



Published in final edited form as:

*Biol Blood Marrow Transplant*. 2010 February ; 16(2): 207. doi:10.1016/j.bbmt.2009.09.015.

## The Preventive Health Behaviors of Long-Term Survivors Cancer and Hematopoietic Stem Cell Transplantation Compared to Matched Controls

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### Abstract

**BACKGROUND**—Little is known about the health promotion, prevention, and disease screening behaviors of cancer survivors treated with hematopoietic cell transplantation (HCT), who undergo arduous treatment and may be at particular risk for late effects and secondary malignancies. The purpose of this study was to examine the current health and secondary prevention behaviors of long-term HCT survivors compared to noncancer matched controls and to identify sociodemographic and clinical factors associated with appropriate prevention practices.

**METHODS**—HCT survivors (n=662) were drawn from 40 North American transplant centers. Peer-nominated acquaintances of survivors matched on sex, age, education, and marital status, served as controls (n=158). Data were collected a mean of 6.7 years post-HCT (range 1.8 – 22.6 years).

**RESULTS**—Despite greater frequency of physical exams, HCT survivor health and screening behaviors were similar to matched controls. Sociodemographic factors were associated with health prevention behaviors in expected ways. Some differences between disease group and type of transplant were found, with survivors of acute leukemia less likely to report regular exercise, autologous transplant survivors more likely than allogeneic to report screenings for breast and cervical cancer, and allogeneic survivors more likely than autologous to report a skin exam in the last year.

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There are no financial disclosures from any authors.

**CONCLUSION**—Despite higher levels of engagement with health care providers, HCT survivor health behaviors were no different than matched controls and comparable to those reported by non HCT cancer survivors. There remains considerable room for improvement. These findings support the need for further education of both HCT survivors and health practitioners.

### Keywords

Cancer; hematopoietic stem cell transplant; bone marrow transplant; health behaviors; cancer survivorship

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## INTRODUCTION

By 2020, it is estimated that the number of cancer survivors in the US will increase to 18 million, with 70% living 5 years or more<sup>1</sup>. The rising number of cancer survivors means more individuals at increased risk for cancer recurrence, secondary cancers, and late effects of treatments<sup>2</sup>. Survivors of hematopoietic cell transplantation (HCT) are at particular risk for adverse outcomes due to the intensity of the conditioning regimen and complications of treatment (e.g., graft vs. host disease)<sup>3,4</sup>. Engaging in health promotion and disease prevention activities could attenuate some of the secondary health problems, as well as improve the quality of life<sup>5</sup>. Although there is a growing literature on the health behaviors of cancer survivors, the prevalence of preventive health behaviors in HCT survivors is largely unknown.

Surviving the rigors of HCT treatment might motivate survivors to protect their health. For some, cancer/HCT could serve as a “wake up call” that life is fragile and good health not guaranteed, motivating them to stop smoking or begin exercising. For others, preventive health behaviors could be a way to maximize post-treatment rehabilitation, recovery, and quality of life, or as a way to exert control over one’s body, during a period of time when little control is experienced. On the other hand, fear of recurrence, desire to avoid medical contact, or lack of financial resources or insurance coverage could reduce the frequency of preventive health practices.

Many cancer survivors do initiate exercise, diet, and other healthful lifestyle changes after diagnosis<sup>(see 6 for review)</sup>. Certain behavior changes, such as quitting smoking and decreasing alcohol consumption, are more pronounced in survivors with cancers related to those behaviors, such as lung and head and neck cancer<sup>6</sup>. Nonetheless, many cancer survivors continue to smoke and/or remain overweight or obese<sup>6, 7</sup> and do not engage in physical activity<sup>7</sup>. The health behavior patterns between cancer survivors and controls<sup>8,9</sup> are often comparable. The incidence of cancer screenings may be somewhat higher in cancer survivors than in those no history of cancer<sup>(see 10 for review)</sup>, though, rates vary considerably.

It is possible that along with differences based on cancer-site, differences in treatment experiences could affect subsequent health behaviors. Compared to conventional cancer treatments, the high dose therapy associated with HCT involves greater intensity and higher risk, which could contribute to greater motivation on the part of HCT survivors to engage in healthy behaviors. Conversely, the intensity of the treatment could lead to greater physical or mental health impairments that could interfere with a survivor’s ability or motivation to engage in some health behaviors, such as exercise. The survivor might feel so “lucky” that they survived that they needn’t be vigilant for a second cancer and other diseases. Nonetheless, HCT survivors appear to have regular follow up with physicians often for many years<sup>3</sup> in contrast to adult survivors treated with conventional therapy (as many as 60% of which report no regular medical follow-up<sup>10</sup>). Thus, this repeated contact of HCT survivors with health providers should increase the likelihood of regular screenings and opportunities for education about health behaviors.

This is the first study to examine the health behaviors and secondary cancer screening rates of long-term HCT survivors compared to matched acquaintance non-cancer controls. The goal of this cross-sectional study was to 1) identify the prevalence of health behaviors, screening rates, and other health practices in very long-term HCT cancer survivors compared to matched, non-cancer controls and 2) identify sociodemographic and clinical factors associated with those health behaviors. We hypothesized that HCT survivors would be more likely to engage in healthy behaviors, cancer screenings, and good health practices than matched controls given the intensity of their treatment and their “second chance at life”. We also sought to determine if there were differences in behaviors based on cancer site, type of transplant, time since transplant, treatment intensity, and presence of graft vs. host disease (GVHD).

## METHODS

This report examines previously unpublished data from a large multi-site study of the long-term QOL of cancer/HCT survivors compared to a subset of matched peer-nominated controls. QOL of the survivors compared to controls was previously presented<sup>11</sup>, as were details regarding survivor characteristics, study procedures, and institutional review board approval obtained from each participant<sup>11</sup>. To be eligible for the study, survivors had undergone single allogeneic or autologous transplant during adulthood for one of four diseases (acute leukemia, chronic myelogenous leukemia, lymphoma, and breast cancer), were at least one year post-transplant, and were in continuous remission since the HCT.

Survivors were randomly selected from a stratified (by disease, type of transplant, time since transplant, and intensity of pre-HCT treatment) list of eligible survivors at 40 transplant centers in North America registered with the Center for International Blood and Marrow Transplantation (CIBMTR). Since the BMT population is predominantly Caucasian, we oversampled African Americans to increase the ethnic diversity of the sample. A total of 2,447 potentially eligible survivors were identified from CIBMTR; 1,946 were randomly selected for potential study enrollment. Of these, contact information was unavailable for 262 and 295 were ineligible, primarily due to death or disease relapse. Attempts were made to reach the remaining survivors; contact was made with 960. Of these, 118 declined participation and 138 provided verbal consent but did not return a consent form. Potential participants who declined or were unable to be contacted, were replaced by the next person on the randomized list. 704 survivors (73.3% of eligible survivors successfully contacted) provided written consent. Of these, 42 were withdrawn from the study for various reasons including voluntary withdrawal, study ineligibility, or loss to follow-up (94% of those consented completed the study).

Controls were survivor acquaintances matched to survivors on sex, age, education, and marital status, with no history of cancer/HCT and no involvement in providing care to the survivor. 90% of study eligible matched acquaintances contacted participated in the study. Data were collected between March 2000 and September 2002.

### Study Measures

Self-reported study measures assessed survivors’ health and secondary prevention behaviors and other health practices, physical functioning, as well as sociodemographic characteristics, including health insurance status. Disease and treatment factors, and functional status, were extracted from CIBMTR registry data. Participant groups completed identical measures. Half of the measures were completed by hand and half were completed during computer-assisted telephone interviews. Medical records were not reviewed to confirm self-reports.

**Preventive Health Behaviors**—A 30-item questionnaire was designed for the study, based on recommended guidelines at the time of the study. Respondents were asked if any of the following procedures were performed in the prior 12 months: physical exam, cholesterol check,

stool checked, sigmoidoscopy or colonoscopy, blood pressure, eye exam, dental exam, skin exam, and flu shot. Additional items for female respondents included clinical breast exam, mammogram, and pap smear, and for male respondents prostate digital rectal exam (DRE) and Prostate Specific Antigen test (PSA). Respondents also were asked how often they currently smoked cigarettes, a pipe, or used chewing tobacco, drank more than 2 glasses of alcoholic beverages a day, and exercised moderately for 20 minutes at least three times a week, responding by using a Likert-type scale.

**Sociodemographic information**—Information included age, race/ethnicity, marital and occupational status, level of education, and annual household income.

**Disease and treatment information**—Information included cancer diagnosis, prior cytotoxic treatment (less or more), and type of transplant (allogeneic or autologous).

**Physical Functioning**—The SF-36 Physical functioning subscale of the SF-36 MOS<sup>12</sup> was used to measure current physical functioning.

### Statistical Analyses

Survivors and controls were compared on age using a 2-sample t-test and on other, categorical demographic characteristics using chi-square tests. Chi-square tests were used to compare prevalence of health behaviors and screening between survivors and controls. Logistic regression models were used to adjust these comparisons for age, gender and education. Within the survivor group, screening and health behaviors were compared between groups defined by gender, age, education, cancer type, transplant type and other demographic and clinical variables. Examination of health behaviors was a predefined exploratory aim of the project; no power calculations were conducted for the exploratory endpoints. All tests are two-sided and no adjustment was made for multiple comparisons.

## RESULTS

Details regarding participant identification and selection were published previously including a flow chart summarizing recruitment of survivors<sup>11</sup>. When compared to all non-participants (those lost to follow up, unreachable, withdrawn from study, passively declined, or actively declined) on demographic characteristics, participants were older (median age 42 vs. 38,  $p < .001$ ), female (62% vs. 52%,  $p < .001$ ), and Caucasian (83% vs. 71%,  $p < .001$ ). However, when participants were compared only to those who actively refused participation, only demographic differences in race/ethnicity remained (83% of participants were Caucasian vs. 68% of those who actively refused participation were Caucasian,  $p < .001$ ).

In examining potential differences between participants and nonparticipants on clinical characteristics, we found the following. When compared to all non-participants (those lost to follow up, unreachable, withdrawn from study, passively declined, or actively declined), participants were less likely to have lymphoma (20% vs. 28%) and more likely to have breast cancer (23% vs. 18%,  $p < .001$ ) than non-participants, respectively. Participants were more likely to be in the early disease status prior to their pre-HCT treatment (61% vs. 48%,  $p < .001$ ) and were more likely to have had an autologous transplant (58% vs. 29%) and less likely to have had an allogeneic transplant (42% vs. 71%,  $p < .001$ ). When participants were compared only to those who actively refused participation, we found no differences in disease group ( $p = 0.12$ ) or disease status prior to HCT ( $p = 0.14$ ). Participants were more likely to have had an autologous transplant than active refusers (58% vs. 42%,  $p = .001$ ).

Table 1 shows demographic characteristics of survivors and controls. The two groups were similar except the survivor group was more likely to be single, with a lower income, and not

working. There were no differences between survivors and controls on health insurance/medical coverage or on reports of having a physician. Table 2 lists clinical characteristics of the survivor group.

### **Reported Health Behaviors, Health Examinations, Cancer Screenings and Influenza Vaccination Practices of Survivors Compared to Matched Controls**

Table 3 lists the prevalence of health behaviors, reported health exams and cancer screenings, and influenza vaccination practices in the last year reported by survivors and controls. There were no differences between survivors and matched controls in tobacco use. Survivors were less likely than controls to engage in regular exercise and to report drinking alcohol, respectively (see Table 3). No group differences on reports of engaging in all three healthy behaviors were found. Body mass index was similar between the two groups.

Compared to controls, survivors were more likely to have had a physical exam ( $p=0.002$ ), blood pressure check ( $p=0.02$ ), and a skin exam ( $p=0.01$ ), but less likely to have had a dental examination ( $p=0.0001$ ). Cancer screening behaviors were similar among the groups, except that survivors were less likely to have had a pap smear ( $p=0.034$ ). Survivors were more likely to have had the influenza vaccine but less likely than controls over the age of 65 (for whom the vaccine is recommended).

### **Sociodemographic Factors Associated with Survivor Health Behaviors**

In bivariate analyses, survivors who were male, of younger age, and had less education were more likely to report smoking than survivors who were female, older, and more educated (Table 4). Male survivors were more likely to report drinking than female survivors, in both univariate and multivariate analyses: (males OR=2.33, 95% CI=1.56–3.45,  $p<.0001$ ). Survivors with more education were more likely to exercise than those with less education, whereas sex and age made no difference.

In multivariate analyses, male gender, younger age, and less education were independently associated with smoking in multivariate analyses (males OR=1.56; 95% CI= .41–98,  $p=0.051$ , younger age OR=.74 per 10 years, 95% CI=0.62–0.89,  $p=0.002$ , and those with less education OR=1.38 for HS/GED or less, 95% CI=0.83–2.28, OR=0.61 for college degree or higher, 95% CI=0.36–1.04;  $p=0.01$ ). There were no group differences in tobacco or alcohol use (survivor vs. Control) after adjusting for sex, age, and education ( $p=0.31$  and  $p=0.057$ , respectively). Age and education, as well as, higher physical functioning, were related to physical activity levels. That is, the survivors who were more likely to engage in physical exercise were older (OR=1.20 per 10 years, 95% CI=1.03–1.40,  $p<0.02$ ), more educated (OR=1.57 for college degree or higher, 95% CI=1.10–2.23; OR=0.82 for HS/GED or less, 95% CI=0.55–1.23,  $p=0.001$ ), and reported higher physical functioning (scored >85 on the SF 36 subscale; OR=3.10, 95% CI=2.24–4.27,  $p<0.0001$ ). The difference in reported exercise behavior among survivors and controls found in univariate analyses, were no longer significant after adjusting for gender, age, education, and physical functioning ( $p=0.63$ ).

Thus, after adjusting for age, sex, and education (and physical functioning for exercise behaviors) the estimated prevalence of the health behaviors of survivors and controls were as follows: tobacco use for survivors vs. controls was 12% vs. 15%, respectively (95% CI=10–15% and 10–23%), physical activity was 34% vs. 32% in survivors and controls, respectively (95% CI=31–38% and 25–40%), and alcohol use was 14% in survivors vs. 25% in controls (95% CI=12–17% and 19–33%).

### **Disease and Treatment Factors associated with Survivor Health Behaviors**

There was no relationship between survivor reported health behaviors (smoking, alcohol use, and exercise) and the number of years since HCT, amount of pre-HCT cytotoxic treatment (less vs. more), or type of transplant (allogeneic vs. autologous). Within the subset of allogeneic survivors, those with chronic GVHD were less likely to smoke ( $p<0.03$ ). Survivors of acute leukemia were less likely to report engaging in regular exercise, than survivors of CML, lymphoma, and breast cancer ( $p<0.04$ ), as well as, less likely to engage in all three health behaviors (smoking, alcohol use, exercise) compared to the other groups ( $p<0.03$ ) (see Table 5).

### **Disease and Treatment Factors Associated with Screening Practices of Survivors**

Differences in reported cancer screening behaviors by disease group and type of transplant are shown in Table 6. Autologous transplant survivors were more likely than allogeneic survivors to report screenings for breast and cervical cancer, which was not solely accounted for by a breast cancer diagnosis. Allogeneic transplant survivors were more likely than autologous to report having had a skin exam in the last year ( $p=0.004$ ).

With regard to intensity of pre-transplant therapy, survivors who received less intensive therapy were more likely to report having had a physical exam in the last year ( $p=0.045$ ) but less likely to report having had an eye exam in the past year than those who received more intensive treatment ( $p=0.05$ ). No other differences were found related to intensity of treatment.

## **DISCUSSION**

This is the first study to examine the health and cancer screening behaviors of long-term cancer/HCT survivors compared to matched non-cancer controls. Contrary to our hypothesis, and despite more frequent physical exams and good access to health care, the preventive health practices of these survivors, for the most part, were no more frequent than those of matched controls (and in some cases less frequent). These results were somewhat surprising given the “second chance at life” afforded these survivors and their increased risk of late effects and second cancers due to the high dose therapy associated with HCT.

With regard to health behaviors, the smoking and alcohol consumption rates reported by the survivors in our study were similar to those reported by other cancer survivors<sup>6</sup>. The physical activity rate reported by survivors in this study (34%) was lower than rates reported in some studies of cancer survivors (42–83%)<sup>5,6,8</sup> though population-based studies have found 22% of cancer survivors physical active<sup>7</sup> and 3/4ths of cancer survivors not meeting physical activity recommendations<sup>8</sup>. Given that physical activity rates and body weight are increasingly recognized as important risk factors for poorer outcomes in cancer survivors<sup>13</sup>, attention is needed here. The secondary cancer screening rates in our study were similar to other studies of cancer survivors. However, in contrast to other studies<sup>8,14</sup>, we did not find these rates to be better than non-cancer controls, which may be explained by the fact the survivors and controls in this study were primarily Caucasian, well-educated, and fairly affluent.

We found autologous HCT survivors more likely to report breast and cervical cancer screenings in the past year compared to allogeneic survivors, who were more likely to have received a skin exam. It is possible that allogeneic and autologous transplant survivors have different expectations for post-transplant outcomes. Allogeneic survivors may expect the treatment to be curative and the risk of second cancers to be small, whereas autologous survivors, aware that the risk of recurrence is fairly high, may be more likely to screen for second cancers. The greater frequency of skin examinations reported by allogeneic survivors could reflect vigilance for signs of GVHD, rather than a focus on skin cancer. Alarming, although the HCT

survivors' reported influenza vaccination rate was greater than controls, it should have been higher than 60% given their "at risk" status<sup>15</sup>.

Our findings that survivor health behaviors were poorer than what we would expect or want, may reflect a lack of education and/or understanding about survivorship issues, such as the need for continued surveillance for second cancers and engagement in healthy behaviors to reduce late effects, risk of other diseases, and improve quality of life. Studies have noted nearly half of cancer survivors are unaware of their increased risk for second cancers<sup>8</sup>. Of course, perceived risk alone is not sufficient for behavior change. Perceived susceptibility, control, and self-efficacy -- constructs described in the Health Belief<sup>16</sup> and other models of behavior change -- may be necessary as well. Future studies should examine the perceptions of risk as well as causal attributions and beliefs regarding the effectiveness of screenings and health behaviors in attenuating these risks.

Given that the survivors in our sample were more likely to have had a physical exam than controls, but for the most part, no more likely to have engaged in healthy behaviors or received cancer screenings and influenza vaccinations, it is possible that their physicians also were unaware of the need for a different pattern of care for them. Studies suggest that as few as 20% of providers are talking to cancer survivors about health behaviors<sup>6</sup> and only 10% of survivors report their physicians talking to them about smoking, exercise, and diet<sup>17</sup>. Gaps in preventive care may be related to type of provider. Primary care physicians provide health care for an increasing number of adult long-term survivors of HCT<sup>3</sup>, and although guidelines exist for recommended screening and preventive practices for long-term HCT survivors<sup>18, 19</sup>, primary care providers (PCPs) may not be aware of them. There is evidence that PCPs are less likely to screen their patients for second cancers than oncologists, who may be less likely to engage in non-cancer-related preventive services<sup>20, 21</sup>. Survivors who see both types of providers tend to receive more services<sup>21</sup>. The Institute of Medicine report on cancer survivorship<sup>22</sup> cites many shortfalls in the post-treatment health and preventive care of cancer survivors highlighted by our results, and recommends the use of transition care plans to help address these issues. However, one could argue that health behavior recommendations should be incorporated into a patient's care from moment of diagnosis, with the goal of maximizing their physical stamina and general health to withstand treatment, as well as to maintain maximal health through survivorship. In fact, there may be a window of opportunity around the time of diagnosis (within 6 months), when health issues are most salient for patients and motivation to live and live well is at its peak<sup>23</sup>.

There were several limitations to the current study. With a cross-sectional design and pre-diagnosis behaviors unknown, it is impossible to determine if health practices changed as a result of the diagnosis and treatment. However, the similarities between the reported behaviors of survivors and matched controls suggest that changes in health behaviors did not occur as a result of the cancer/HCT. Unfortunately, there were no standardized measures of health and screening behaviors at the time of the study, thus we developed our own, making cross-study comparisons difficult. A particular limitation of our measure was that it asked about health screening behaviors in the past year, though some recommendations are for less than yearly exams (e.g., Pap smears are recommended every 1–3 years). Guidelines for recommended health behaviors have undergone recent changes, which may affect the representativeness of these data to current and future long-term HCT survivor's health behaviors. Development of standardized questionnaires of health behaviors and screenings, including dietary behaviors which we did not address, would be an asset to this area of study, albeit challenging to accomplish as recommendations change over time.

Additional limitations of the study is that our sample was predominantly Caucasian (which reflects the ethnic make up of the BMT patient population as a whole) and Caucasians were

more likely to participate in the study than non-Caucasians, limiting generalizability of results to non-Caucasians. These two issues are particularly important since other studies have shown that health behaviors differ by race/ethnicity. Although we used randomization of eligible survivors in an attempt to get as representative of a sample as possible, we did find other differences between participant and non-participants. Compared to all non-participants, participants were slightly older, more likely to be female, less likely to have had lymphoma and more likely to have had breast cancer, more likely to be in the early disease (than intermediate or advanced) status prior to their pre-HCT treatment, and more likely to have had an autologous transplant. However, none of these differences were found (except that participants were more likely to have had an autologous transplant) when comparing participants to those who actively refused study participation. Further studies are needed to address these potential shortcomings.

Taken as a whole, it does not appear that the experience of cancer along with the intense HCT treatment results in significantly better health behavior and screening practices after treatment than those exhibited by similar others who have not experienced a cancer diagnosis. Although many of the health behaviors and screening rates reported in these HCT survivors were comparable to those reported by cancer survivors in other studies, there remains considerable room for improvement. To effectively manage, treat, and prevent comorbidities, health promotion and lifestyle interventions to optimize health during and after cancer treatment are necessary. We need to educate provider, survivors, and family caregivers. To maximize effectiveness, these conversations should begin shortly after diagnosis.

## Acknowledgments

This research was supported by grants R01 CA81320 (PI: John Wingard, M.D.) and K23 CA82350 (PI: Doug Rizzo, M.D.) from the National Institutes of Health and a Survivorship grant from the Lance Armstrong Foundation.

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**Table 1**

Demographic Characteristics For Survivors (n=662) and Matched Controls (n=158) and Survivor Clinical Characteristics

Variable	Survivors	Matched Controls
Age (yrs)	M=49.1, SD=10.3, Range 21 – 77	M=50.1, SD= 14.2, Range 27 – 76
Male	38%	30%
Married or Partnered †	73%	87%
Caucasian	92%	95%
Education		
≤High School Graduate	29%	19%
Some College/Technical/AA	32%	32%
College Degree or higher	39%	49%
Occupational Status †		
Working or Student	73%	75%
Not Working	15%	5%
Retired	11%	20%
Annual Family Income **		
< \$40,000	33%	18%
\$40,000 – \$80,000	39%	47%
> \$80,000	28%	34%
Health insurance, % covered	96%	97%
Have a physician	98%	97%

Note: Percentages shown represent the percentage of respondents with non-missing data for that variable. Some percentages may not add to 100% due to rounding.

\*\* P < .05

† P < .01

‡ P < .001

**Table 2**

Clinical Characteristics of Survivors (n=662).

Time since HCT (yrs)	Mean = 7.0	SD = 3.1	Median = 6.6	Range = 1.8 – 22.6
Type of Transplant				
	Allogeneic HCT		n = 272	(41%)
	Autologous HCT		n = 390	(59%)
Malignant disease at Initial Diagnosis				
	AML/ALL		n = 243	(37%)
	Breast Cancer		n = 156	(24%)
	Hodgkin's/Non-Hodgkin's Lymphoma		n = 132	(20%)
	CML		n = 131	(20%)
Intensity of pre-HCT cytotoxic treatment*				
	Less intense		n = 441	(67%)
	More intense		n = 221	(33%)
Allogeneic transplant survivors with CGVHD			n = 83	(40%)

\* The *less intense* treatment group included patients transplanted for chronic phase CML within one year of diagnosis, patients transplanted for acute leukemia or lymphoma in first complete remission and patients transplanted for adjuvant treatment of high risk Stage II or III breast cancer. The *more intense* treatment group included those transplanted for chronic phase CML > 1 year after diagnosis, those transplanted for accelerated or blast phase CML, those transplanted for acute leukemia or lymphoma beyond first remission and those transplanted for metastatic breast cancer.

Note: Some percentages may not add to 100% due to rounding.

Abbreviations: HCT, hematopoietic cell transplantation; AML, acute myelogenous leukemia; ALL, acute lymphocytic leukemia; CML, chronic myelogenous leukemia; CGVHD, chronic graft vs. host disease

**Table 3**  
 Reported Health Promotion Behaviors, Examinations, Cancer Screenings, and Influenza Vaccination Practices of Survivors Compared to Matched Controls

	Survivors N (%)	Matched Controls N (%)	p- value
<b>HEALTH PROMOTION BEHAVIORS</b>			
How often do you smoke?			
Never	555 (87)	133 (85)	0.547
Rarely, Sometimes, Often, Always	82 (13)	133 (85)	
How often do you drink more than 2 alcoholic beverages per day?			
Never, Rarely	542 (85)	117 (75)	0.003
Sometimes, Often, Always	96 (15)	36 (25)	
How often do you exercise moderately for 20 minutes at least 3 times a week?			
Never, Rarely, Sometimes	407 (64)	86 (55)	0.046
Often, Always	231 (36)	70 (45)	
Engagement in all 3 health behaviors*			
No	461 (72)	105 (67)	0.232
Yes	178 (28)	51 (33)	
<b>Body Mass Index</b>			
Under weight (BMI < 18.5)	19 (3)	3 (2)	0.586
Normal (BMI = 18.5–24.9)	275 (45)	77 (51)	
Overweight (BMI = 25–29.9)	277 (45)	59 (39)	
Obese (BMI ≥ 30)	45 (7)	12 (8)	
<b>EXAMINATIONS AND CANCER SCREENINGS IN THE LAST 12 MONTHS</b>			
<b>Physical exam</b>			
Yes	582 (91.08)	123 (80.39)	0.0018
No	57 (8.92)	30 (19.61)	
<b>Blood Pressure check</b>			
Yes	614 (96.1)	138 (90.2)	0.0189
No	25 (3.9)	15 (9.8)	
<b>Dental exam</b>			
Yes	491 (76.96)	139 (90.85)	0.0001

	Survivors N (%)	Matched Controls N (%)	p- value
No	147 (23.04)	14 (9.15)	
Skin exam			
Yes	302 (47.41)	55 (35.95)	0.011
No	335 (52.59)	98 (64.05)	
Colorectal cancer screening (FOB, sigmoidoscopy, and/or colonoscopy, age 50+ only)			
Yes	143 (47.04)	43 (57.33)	0.110
No	161 (52.96)	32 (42.67)	
Breast cancer screening (CBE and/or mammogram, women 50-65 only)			
Yes	132 (76.74)	37 (84.09)	0.292
No	40 (23.26)	7 (15.91)	
Pap smear (women only)			
Yes	292 (72.64)	90 (82.57)	0.034
No	110 (27.37)	19 (17.43)	
Prostate cancer screening (DRE and/or PSA, men 50+ only)			
Yes	72 (62.61)	20 (80.00)	0.097
No	43 (37.39)	5 (20.00)	
All suggested screening (listed above) for age/gender			
Yes	105 (16.43)	31 (19.87)	0.306
No	534 (83.57)	125 (80.13)	
VACCINATIONS IN THE LAST 12 MONTHS			
Influenza Vaccination**			
Yes	381 (59.72)	50 (32.68)***	<0.001
No	257 (40.28)	103 (67.32)	

\* Defined as never smoking, never or rarely drinking alcohol, and often or always engaging in exercise

\*\* Since there are different physician preferences about immunizations in patients with active graft vs. host disease (GVHD), we excluded the 83 survivors who reported having active GVHD.

\*\*\* 73% of controls over the age of 65 and 95% of survivors over the age of 65 reported having received the influenza vaccine (p=0.072).

Numbers may not add up because of missing data

**Table 4**

## Health Behaviors of Survivors by Sex, Age, and Educational Status

Variable	Smoking % ( $\pm 95\%$ CI)	Drinking % ( $\pm 95\%$ CI)	Exercising % ( $\pm 95\%$ CI)
Male	16.7 (12.1–22.1)	20.1 (15.2–25.8)	36.3 (30.2–42.8)
Female	10.7 (7.8–14.1)	12.1 (9.1–15.7)	36.1 (31.4–41.0)
	<i>P</i> 0.03	0.007	0.96
Age (years)			
20–39	15.91 (10.1–23.3)	15.2 (9.5–22.4)	34.9 (26.8–43.6)
40–59	13.47 (10.3–17.2)	15.92 (12.5–19.9)	35.3 (30.6–40.2)
>60	6.73 (2.8–13.4)	11.54 (6.1–19.3)	41.4 (31.8–51.4)
	<i>P</i> 0.04	0.48	0.33
Education			
$\leq$ HS/GED	17.11 (12.0–23.3)	14.9 (10.1–20.8)	85.11 (79.2–89.9)
Some college	12.44 (8.2–17.8)	16.9 (12.0–22.8)	83.08 (77.2–88.0)
$\geq$ College degree	9.35(6.0–13.7)	13.8 (9.8–18.8)	86.18 (81.2–90.2)
	<i>P</i> 0.02	0.78	0.0001

Abbreviations: HS, High school; GED, General Educational Development

**Table 5**

Survivor Health Behaviors by Disease Group (n=662)

	Acute leukemia	CML	Lymphoma	Breast Cancer	p-value
How often do you smoke?					
Never	202 (86.3%)	107 (85.6%)	111 (86.0%)	135 (90.6%)	0.545
Rarely...Always	32 (13.7%)	18 (14.4%)	18 (14.0%)	14 (9.4%)	
How often do you drink more than 2 alcoholic beverages per day?					
Never, Rarely	199 (85.0%)	106 (84.8%)	111 (86.0%)	126 (84.0%)	0.972
Sometimes...Always	35 (15.0%)	19 (15.2%)	18 (14.0%)	24 (16.0%)	
How often to you exercise moderately for 20 minutes at least 3 times a week?					
Often, Always	68 (29.1%)	49 (39.2%)	51 (39.5%)	63 (42.0%)	0.037**
Never...Sometimes	166 (71.9%)	76 (60.8%)	78 (60.5%)	87 (58.0%)	
All 3 healthy behaviors*?					
Yes	50 (21.4%)	35 (27.8%)	43 (33.3%)	50 (33.3%)	0.028***
No	184 (78.6%)	91 (72.2%)	86 (66.7%)	100 (66.7%)	

\* Defined as never smoking, never or rarely drinking alcohol, and often or always engaging in exercise

\*\* Pairwise comparisons: AL vs. CML: p=0.051; AL vs. lymphoma: p=0.042; AL vs. BC: p=0.009

\*\*\* Pairwise comparisons: AL vs. CML: p=0.172; AL vs. lymphoma: p=0.012; AL vs. BC: p=0.009

Abbreviations: CML, chronic myelogenous leukemia; AL, acute leukemia, BC, breast cancer

**Table 6**  
Survivor Health Examinations and Cancer Screening Behaviors by Disease Group and Type of Transplant (n=662)

	Acute leukemia n (%)	CML n (%)	Lymphoma n (%)	Breast CA n (%)	p-value	Allogeneic n (%)	Autologous n (%)	p-value
Physical exam	209 (89)	116 (92)	111 (86)	146 (97)	0.006	240(92)	342(91)	0.519
Eye exam	156 (67)	92 (73)	84 (65)	96 (64)	0.409	183(70)	245 (65)	0.161
Skin exam	111 (47)	72 (58)	48 (38)	71 (47)	0.017	141(54)	161(43)	0.004
Colorectal cancer screening (age 50+ only)	37 (42)	23 (43)	32 (44)	51 (57)	0.144	38(43)	105(49)	0.329
Breast cancer screening (women 50–65)	27 (71)	17 (61)	20 (77)	68 (85)	0.051	28(61)	104(83)	** 0.003
Pap smear (women)	81 (63)	50 (74)	47 (81)	114 (77)	0.027	94(66)	198(77)	*** 0.021
Prostate cancer screening (men 50+)	23 (49)	18 (78)	31 (72)	NA	0.020	22(54)	50(69)	0.093
ALL suggested screenings	32 (14)	28 (22)	18 (14)	27(18)	0.157	46(18)	59(16)	0.499

\*\* Pairwise comparisons: BC vs. AL, p=0.074; BC vs. CML, 0.007; BC vs. Lymphoma, p=0.737

\*\*\* Pairwise comparisons: BC vs. AL, p=0.012; BC vs. CML, 0.577; BC vs. Lymphoma, p=0.531

Abbreviations: CML, chronic myelogenous leukemia; AL, acute leukemia; BC, breast cancer

We acknowledge that mammograms may be indicated for some HCT survivors less than 50 years of age. However, for purposes of comparison with controls, we report only on those women between the ages of 50–65, who reported breast cancer screenings.