	%	Siblings n=551 No.	%
Current age, y												
25-34	3793	57	985	46	1345	52	464	45	1069	60	242	44
35-44	2302	34	806	38	973	38	390	38	581	32	213	3
45+	576	9	338	16	271	10	172	17	137	8	96	17
Sex												
Male	3385	51	964	45	1389	54	492	48	937	52	257	47
Female	3286	49	1165	55	1200	46	534	52	850	48	294	53
Race^b												
White, non-Hispanic	5767	87	1917	93	2304	89	928	94	1556	88	495	93
Black, non-Hispanic	208	3	39	2	48	2	18	2	72	4	13	2
Hispanic	239	4	51	3	83	3	17	2	55	3	15	3
Other/mixed	436	7	50	3	149	6	26	3	101	6	11	2
Education^c												
<High school	1160	18	266	13	121	5	42	4	406	23	118	21
Some college or more	5465	82	1857	87	2465	95	981	96	1373	77	432	79
Marital status^d												
Married	3371	49	1385	65	1503	58	681	67	836	47	337	62
Not married	3275	51	736	35	1078	42	343	34	942	53	211	38
Children												
Yes	2533	38	1287	60	948	37	573	56	666	37	349	63
No	4138	62	842	40	1641	63	453	44	1121	63	202	37
Health insurance^e												
Canadian	406	6	172	8	167	6	90	9	91	5	49	9
Yes	5522	83	1786	84	2296	89	894	87	1499	84	460	83
No	695	11	167	8	115	4	42	4	189	11	42	8
Employment status												
Full-time (≥30 h)	4358	90	1559	90	2401	93	932	91	1519	85	496	90
Part-time (<30 h)	487	10	168	10	188	7	94	9	268	15	55	10
									31	7	19	13
									438	93	131	87
									NA	NA	NA	NA
									7	19	13	13
									28	503	35	28
									72	1289	65	72
									82	1496	92	82
									157	9	4	157
									9	7	2	9
									1071	59	202	50
									613	34	147	37
									142	8	53	13
									649	36	95	24
									1177	64	307	76
									411	92	135	92
									411	92	135	92
									11	2	1	1
									17	4	5	3
									29	6	6	4
									130	28	52	35
									338	72	97	65
									228	49	89	60
									240	51	60	40
									173	37	92	61
									296	63	58	39
									746	41	273	68
									1080	59	129	32
									7	117	7	18
									1368	76	324	81
									315	18	58	14

^a Full sample comprises employed and unemployed participants aged ≥25 years with available employment and occupational information except for employment status, which is calculated only for currently employed participants. All survivor-sibling comparisons significant at $P < .001$ for the full sample except for employment status.

^b Race/ethnicity reported by n=6650 survivors; n=2057 siblings.

^c Highest achieved education reported by n=6625 survivors; n=2123 siblings.

^d Marital status reported n=6646 survivors; n=2121 siblings.

^e Health insurance reported by n=6623 survivors; n=2125 siblings.

Table 3. Relative Risk and 95% Confidence Intervals of Survivors' Occupational Status Compared With Siblings^a

	Professional ^a			Nonphysical ^a			Physical ^a			Unemployed ^b		
	RR	95% CI	P	RR	95% CI	P	RR	95% CI	P	RR	95% CI	P
Siblings (referent)	1			1			1			1		
All survivors	0.93	0.89-0.98	.003	1.15	1.07-1.24	<.001	0.97	0.82-1.16	.75	1.45	1.32-1.60	<.001
Leukemia	0.79	0.74-0.85	.001	1.27	1.16-1.40	<.001	1.26	1.03-1.54	.004	1.26	1.11-1.41	<.001
Central nervous system	0.72	0.65-0.81	<.001	1.48	1.31-1.67	<.001	1.04	0.77-1.41	.75	2.36	2.10-2.66	<.001
Hodgkin disease	1.04	0.97-1.11	.28	0.99	0.87-1.12	.88	0.85	0.64-1.12	.06	1.31	1.14-1.50	<.001
Non-Hodgkin lymphoma	0.89	0.81-0.99	.03	1.16	1.00-1.33	.05	1.01	0.75-1.35	.42	1.47	1.24-1.73	<.001
Wilms tumor	0.98	0.88-1.09	.71	1.11	0.95-1.30	.17	0.84	0.57-1.23	.21	1.34	1.12-1.59	<.001
Neuroblastoma	0.96	0.83-1.09	.50	1.10	0.91-1.34	.32	0.85	0.53-1.32	.97	1.23	0.99-1.53	.06
Soft tissue sarcoma	1.03	0.95-1.12	.51	0.98	0.85-1.14	.81	0.93	0.68-1.28	.67	1.27	1.08-1.49	.004
Bone cancer	1.12	1.04-1.21	.003	0.97	0.84-1.13	.72	0.37	0.23-0.61	<.001	1.56	1.25-1.80	<.001

RR indicates relative risk; CI, confidence interval.

^aRegressions compare the occupation of interest to the other 2 occupational categories among employed participants. The analyses included survivors (n=4836) and siblings (n=1670) who had available occupational and demographic variables (age, race, and sex).

^bThe unemployed regression model compared unemployed to employed participants.

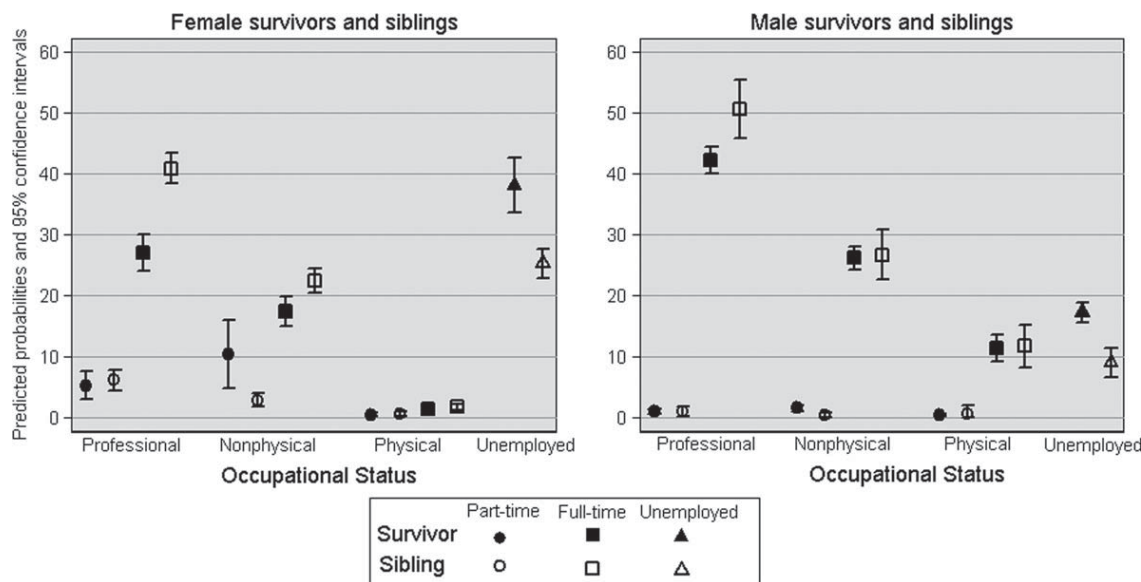


Figure 2. Predicted probabilities of occupational status for survivors and siblings by sex are illustrated. Survivors (6662) and siblings (2072); estimates were adjusted for current age and race and for an interaction for survivor status by sex. Unemployment did not include full-time or part-time status.

(range, \$32,400-\$70,870) compared with less than \$24,000 (range, \$15,390-\$34,290) for Service/Blue Collar.²⁶ Within occupational categories, personal income was lower for survivors compared with siblings even when adjusted for education. Future studies should examine more detailed assessment of survivors' career decisions and occupations and the effect on income. There may be work experiences or lifestyle decisions that differ between the survivors and siblings not captured in our categories.

In addition, survivors with chronic health problems may be intermittently employed, affecting their income potential despite working in similar fields as siblings.

Certain cancer and treatment-related factors were linked to occupational differences. CNS tumor resection was associated with decreased Professional employment, and all surgery types were associated with unemployment. Platinum chemotherapy, which was primarily used in the CCSS cohort for osteosarcoma patients,

Table 4. Relative Risk and 95% Confidence Intervals of Survivors' Occupational Status by Cancer and Treatment-Related Factors

	Professional ^c (n=2589)			Employed (n=4845) ^a			Physical ^c (n=469)			Unemployed ^{a,b} (n=1826)		
	RR	95% CI	P	RR	95% CI	P	RR	95% CI	P	RR	95% CI	P
Current age, y												
25-34 (ref)	1			1			1			1		
35-44	1.00	0.91-1.09	.93	1.00	0.87-1.14	.98	1.02	0.74-1.40	.90	1.04	0.90-1.20	.60
45+	0.95	0.81-1.11	.52	0.98	0.76-1.25	.84	1.36	0.75-2.47	.32	0.96	0.74-1.26	.79
Sex												
Men (ref)	1			1			1			1		
Women	1.13	1.07-1.19	<.001	1.19	1.10-1.29	<.001	0.19	0.14-0.25	<.001	1.93	1.76-2.11	<.001
Race												
White, non-Hispanic (ref)	1			1			1			1		
Black, non-Hispanic	0.67	0.51-0.88	.004	1.51	1.24-1.85	<.001	0.84	0.39-1.82	.66	1.36	1.09-1.70	.007
Hispanic	0.98	0.83-1.16	.83	0.91	0.71-1.17	.47	1.40	0.86-2.28	.18	1.33	1.09-1.61	.004
Other/mixed	0.99	0.88-1.12	.90	1.00	0.85-1.18	.96	0.95	0.65-1.39	.79	1.34	1.17-1.55	<.001
Age at diagnosis, y												
≤4 (ref)	1			1			1			1		
5-9	1.16	1.05-1.27	.003	0.92	0.82-1.04	.19	0.75	0.57-0.97	.03	0.94	0.82-1.07	.34
10-14	1.31	1.18-1.46	<.001	0.83	0.71-0.96	.01	0.59	0.42-0.83	.002	0.88	0.75-1.03	.11
≥15	1.32	1.14-1.52	<.001	0.83	0.68-1.01	.07	0.49	0.32-0.80	.005	0.85	0.68-1.06	.14
Cranial radiation												
None (ref)	1			1			1			1		
Scatter low	1.01	0.95-1.08	.66	1.00	0.90-1.11	.99	0.82	0.63-1.05	.11	0.98	0.87-1.11	.79
Scatter high	1.05	0.92-1.20	.48	0.85	0.65-1.13	.26	1.06	0.63-1.79	.81	0.97	0.72-1.31	.85
<18 Gy	0.88	0.78-0.98	.02	1.15	0.99-1.33	.06	1.03	0.76-1.41	.87	0.91	0.76-1.10	.35
18-24 Gy	0.71	0.64-0.80	<.001	1.29	1.15-1.47	<.001	1.57	1.20-2.05	.001	1.00	0.85-1.16	.96
25-34 Gy	0.73	0.57-0.92	.008	1.42	1.14-1.79	.002	0.93	0.48-1.82	.84	1.04	0.76-1.42	.81
≥35 Gy	0.78	0.67-0.92	.002	1.30	1.12-1.52	.001	0.96	0.65-1.41	.84	1.61	1.39-1.87	<.001
Platinum chemotherapy	NA			NA						NA		
No (ref)							1					
Yes							0.34	0.14-0.80	0.01			
CNS tumor resection							NA					
No (ref)	1			1						1		
Yes	0.82	0.73-0.92	.001	1.23	1.09-1.40	.001				1.29	1.12-1.48	<.001
Amputation	NA			NA			NA					
No (ref)										1		
Yes										1.30	1.09-1.55	.003
Limb-sparing	NA			NA			NA					
No (ref)										1		
Yes										1.40	1.00-1.97	.05

RR indicates relative risk; CI, confidence interval.

^a Adjusted for treatment era, which was nonsignificant in all models.^b The unemployed regression estimate compared the unemployed survivors to the employed survivors; sample size was n=5985.^c Regressions compare the occupation of interest to the other 2 categories. Sample sizes were Professional, n=4421; Nonphysical, n=4259; and Physical, n=4258. These sum to less than 4845 because of missing treatment information.

conferred a 66% decreased likelihood of reporting Physical work, although because of the small number in this category, this finding should be interpreted with caution. Conversely, the bone cancer diagnosis group was the only diagnosis group more likely to be working in Pro-

fessional jobs than siblings. Among CCS, a younger age at diagnosis is associated with cognitive impairment, and learning disabilities requiring special education,^{7,11} and an increased risk of specific medical conditions.²⁷ We found as age of diagnosis increased, the likelihood of

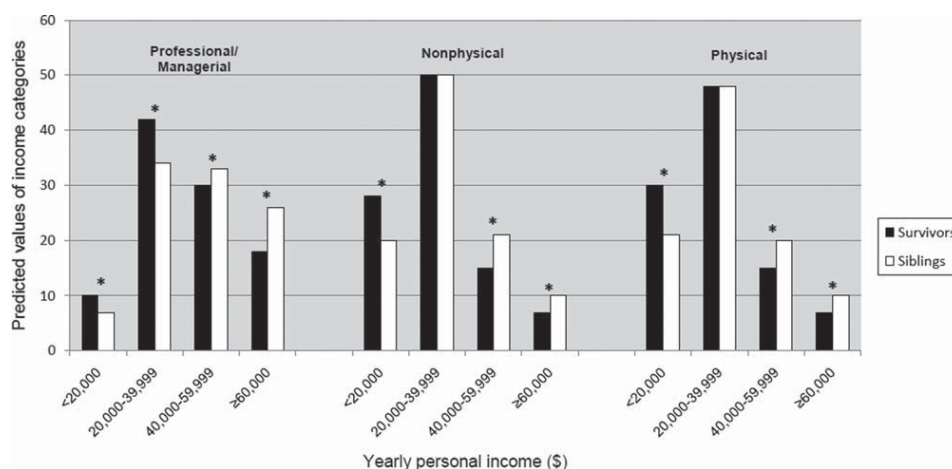


Figure 3. Predicted probabilities are shown by yearly personal income by occupation for survivors versus siblings. *Income category difference between survivors and siblings was significant at $P < .05$. The models were adjusted for sex, age, race, marital status, and full-time or part-time employment status.

Professional employment increased, whereas survivors diagnosed at a younger age were more likely to hold Service/Blue Collar jobs.

Fewer survivors were employed in Professional jobs, and higher proportions of survivors held Nonphysical jobs among those with higher cranial radiation doses. Midrange doses (18 Gy to 25 Gy) were the only cranial radiation doses associated with an increased likelihood of Physical work, suggesting that survivors with a history of higher doses may not be physically able to work in certain occupations. Patients receiving cranial radiation—typically CNS and leukemia patients—often face neurocognitive deficits, including motor skill limitations and decreased abilities in acquiring new skills and information, although the risk decreases with lower doses.^{5,6,28} Not only are these survivors at a higher risk for poor health outcomes and unemployment,^{8,18} but when they are working, our findings suggest they may be disproportionately employed in lower-skill positions.

Black survivors were less likely to be employed in Professional and more often in Nonphysical occupations than white survivors, whereas no racial/ethnic differences were found for siblings. In an earlier study, black survivors reported similar health status as white survivors in analyses adjusted for socioeconomic status.²⁹ When we controlled for socioeconomic variables, such as education, our racial and ethnic occupational differences persisted, suggesting that there may be factors beyond health status influencing racial/ethnic employment differences. CCS report difficulties obtaining employment,³⁰ and minority race survivors may face differential discrimination by employers for

hiring or providing access to training or career advancement opportunities.

The differences in our results, depending on the inclusion of unemployed or only employed survivors, demonstrate the need to compare both groups because of the high proportion of unemployed female survivors. In analyses limited to employed survivors, female survivors were more likely than male survivors to be employed in Professional occupations. However, when we considered the proportion unemployed in the denominator, female survivors were less likely to work in these occupations and more likely to be unemployed compared with male survivors and male and female siblings. These results suggest that future studies should investigate how the cancer experience differentially affects career decisions for female survivors, including the decision to work, and whether to work full-time or part-time. Coupled with our earlier analyses that found female survivors at an increased risk of health-related unemployment,³¹ female survivors may be particularly vulnerable for poor labor-force outcomes.

There are certain limitations with this study. Aggregating occupations may obscure further job skill differences between survivors and siblings. Although there are well known indicators of occupational status and social class available, such as the Duncan Socioeconomic Index, we hypothesized that occupational groupings tied to potential differences in skills and physical ability would best describe our population, and our sensitivity analyses showed the robustness of our classifications. Using cross-sectional occupational information limited our ability to detect further differences if we had been able to

summarize years of experience in specific occupations or other longitudinal occupational measures. Also, we did not have information on comorbidities beyond cancer recurrence and secondary cancers, which may impact on CCS occupational outcomes.

Childhood socioeconomic status and parental occupation are predictive of adult employment and occupational status, and these were not available in the current study. However, by comparing the survivors to a sibling cohort, we provided some control for childhood socioeconomic status, although not all survivors had a sibling pair (1592 pairs in the full sample). In addition, 24% of survivors and 19% of siblings have been lost to follow-up or refused participation since baseline. Because individuals with lower socioeconomic status are less likely to participate in health surveys, our estimates of the proportion of survivors in low-skill jobs may be conservative.

CCS are less often employed in higher-skill occupations. Future studies are needed to determine why survivors make specific career decisions, to elucidate what survivors need to be successful in the workplace, and to assess the barriers survivors face in developing their careers. Long-term survivorship programs should offer vocational assistance to CCS from the point of initial treatment throughout their careers, and these programs may need to provide a broad array of services depending on a survivor's psychosocial or health status to maximize their occupational potential. High-risk survivors, because of their treatment history or demographic background, may also need additional resource assistance from community vocational or educational services.

Barriers exist to getting occupational services to the neediest survivors. Uninsured CCS may not be able to obtain survivorship services, and, even for insured survivors, occupational rehabilitation services may not be covered. Furthermore, current national policies that encourage workforce participation for individuals with disabilities should be extended to provide those employed in low-skill and entry-level jobs—such as many adult survivors of childhood cancer—opportunities to advance their careers.¹² As research continues to acknowledge the social, psychological, and financial impacts of childhood cancer, identifying survivors for occupational intervention will help to improve their quality of life.

CONFLICT OF INTEREST DISCLOSURES

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