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Health behaviors among breast, prostate, and colorectal cancer survivors: a US population-based case-control study, with comparisons by cancer type and gender

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Abstract
Purpose The aim of this study is to compare health behaviors between breast, prostate, female, and male colorectal cancer survivors to noncancer controls, stratified by short- and long-term survivors, and between cancer types and genders.
Methods A 3:1 population-based sample of breast (6,259), prostate (3,609), female colorectal (1,082), and male colorectal (816) cancer survivors from the 2009 Behavioral Risk Factor Surveillance System survey were matched to noncancer controls on age, gender, race/ethnicity, income, insurance, and region of the US. The likelihood of flu immunization, physical check-up, cholesterol check, body mass index (BMI), physical activity, diet (5-A-Day), smoking, and alcohol use were compared between groups using binomial logistic regression models.
Results Short-term breast cancer survivors were significantly more likely to meet multiple behavioral recommendations, than controls, but the likelihood decreased in the long term. Breast and female colorectal cancer survivors were up to 2.27 (95 % CI 1.90, 2.71) and 1.89 times more likely (95 % CI 1.60, 2.24) to meet the 5-A-Day and BMI recommendations, up to 0.54 times less likely (95 % CI 0.46, 0.64) to drink any alcohol, but were 0.68 times less likely (95 % CI 0.49, 0.95) to meet the physical activity recommendation, compared to prostate and male colorectal cancer survivors.
Conclusions Some cancer survivors may engage in better health behaviors shortly after diagnosis, but the majority of cancer survivors do not have better health behaviors than individuals without a history of cancer. However, a consistent pattern of behavioral differences exist between male and female cancer survivors.
Implications for Cancer Survivors Gender differences in health behaviors among cancer survivors may be influenced by perceptions of masculinity/femininity and disease risk. Ongoing health behavioral promotion and disease prevention efforts could be improved by addressing these perceptions.

Keywords Cancer survivors · Breast cancer · Prostate cancer · Colorectal cancer · Health behaviors · Population-based study · Case-control · Gender differences

Introduction

Obesity is a known risk factor for various primary cancers, as well as cancer recurrence and noncancer-related mortality [1–4]. High rates of obesity and obesity-related health conditions have been observed among cancer survivors, particularly among the most prevalent types of cancer survivors, breast, prostate, and colorectal [5–8]. In response, the American Cancer Society (ACS) has published guidelines for recommended health behaviors pertaining to physical activity, diet (commonly referred to as 5-A-Day), smoking, and alcohol use, intended to improve cancer survival, overall health, and health-related quality of life among cancer survivors [9]. Guideline recommendations for receipt of clinical preventive care, applicable to cancer survivors, have been published by the CDC and the United States Preventive Services Task Force (USPSTF) [10, 11]. Despite these recommendations, it

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remains uncertain how the health behaviors of individuals with a history of cancer differ from those without a history of cancer, and how health behaviors differ among cancer survivors by cancer type and gender.

Despite the scare of cancer, that many may consider a cue to action, cancer survivors may be no more likely to engage in recommended health behaviors, than individuals without a history of cancer; however, there is some discrepancy among the existing literature. Population-based studies conducted in the US and Australia found that survivors of breast, prostate, and colorectal cancers were no more likely to meet recommendations for physical activity, diet, smoking, and alcohol consumption health behaviors than individuals without a history of cancer [6, 12]. Yet, more recent studies among US and Korean populations found that breast, prostate, and colorectal cancer survivors were less likely to be current smokers or consume any or heavy amounts of alcohol, but while Korean cancer survivors were not more likely to engage in recommended levels of physical activity, US cancer survivors were either more likely to engage in some physical activity or no physical activity [13, 14]. Conversely, a different US population-based study reported that cancer survivors were 9 % more likely to meet the physical activity recommendation, after adjusting for demographic and health characteristics [5]. Less is known about clinical preventive care among cancer survivors. A study conducted in the UK found that breast, prostate, and colorectal cancer survivors were more likely to receive routine flu immunization, than noncancer controls, but did not differ in receipt of routine blood cholesterol tests, while breast and prostate cancer survivors were less likely to receive routine blood pressure tests [15]. Receipt of recommended clinical preventive services has not been studied among cancer survivors in the US. However, the competing demands of survivorship management and cancer surveillance may decrease the likelihood of general clinical preventive care among some cancer survivors [16].

Studies comparing health behaviors by cancer type have reported widely variable rates of recommended physical activity and 5-A-Day among prostate (29–43 % and 16–60 %), breast (20–37 % and 18–42 %), and colorectal cancer survivors (20–35 % and 16–43 %), although prostate cancer survivors were generally found to engage in higher rates of these behaviors [12, 17]. The majority of breast, prostate, and colorectal cancer survivors were reported to meet the ACS recommendation for not smoking (88–92 %), but alcohol use between cancer types has varied from study to study [5, 12, 17]. Differences in receipt of clinical preventive care between cancer types, as well as differences in lifestyle behaviors and receipt of clinical preventive care between genders among cancer survivors remain unknown. However, documented differences in lifestyle behaviors and health information seeking between breast, prostate, and colorectal cancer survivors suggest that differences in clinical preventive care are also likely to exist. Moreover, notable differences in physical activity, diet, and alcohol consumption have been reported between genders within the general population [18–20]. Therefore, it stands to reason that differences in health behaviors between genders may also exist among cancer survivors.

Given that not all cancer survivors may engage in healthy behaviors equally, counseling for health behavior change, disease prevention, and management provided to cancer survivors could benefit by understanding how survivors differ in their behaviors from similar individuals without a history of cancer, cancer type, and genders. Therefore, the purpose of this study was to address the limitations and knowledge gaps of previous research by providing comprehensive understanding of the association between history of cancer, cancer type, gender, and recommended health behaviors. Study objectives were to compare (1) the prevalence of physical activity, 5-A-Day, smoking, alcohol use, receipt of flu immunization, physical check-up, and blood cholesterol check, as recommended by the ACS, CDC, and USPSTF, pertaining to between breast, prostate, female colorectal, and male colorectal cancer survivors to their noncancer control groups matched for age, gender, race/ethnicity, income, insurance status, and region of the US; (2) the likelihood of recommended health behaviors for each cancer type, stratified by short- and long-term survivors, to noncancer controls; (3) and the likelihood of recommended health behaviors between cancer types and genders.

Methods

Study design

This study used a retrospective, cross-sectional matched case-control design. Breast, colorectal, and prostate cancer survivors were matched to noncancer controls on specific groups of age, gender, race/ethnicity, income, insurance status, and region of the US.

Data

Cancer survivors and controls were sampled from the CDC's national 2009 Behavioral Risk Factor Surveillance System (BRFSS) survey, an annual, state-based telephone survey administered to noninstitutionalized citizens aged >18 years in all 50 states, the District of Columbia, Puerto Rico, the US Virgin Islands, and Guam, collecting data on disease prevalence, risky health behaviors, preventive health care utilization, perceived health status, access to health care services, sociodemographic, and environmental characteristics [21]. The core component is a standard set of questions administered to all states and territories. In 2009, the response rate was 52.5 %, with a total sample size of 432,607 [22, 23]. Optional modules collecting information on select topics are

administered on a state by state basis. This study used data from the core component file, excluding responses from Puerto Rico, the US Virgin Islands, and Guam.

Study sample

Cancer survivors

Survivors of breast, prostate, and colorectal cancer and age at diagnosis were identified from questions about ever being diagnosed with cancer, cancer type, number of different cancer diagnoses, and age at diagnosis. Inclusion criteria were that individuals be diagnosed with only 1 type of cancer (breast, prostate, or colorectal), age >18 years, no missing responses on any of the dependent variables, and >1 year post diagnosis. The final sample consisted of 6,259 female breast, 3,609 prostate, 1,082 female colorectal, and 816 male colorectal cancer survivors.

Controls

Noncancer controls were selected from those without missing responses for any dependent variables. Logistic regressions generated propensity scores for survivors and potential noncancer controls conditional upon the probability of the individual having had cancer and belonging to specific groups of age, gender, race/ethnicity, income, insurance status, and region of the US. A 3:1 ratio of controls and survivors were matched without replacement using the greedy algorithm. Chi-square tests were performed to determine covariate balance between survivors and controls. Balance was achieved between survivors and controls for all covariates adjusted for in the matching process.

Measures

Dependent variables

ACS guidelines for recommended health behaviors are defined as receiving >150 min of moderate-to-vigorous physical activity per week, consuming >5 servings of fruits and vegetables per day (5-A-Day), not smoking, and avoiding heavy alcohol use (>2 drinks per day for men, and >1 for women). The ACS also recommends that cancer survivors maintain a healthy, normal weight, specifically a body mass index (BMI) between 18.5 and 25 kg/m^2. CDC and USPSTF guidelines for recommended general preventive care vary by service, age, and risk factors, but include annual influenza (flu) immunization, annual or biannual physical check-ups, and blood cholesterol checks every 5 years or shorter intervals for individuals at increased risk for high lipid levels [10, 11]. Responses to dependent variable were dichotomized as "recommended" and "not recommended." Specific responses for each dependent variable categorized as "recommended" or "not recommended" are as follows: physical activity ("recommended" = >150 min of moderate-to-vigorous physical activity per week, "not recommended" = <150 min of moderate-to-vigorous physical activity per week); 5-A-Day ("recommended" = >5 servings of fruits and vegetables per day, "not recommended" = <5 servings of fruits and vegetables per day); smoking ("recommended" = never smoked or former smoker, "not recommended" = current smoker); alcohol use ("recommended" = <2 drinks per day for men, and < 1 for women, "not recommended" = >2 drinks per day for men, and >1 for women); BMI ("recommended" = normal weight, where 18.5 kg/m^2<BMI<25.0 kg/m^2, "not recommended" = overweight, where 25.0 kg/m^2<BMI<30.0 kg/m^2 or obese, where BMI >30.0 kg/m^2); last flu immunization ("recommended" = <1 year, "not recommended" = >1 year or never); last physical check-up ("recommended" = <2 years, "not recommended" = >2 years or never); and last blood cholesterol check ("recommended" = <2 years, "not recommended" = >2 years or never).

Independent variables

Independent variables controlled for were age, race/ethnicity, marital status, education, employment status (employed or other, where "employed" = employed for wages or self-employed and "other" = out of work >1 year, out of work <1 year, homemaker, student, retired, or unable to work), income, insurance status, usual source of care, metro status (metro or non-metro), regions of the US (Northeast, Midwest, West, and South), activity limitations (i.e., limited in any way in any activities because of physical, mental, or emotional problems) (yes or no), and perceived general health (excellent/very good, good, fair/poor). Presence of a specific health condition was confirmed with an affirmative response to the question "Has a doctor, nurse, or other health professional ever told you that you had any of the following?" Health conditions controlled for were heart disease (myocardial infarction, angina, or coronary heart disease), hypertension (high blood pressure), high cholesterol (adults who had their blood cholesterol checked and told it was high), diabetes (diabetes, gestational diabetes, or borderline diabetes), stroke, asthma, and arthritis.

Statistical methods

Chi-square tests compared significant differences in individual characteristics, health conditions, and health behaviors between survivors and controls, with significance set at $P<.05$. The probabilities of engaging in specified levels of health behaviors were compared using logistic regression models controlling for the independent variables described above. Parameter estimates calculated in the regression models are

presented as adjusted odds ratios (AOR) with their corresponding 95 % confidence intervals (CI). Due to small cell sizes, responses for alcohol consumption were categorized as "drink any alcohol" or "no drinks in past 30 days." Models comparing survivors to controls were stratified by time since diagnosis (1–5 years and >5 years). All analysis were conducted using survey procedures in SAS version 9.2 software (SAS Institute Inc., Cary, NC) to account for the complex sample design of the BRFSS.

Results

Characteristics of cancer survivors

The majority of cancer survivors were living >5 years post-diagnosis (58.7–71.6 %), and were >65 years of age (53.8–76.4 %) (Table 1). All cancer types reported more activity limitations ($.001<P<.003$) and fair/poor general health ($P<.001$), than controls (Table 2). Breast cancer survivors reported a greater prevalence of arthritis (53.0 vs. 48.3 %; $P=.001$), diabetes (18.1 vs. 16.0 %; $P=.036$), and high cholesterol (48.8 vs. 46.3 %; $P=.002$) than controls. Similarly, prostate cancer survivors reported a greater prevalence of arthritis (47.8 vs. 41.7 %; $P<.001$), hypertension (58.3 vs. 53.9 %; $P=.008$), and high cholesterol (53.9 vs. 48.5 %; $P<.001$) than controls.

Health behaviors of cancer survivors compared to noncancer controls

Compared to noncancer controls, fewer female colorectal (30.3 vs. 38.4 %; $P=.002$) and male colorectal cancer survivors (39.8 vs. 47.1 %; $P=.014$) met the physical activity recommendation, but more breast cancer survivors met the 5-A-Day recommendation (34.4 vs. 31.6 %; $P=.035$) and fewer prostate cancer survivors were current smokers (7.8 vs. 9.9 %; $P=.025$) than controls (Table 3). Additionally, more breast and prostate cancer survivors received recommended flu immunization ($P<.001$ and $P=.002$), physical check-up ($P<.001$ and $P<.001$), and cholesterol check ($P<.001$ and $P<.001$) than controls, whereas female and male colorectal did not differ from their noncancer controls in receipt of recommended general preventive care Table 3.

Among short-term cancer survivors, adjusted models showed that breast cancer survivors were 37, 59, and 49 %, respectively, more likely to meet the 5-A-Day recommendation (95 % CI 1.11, 1.70), not smoke (95 % CI 1.16, 2.20), and receive recommended flu immunization (95 % CI 1.19, 1.86) than controls.

Among long-term cancer survivors, breast cancer survivors were more likely to be of normal weight (AOR, 1.16; 95 % CI 1.01, 1.33) and receive recommended flu immunization (AOR, 1.16; 95 % CI 1.01, 33) than controls. Long-term female colorectal cancer survivors were less likely to meet the physical activity recommendation (AOR, 0.72; 95 % CI 0.54, 0.97), while long-term male colorectal cancer survivors were 58 and 49 % less likely to receive recommended physical check-up (AOR, 0.42; 95 % CI 0.24, 0.74) and cholesterol check (AOR, 0.51; 95 % CI 0.28, 0.94) than controls.

Health behaviors compared among cancer types and genders

Few differences in health behaviors emerged between cancer types, with the exception that prostate cancer survivors were more likely (AOR, 1.35; 95 % CI 1.01, 1.80) to meet the physical activity recommendation, than male colorectal cancer survivors (Table 4). However, comparisons between genders revealed that breast cancer survivors were 27 % less likely (95 % CI 0.62, 0.86) to meet the physical activity recommendation, but were more than twice as likely (AOR, 2.27; 95 % CI 1.90, 2.71) to meet the 5-A-Day recommendation, 89 % more likely to be of normal weight (95 % CI 1.60, 2.24) and 46 % less likely (95 % CI 0.46, 0.64) to drink alcohol, than prostate cancer survivors. Likewise, female colorectal cancer survivors were 32 % less likely (AOR, 0.68; 95 % CI 0.49, 0.95) to meet the physical activity recommendation, but were 73 % more likely to meet the 5-A-Day recommendation (95 % CI 1.21, 2.49), 88 % more likely to be of normal weight (95 % CI 1.34, 2.65), and 45 % less likely (95 % CI 0.45, 0.93) to drink alcohol, than male colorectal cancer survivors.

Discussion

Only a minority of cancer survivors are meeting the ACS recommendations for physical activity (30.3–46.6 %), 5-A-Day (20.0–34.4 %), and healthy weight (25.0–39.9 %), while the majority refrain from smoking and receive recommended routine preventive care. Although, the estimated rates of physical activity are higher than those reported by Coups and Ostroff (2005) (19.7–29.3 %) and Bellizzi et al. (2005) (23.7–30.1 %), whose studies utilized data from the 1998 to 2001 National Health Interview Survey, they are more similar to those recently reported by Blanchard et al. (2008) (35.0–43.2 %) [5, 12, 17]. As the ACS did not publish guidelines for recommended health behaviors for cancer survivors until 2003, therefore these higher prevalence estimates may reflect a gradual adoption of the physical activity recommendation [24]. Estimates for survivors meeting the 5-A-Day, smoking, and weight recommendation are within the range of those previously reported [5, 12, 17].

Health behavior comparisons between cancer survivors and similarly matched individuals without a history suggest that short-term breast cancer survivors are more likely to meet the 5-A-Day, smoking, and flu immunization

Table 1 Description of cancer survivors and noncancer controls: Behavioral Risk Factor Surveillance System, 2009

	BC		BC controls		*P*	CC (female)		CC controls		*P*	CC (male)		CC controls		*P*	PC		PC controls		*P*
	n	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]	
Total	6,259	25.0	18,784	75.0		1,082	25.0	3,260	75.0		816	25.0	2,107	75.0		3,609	25.0	10,839	75.0	
Time since diagnosis					–					–					–					–
1–5 Years	1,779	28.4	–	–		329	33.4	–	–		298	40.1	–	–		1,408	41.3	–	–	
>5 Years	4,480	71.6	–	–		753	66.6	–	–		518	59.9	–	–		2,201	58.7	–	–	
Age					0.289					0.961					0.962					0.126
18–49	378	10.1	1,142	12.1		38	6.8	117	8.1		34	8.8	106	10.6		18	1.1	53	2.6	
50–54	472	10.8	1,410	10.0		54	8.2	167	8.7		37	6.5	109	6.8		63	3.4	185	2.6	
55–59	696	12.4	2,081	11.7		90	8.0	267	8.7		74	10.4	224	9.3		171	5.8	514	6.3	
60–64	887	12.9	2,689	13.9		112	10.8	338	10.4		115	15.0	347	14.7		410	13.2	1,236	13.3	
65–69	977	13.6	2,923	13.3		125	10.4	385	9.3		140	15.8	423	16.4		595	13.3	1,812	15.0	
70–74	925	11.9	2,774	12.2		186	17.0	560	15.0		125	13.7	376	12.7		729	17.8	2,163	18.4	
>75	1,924	28.3	5,765	26.9		477	38.8	1,426	39.6		291	29.8	874	29.5		1,623	45.3	4,876	41.8	
Gender					1.000					1.000					1.000					1.000
Female	6,259	100.0	18,784	100.0		1,082	100.0	3,260	100.0		0	0.0	0	0.0		0.0	0.0	0.0	0.0	
Male	0	0.0	0	0.0		0	0.0	0	0.0		816	100.0	2,107	100.0		3,609	100.0	10,839	100.0	
Race/ethnicity					0.287					0.287					0.526					0.679
White	5,435	80.6	16,329	81.6		943	82.9	2,844	80.1		697	80.7	2,107	80.1		3,034	78.5	9,152	78.1	
AA	405	10.1	1,216	8.0		78	10.7	229	8.9		52	10.1	151	8.2		352	12.4	1,026	13.2	
Latino	162	5.1	475	5.4		26	2.1	79	5.3		33	6.3	96	7.6		93	5.5	275	4.6	
Other	257	4.3	764	5.0		35	4.2	108	5.7		34	2.9	105	4.0		130	3.6	386	4.2	
Marital status					0.124					0.306					0.419					0.161
Married	2,965	59.7	9,023	59.0		433	56.8	1,299	52.3		522	75.4	1,611	75.3		2,486	77.2	7,232	76.3	
Widowed	1,929	22.2	6,002	22.6		434	26.6	1,320	30.6		140	11.0	372	8.9		555	10.6	1,854	11.4	
Sep/Divorced	1,009	13.2	2,756	12.2		172	13.3	495	13.2		106	9.4	329	10.8		401	9.1	1,219	8.0	
Never married	356	4.9	1,003	6.2		43	3.4	146	4.0		48	4.2	147	5.0		167	3.2	534	4.3	
Education					<0.001***				0.307					0.107					0.562	
<HS	435	6.4	1,727	8.9		139	15.4	407	13.9		98	11.7	284	11.4		376	9.7	1,224	10.5	
HS grad	1,960	29.6	6,399	31.8		407	36.9	1,225	33.6		262	30.5	742	28.8		971	25.5	3,129	26.7	
Some Col/TS	1,793	27.6	5,188	27.2		314	26.0	821	25.6		189	25.4	554	20.8		791	22.8	2,367	22.5	
Col/TS Grad	2,071	36.4	5,470	32.0		222	21.7	807	26.9		267	32.4	879	39.1		1,471	42.2	4,119	40.2	
Employment status					0.069					0.301					0.911					0.049*
Employed	1,908	33.4	5,963	35.8		209	24.0	735	27.1		248	36.4	735	36.7		794	23.9	2,652	27.1	
Unemployed	4,351	66.6	12,821	64.2		873	76.0	2,525	72.9		568	63.6	1,724	63.3		2,815	76.1	8,187	72.9	
Family income					0.179					0.440					0.436					
<$25,000	1,829	24.5	5,519	24.6		434	31.9	1,301	34.5		238	25.8	732	28.2		784	19.4	2,356	19.3	
$25,000–$35,000	834	10.9	2,493	12.1		144	12.3	444	13.2		114	13.5	341	11.8		499	12.0	1483	11.6	
$35,000–$50,000	919	14.7	2,742	14.5		131	12.3	395	12.3		124	14.8	367	12.8		637	17.5	1,924	17.2	

Table 1 (continued)

	BC		BC controls		*P*	CC (female)		CC controls		*P*	CC (male)		CC controls		*P*	PC		PC controls		*P*
	n	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]	
$50,000–$75,000	746	12.1	2,238	13.2		95	12.9	287	10.8		112	16.9	336	14.3		573	15.7	1,690	15.6	
>$75,000	1,066	22.9	3,202	22.9		112	13.1	342	15.5		158	22.2	475	25.5		774	25.1	2,303	25.9	
Missing/DK	865	14.8	2,590	12.6		166	17.5	491	13.7		70	6.9	208	7.3		342	10.2	1,083	10.3	
Insurance status					0.772					0.893					0.742					0.832
Insured	6,029	95.8	18,105	96.0		1,048	96.0	3,153	95.9		781	96.0	2,362	95.5		3,532	97.9	10,630	98.0	
Uninsured	230	4.2	679	4.0		34	4.0	107	4.1		35	4.0	97	4.5		77	2.1	209	2.0	
Usual source of care					<0 .001***				0.697					<0 .001***			<0 .001***			
Yes	6,029	96.3	17,646	93.2		1,051	94.9	3,101	94.1		769	94.6	2,227	89.2		3,473	96.5	10,039	93.2	
No	225	3.7	1,118	6.8		31	5.1	153	5.9		47	5.4	229	10.8		130	3.5	787	6.8	
Region of the US					0.373					0.964					0.907					0.143
Northeast	1,215	22.1	3,644	20.4		191	20.6	581	19.8		152	16.5	453	17.8		610	19.6	1,851	17.7	
Midwest	1,582	24.2	4,743	24.0		311	25.3	931	24.5		212	24.3	627	23.7		888	23.3	2,655	22.5	
South	1,935	33.9	5,799	34.3		363	37.1	1,107	37.7		266	40.3	812	38.8		1,146	36.3	3,491	39.9	
West	1,527	19.8	4,598	21.3		217	17.0	641	18.0		186	18.9	567	19.6		965	20.8	2,842	19.9	
Metro status					0.071					0.231					0.919					0.246
Metro	4,176	82.1	12,273	80.5		677	77.8	2,059	80.5		512	79.1	1,562	79.4		2,352	81.0	7,071	79.7	
Non-metro	2,060	17.9	6,419	19.5		402	22.2	1,183	19.5		299	20.9	888	20.6		1,242	19.0	3,718	20.3	

BC breast cancer, *CC* colorectal cancer, *PC* prostate cancer, *AA* African-American, *Sep* separated, *HS* high school, *Grad* graduate, *Col* college, *TS* technical school, *DK* don't know, *Perc* perceived, *Excel* excellent

[a] Weighted percentages

*$P<.05$; **$P<.01$; ***$P<.001$

Table 2 Health condition s and health behaviors of cancer survivors and noncancer controls: Behavioral Risk Factor Surveillance System, 2009

	BC		BC controls		*P*	CC (female)		CC controls		*P*	CC (male)		CC controls		*P*	PC		PC controls		*P*
	n	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]	
Total	6,259	25	18,784	75		1,082	25	3,260	75		816	25	2,459	75		3,636	25	10,908	75	
Arthritis					0 .001***					0.102					0.071					<0 .001***
Yes	3,525	53.0	9,811	48.3		652	60.4	1,837	55.0		350	46.4	1,055	41.1		1,805	47.8	4,686	41.7	
No	2,721	47.0	8,920	51.7		426	39.6	1,410	45.0		464	53.6	1,397	58.9		1,797	52.2	6,093	58.3	
Asthma					0.607					0.979					0.003					0.675
Yes	815	13.4	2,424	13.9		145	12.5	378	12.5		92	13.3	213	8.0		361	9.5	907	9.0	
No	5,425	86.6	16,314	86.1		932	87.5	2,874	87.5		722	86.7	2,241	92.0		3,241	90.5	9,894	91.0	
Heart Disease					0.189					0.707					0.536					0.084
Yes	648	8.8	1,988	9.7		151	12.2	410	11.6		175	19.0	574	20.3		775	20.1	2,509	22.5	
No	5,545	91.2	16,608	90.3		922	87.8	2,806	88.4		634	81.0	1,855	79.7		2,785	79.9	8,207	77.5	
Diabetes					0.036*					0.419					0.211					0.758
Yes	1,139	18.1	3,088	16.0		244	18.9	632	20.6		214	25.0	578	21.9		813	23.7	2,507	23.2	
No	5,116	81.9	15,687	84.0		838	81.1	2,627	79.4		600	75.0	1,877	78.1		2,793	76.3	8,321	76.8	
Hypertension					0.796					0.295					0.094					0.008**
Yes	3,214	46.6	9,579	46.9		626	57.0	1,848	53.5		453	53.4	1,309	48.5		2,181	58.3	6,034	53.9	
No	3,038	53.4	9,168	53.1		454	43.0	1,400	46.5		362	46.6	1,141	51.5		1,425	41.7	4,781	46.1	
High Cholesterol					0.002**					0.437					0.933					<0 .001***
Yes	3,203	48.8	9,184	46.3		547	47.4	1,665	48.5		387	49.3	1,217	49.1		1,974	53.9	5,307	48.5	
No	2,874	47.8	8,728	48.0		498	49.1	1,455	46.4		392	46.4	1,138	46.5		1,545	43.6	5,076	46.9	
No test	182	3.4	872	5.7		37	3.5	140	5.1		37	4.3	104	4.4		90	2.5	456	4.6	
Stroke					0.517					0.472					0.716					0.894
Yes	319	4.7	1,023	5.1		90	8.2	206	6.7		56	6.4	188	6.9		264	6.9	809	6.8	
No	5,923	95.3	17,712	94.9		989	91.8	3,046	93.3		757	93.6	2,266	93.1		3,333	93.1	10,809	93.2	
Activity limitations					<0 .001***					0.003**					<0 .001***					0.003**
Yes	1,986	30.4	5,270	25.4		381	37.2	980	28.3		291	39.4	713	23.9		1,103	29.3	2,939	24.9	
No	4,251	69.6	13,441	74.6		695	62.8	2,263	71.7		521	60.6	1,736	76.1		2,492	70.7	7,860	75.1	
Perc. general health					<0 .001***					<0 .001***					<0 .001***					<0 .001***
Excel/very good	2,463	40.8	9,138	51.9		339	31.6	1,393	44.1		257	31.0	1,079	47.5		1,306	37.2	4,722	45.4	
Good	2,251	36.2	5,788	29.3		369	32.4	1,036	31.2		290	39.8	761	30.7		1,322	38.6	3,666	34.0	
Fair/poor	1,507	23.0	3,742	18.8		368	36.0	803	24.6		262	29.2	606	21.9		958	24.2	2,379	20.6	
Flu immunization<1 Year					< 0.001***					0.755					0.431					0.002**
Yes	4,197	63.8	11,511	57.5		744	62.2	2,104	61.2		520	60.3	1,537	57.9		2,632	71.0	7,323	65.8	
No	2,062	36.2	7,273	42.5		338	37.8	1,156	38.8		296	39.7	922	42.1		977	29.0	3,516	34.2	
Physical check-up					<0 .001***					0.252					0.979					<0 .001***
<2 years ago	5,835	93.7	17,023	91.4		1,007	94.0	2,994	91.9		743	91.2	2,218	91.3		3,408	95.5	9,939	92.9	

Table 2 (continued)

	BC		BC controls		*P*	CC (female)		CC controls		*P*	CC (male)		CC controls		*P*	PC		PC controls		*P*
	n	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]		*n*	%[a]	*n*	%[a]	
>2 years ago/never	424	6.3	1,761	8.6		75	6.0	266	8.1		73	8.8	241	8.7		201	4.5	900	7.1	
Cholesterol check					<0 .001***					0.343					0.338					<0 .001***
<2 years ago	5,650	91.0	16,482	87.5		975	91.6	2,879	89.6		722	90.3	2,193	88.3		3,366	94.6	9,773	91.0	
>2 years ago/never	549	9.0	2,136	12.5		92	8.4	343	10.4		89	9.7	246	11.7		216	5.4	988	9.0	
Body mass index					0.989					0.408					0.289					0.961
Normal	2,395	39.9	7,376	39.9		408	36.4	1,269	38.9		211	25.0	666	27.8		983	28.0	3,113	28.1	
Overweight/obese	3,864	60.1	11,408	60.1		674	63.6	1,991	61.1		605	75.0	1,793	72.2		2,626	72.0	7,726	71.9	
Physical activity					0.324					0.002**					0.014*					0.769
Recommended	2,591	41.2	7,839	42.6		377	30.3	1,237	38.4		318	39.8	1,144	47.1		1,687	46.6	4,992	47.1	
Not recommended	3,668	58.8	10,945	57.4	0.035*	705	69.7	2,023	61.6	0.092	498	60.2	1,315	52.9	0.603	1,922	53.4	5,847	52.9	0.652
5-A-Day																				
>5 Servings/day	2,026	34.4	5,824	31.6		308	28.3	1,040	33.2		153	20.0	495	21.3		802	21.5	2,283	22.2	
<5 Servings/day	4,233	65.6	12,960	68.4		774	71.7	2,220	66.8		663	80.0	1,964	78.7		2,807	78.5	8,556	77.8	
Smoking status					0.052					0.765					0.087					0.025*
Current smoker	610	10.3	2,164	12.0		123	11.5	325	10.9		85	10.6	314	14.1		290	7.8	1,067	9.9	
Does Not Smoke	5,649	89.7	16,620	88.0		959	88.5	2,935	89.1		731	89.4	2,145	85.9		3,319	92.2	9,772	90.1	
Alcohol					0.448					0.94					0.173					0.429
Drinker any alcohol	2,535	42.7	7,387	41.6		334	36.0	1,074	35.7		410	49.9	1,243	53.9		1,834	54.6	5,485	53.2	
Does not drink	3,724	57.3	11,397	58.4		748	64.0	2,186	64.3		406	50.1	1,216	46.1		1,775	45.4	5,354	46.8	

BC breast cancer, *CC* colorectal cancer, *PC* prostate cancer, *Perc* perceived, *Excel* excellent

[a] Weighted percentages

*$P<.05$; **$P<.01$; ***$P<.001$

Table 3 Logistic regression of the health behaviors of cancer survivors to non-cancer controls: Behavioral Risk Factor Surveillance System, 2009

Health behavior	Time since diagnosis	Breast cancer		Colorectal cancer (female)		Colorectal cancer (male)		Prostate cancer	
		AOR	95 % CI	AOR	95 % CI	AOR	95 % CI	AOR	95 % CI
Last flu immunization									
>1 year	1–5 years	1	–	1	–	1	–	1	–
<1 year		1.49	(1.19, 1.86)***	0.78	(0.52, 1.19)	1.3	(0.84, 2.04)	1.1	(0.87, 1.39)
>1 year	>5 years	1	–	1	–	1	–	1	–
<1 year		1.16	(1.01, 1.33)*	0.98	(0.73, 1.32)	0.78	(0.56, 1.09)	1.15	(0.95, 1.40)
Last physical check-up									
>2 years	1–5 years	1	–	1	–	1	–	1	–
<2 years		1.18	(0.75, 1.84)	1.9	(0.90, 4.03)	0.97	(0.47, 2.00)	1.29	(0.81, 2.06)
>2 years	>5 years	1	–	1	–	1	–	1	–
<2 years		1.14	(0.90, 1.44)	0.93	(0.53, 1.65)	0.42	(0.24 ,0.74)	1.05	(0.75, 1.47)
Last cholesterol check									
>2 years	1–5 years	1	–	1	–	1	–	1	–
<2 years		1.35	(0.89, 2.03)	2.17	(0.74, 6.34)	0.8	(0.35, 1.79)	1.47	(0.92, 2.34)
>2 years	>5 years	1	–	1	–	1	–	1	–
<2 years		0.98	(0.76, 1.25)	0.68	(0.40, 1.18)	0.51	(0.28, 0.94)*	0.90	(0.64, 1.27)
Body mass index									
Overweight/obese	1–5 years	1	–	1	–	1	–	1	–
Normal weight		0.91	(0.73, 1.13)	1.55	(0.98, 2.46)	0.68	(0.42, 1.11)	1.08	(0.85, 1.38)
Overweight/obese	>5 years	1	–	1	–	1	–	1	–
Normal weight		1.16	(1.01, 1.33)*	0.91	(0.67, 1.23)	1.19	(0.86, 1.64)	1.02	(0.85, 1.22)
Physical activity									
Not recommended	1–5 years	1	–	1	–	1	–	1	–
Recommended		1	(0.81, 1.24)	1.05	(0.66, 1.67)	0.84	(0.54, 1.29)	1.05	(0.84, 1.19)
Not recommended	>5 years	1	–	1	–	1	–	1	–
Recommended		1.07	(0.94, 1.22)	0.72	(0.54, 0.97)*	0.8	(0.59, 1.10)	0.99	(0.85, 1.19)
5-A-Day									
<5 Servings/day	1–5 years	1	–	1	–	1	–	1	–
>5 Servings/day		1.37	(1.11, 1.70)**	0.9	(0.57, 1.40)	0.83	(0.48, 1.43)	1.15	(0.89, 1.48)
<5 Servings/day	>5 years	1	–	1	–	1	–	1	–
>5 Servings/day		1.06	(0.93, 1.22)	0.8	(0.59, 1.08)	0.92	(0.67, 1.28)	0.86	(0.71, 1.04)
Smoking status									
Current smoker	1–5 years	1	–	1	–	1	–	1	–
Does not smoke		1.59	(1.16, 2.20)**	1.37	(0.71, 2.64)	1.45	(0.84, 2.51)	1.09	(0.75, 1.57)
Current smoker	>5 years	1	–	1	–	1	–	1	–
Does not smoke		1.08	(0.86, 1.37)	0.97	(0.61, 1.53)	1.24	(0.68, 2.24)	1.22	(0.89, 1.67)
Alcohol consumption									
Does not drink	1–5 years	1	–	1	–	1	–	1	–
Drink any		1.1	(0.89, 1.37)	1.05	(0.64, 1.73)	0.92	(0.60 ,1.41)	1.17	(0.93, 1.47)
Does not drink	>5 years	1	–	1	–	1	–	1	–
Drink Any		1.1	(0.96, 1.26)	1.17	(0.83, 1.64)	0.88	(0.64, 1.22)	0.97	(0.81, 1.15)

All regressions controlled for the following covariates: race/ethnicity, age, marital status, metro status, region of US, education, employment status, income, health insurance, unusual source of care, activity limitations, perceived general health, arthritis, asthma, cardiovascular disease-metabolic syndrome, and stroke

AOR adjusted odds ratios, *CI* confidence intervals

*$P<.05$; **$P<.01$; ***$P<.001$

Table 4 Logistic regression comparison of health behaviors of cancer survivors by cancer type and gender: Behavioral Risk Factor Surveillance System, 2009

Health behavior	Breast cancer		Prostate cancer		Colorectal cancer (female)		Breast cancer	
	vs. colorectal (female)		vs. colorectal (male)		vs. colorectal (male)		vs. prostate	
	AOR	95 % CI	AOR	95 % CI	AOR	95 % CI	AOR	95 % CI
Last flu immunization								
>1 year	1	–	1	–	1	–	1	–
<1 year	1.22	(0.93, 1.60)	1.21	(0.91, 1.61)	1.06	(0.76, 1.50)	1.03	(0.86, 1.23)
Last physical check-up								
>2 years/never	1	–	1	–	1	–	1	–
<2 years	0.94	(0.55, 1.60)	1.68	(0.97, 2.91)	1.7	(0.89, 3.26)	0.85	(0.61, 1.19)
Last cholesterol check								
>2 years/never	1	–	1	–	1	–	1	–
<2 years	1	(0.59, 1.70)	1.32	(0.77, 2.25)	1.39	(0.73, 2.63)	0.88	(0.63, 1.24)
Body mass index								
Overweight/obese	1	–	1	–	1	–	1	–
Normal weight	1.04	(0.81, 1.35)	1.01	(0.76, 1.35)	1.88	(1.34, 2.65)***	1.89	(1.60, 2.24)***
Physical activity								
Not recommended	1	–	1	–	1	–	1	–
Recommended	1.26	(0.98, 1.62)	1.35	(1.01, 1.80)*	0.68	(0.49, 0.95)*	0.73	(0.62, 0.86)***
5-A-Day								
<5 servings/day	1	–	1	–	1	–	1	–
>5 servings/day	1.2	(0.93, 1.54)	1	(0.72, 1.39)	1.73	(1.21, 2.49)**	2.27	(1.90, 2.71)***
Smoking status								
Current smoker	1	–	1	–	1	–	1	–
Does not smoke	1.13	(0.77, 1.65)	1.01	(0.64, 1.58)	1.02	(0.62, 1.68)	1.25	(0.95, 1.65)
Alcohol consumption								
Does not drink	1	–	1	–	1	–	1	–
Drink any	0.94	(0.69, 1.27)	1.13	(0.86, 1.49)	0.65	(0.45, 0.93)*	0.54	(0.46, 0.64)***

All regressions controlled for the following covariates: race/ethnicity, age, marital status, metro status, region of US, education, employment status, income, health insurance, unusual source of care, activity limitations, perceived general health, arthritis, asthma, cardiovascular disease-metabolic syndrome, and stroke

Abbreviations: AOR, Adjusted Odds Ratios; CI, Confidence Intervals

*$P<.05$; **$P<.01$; ***$P<.001$

recommendation. Yet, the likelihood of these recommended health behaviors decrease between short- and long-term breast cancer survivors. Moreover, long-term colorectal cancer survivors are actually less likely to meet the physical activity recommendation or receive recommended routine preventive care, than controls. Previous research has identified associations between unhealthy behaviors and underuse of preventive services and a discontinuity of care between oncology specialist and primary care providers, as well as increasing age, and a decreasing sense of urgency to engage in healthy behaviors as the time since diagnosis increases [25, 26]. Regardless of the reason, it appears that cancer survivors become less likely to engage in recommended health behaviors as time from diagnosis increases.

Few differences were observed between cancer types, with the exception that prostate cancer survivors are 35 % more likely to meet the physical activity recommendation, compared to male colorectal cancer survivors. This finding is likely due to the physical and activity limitations often reported by colorectal cancer survivors, particularly those living with a permanent ostomy [27, 28]. However, a notable pattern of differences emerged between genders. Breast and female colorectal cancer survivors are as much as 2.27 times more likely to meet the 5-A-Day recommendation, almost 90 % more likely to be of normal weight, while less likely to drink alcohol, compared to prostate and male colorectal cancer survivors. Yet, females are about 30 % less likely to meet the physical activity recommendation, compared to the male

cancer survivors. Mosher et al.'s (2009) study of lifestyle factors among older, long-term cancer survivors also found that more breast and female colorectal cancer survivors maintained a healthier diet, but engaged in lower rates of recommended physical activity, than prostate and male colorectal cancer survivors [29]. This pattern of differences in health behaviors between genders has not been limited to cancer survivors. Compared to females, higher rates of physical activity, but a greater consumption of alcohol, diets high in meat, fat, and salt, and lower in fruit and vegetables, have been observed among adult males in the general population and among individuals with chronic diseases throughout multiple countries [18–20, 30, 31]. This phenomenon may be explained by masculinity/femininity theory. This theory posits that men's health practices are shaped by their desire to adhere to dominant masculine ideals shaped by life-long cultural norms, such as engaging in physical demanding activities, consuming red meat, and heavy alcohol use, whereas women are more likely to manage their weight through diet modification [19, 31–33].

However, adherence to gender norms may not be the only explanation for observed differences in health behaviors between genders. Various behavioral models such as the Health Belief Model are to describe the relationship between an individual's risk perceptions and the corresponding health behavior [34]. Cardiovascular disease is the leading cause of death for both men and women, but has historically been viewed as "man's disease" [35]. Despite efforts to raise public awareness, still only 54 % of women recognize cardiovascular disease to be their leading cause of death, while many still believe that breast cancer is their potentially biggest health problem [36]. A lack of perceived susceptibility for developing cardiovascular disease may contribute to less recommended physical activity among women, compared to men. In addition to risk perceptions, a study of health-related quality of life among breast, prostate, and colorectal cancer survivors found that female cancer survivors were more likely to report unfavorable perceptions of their mental health, sleep quality, and amount of emotional support received, compared to male cancer survivors. Yet, few differences were found between genders with regards to general and physical health perceptions [37].

Interventions for health behavioral change, including diet and physical activity, have produced positive health benefits among cancer survivors [38, 39]. However, the uptake of these behaviors by cancer survivors has not been better than individuals without a history of cancer [5, 12]. Furthermore, one third of cancer survivors with cardiovascular risk factors may not be engaging in discussion or receiving counseling for health behavior change [4]. The National Cancer Survivorship Resource Center was recently created in a collaborative effort by the American Cancer Society and George Washington University Cancer Institute, and is currently developing clinical follow-up care guidelines for primary care providers that include guidance on the prevention and management of chronic diseases, with an emphasis on promoting healthy behaviors [40]. Given the need for these services among cancer survivors, this may be an area for primary care providers to take the lead role in survivorship care. Furthermore, given the current study findings, efforts to promote healthy behaviors, disease prevention, and management among cancer survivors could benefit by addressing misconceptions regarding risk of cardiovascular disease and unhealthy behaviors that may be influenced by long held notions of gender norms. Previous health behavioral interventions that addressed perceptions regarding gender roles and/or ideals among noncancer populations have demonstrated positive results [41]. Existing survivorship care models could be improved by addressing gender differences in health perceptions and behaviors. Together, these efforts could help to reduce illness burden, and improve the health and well-being of cancer survivors.

This study was limited in its ability to control for stage at diagnosis and type of treatment received among cancer survivors, factors known to affect health and health-related quality of life, and potentially health behaviors. However, these factors were not assessed for in the 2009 BRFSS. Instead, cancer survivors sampled were limited to those >1 year past diagnosis to avoid including survivors who may be undergoing intensive treatment and therefore have competing demands with engaging in certain healthy behaviors. Another limitation is that this study was unable to compare routine preventive cancer screenings since these services were also not assessed for core component of the 2009 BRFSS. Additionally, responder bias is an inherent limitation of self-reported data. Strengths of this study include the utilization of data from a recent, large national survey, with cancer survivors representing a diverse range in age and time since diagnosis. Furthermore, this study rigorously matched each cancer type to their own control group to minimize the confounding effects of individual characteristics, while adding to the extant literature by providing comprehensive comparisons of health behaviors between cancer survivors and noncancer controls, stratified by time since diagnosis, and between cancer types and genders.

In conclusion, only a minority of cancer survivors met the ACS guidelines for recommended physical activity and 5-A-Day, but most received recommended general preventive care and did not smoke. Breast cancer survivors may be more likely to meet guidelines recommended health behaviors, than similar individuals without a history of cancer, yet the likelihood of these behaviors decrease in the long term. Few distinctions in health behaviors are observed between cancer types, but the pattern of differences in health behaviors between genders suggest that male and female cancer survivors' health behaviors may be influenced by behavioral and health

perceptions associated with gender. Health behaviors, chronic disease prevention, and management among cancer survivors could be improved by the National Cancer Survivorship Resource Center's development of survivorship care guidelines for primary care providers and by addressing gender differences in health perceptions and behaviors.

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