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A population-based study comparing HRQoL among breast, prostate, and colorectal cancer survivors to propensity score matched controls, by cancer type, and gender

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Abstract

Background—Objectives were to compare health-related quality of life (HRQoL) between breast cancer survivors, prostate cancer survivors (PCS), and colorectal cancer survivors (CCS) to matched controls, stratified by short and long-term survivors, by cancer type, and gender.

Methods—By using the 2009 Behavioral Risk Factor Surveillance System, propensity scores matched three controls to adult survivors >1 year past diagnosis ($N = 11,964$) on age, gender, race/ethnicity, income, insurance status, and region of the USA Chi-square tests and logistic regression models compared HRQoL outcomes (life satisfaction, activity limitations, sleep quality, emotional support, general, physical, and mental health).

Results—Although all cancer survivors reported worse general health ($p < 0.000$) and more activity limitations ($p < 0.004$) than controls, these disparities decreased among long-term survivors. Short-term PCS and male CCS were more likely to report worse outcomes across additional domains of HRQoL than controls, but PCS were 0.61, 0.63, and 0.70 times less likely to report activity limitations, fair/poor general health, and 1–15 bad physical health days in the past month than male CCS. Breast cancer survivors and female CCS were 2.12 and 3.17, 1.58 and 1.86, and 1.49 and 1.53, respectively, times more likely to report rarely/never receiving needed emotional support, 1–15 bad mental health days in the past month, and not receiving enough sleep 1–15 days in the past month than PCS and male CCS.

Conclusions—Cancer survivors experience worse HRQoL than similar individuals without a history of cancer and the severity of affected HRQoL domains differ by time since diagnosis, cancer type, and gender.

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Conflicts of interest

The authors have indicated no potential conflicts of interest.

Introduction

HRQoL of cancer survivors

Over two-thirds of the 12.5 million cancer survivors in the USA are now living 5 years post diagnosis, with survivors of breast (22%), prostate (20%), and colorectal cancer (9%) comprising over 50% of the survivor population [1,2]. Yet, many cancer survivors experience late and/or long lasting symptoms and effects attributable to the cancer, and its treatment that are detrimental to their physical, mental, psychosocial, and functional health statuses, and consequently, health-related quality of life (HRQoL). Numerous study findings have consistently documented the unique and shared symptoms and effects experienced by breast, prostate, and colorectal cancer survivors. Breast cancer survivors often experience physical limitations, pain, and swelling in the arm and/or shoulder near the surgery site, hormonal and fertility changes, chronic fatigue and sleep disturbances, anxiety and depression, sexual dysfunction, and dissatisfaction with body image. Similarly, prostate and colorectal cancer survivors often experience pain at the surgery site, chronic fatigue and sleep disturbances, anxiety and depression, sexual dysfunction. Additional symptoms include urinary and bowel dysfunction, dissatisfaction with body image due to changes in physical appearance associated with androgen deprivation therapy for prostate cancer or the presence of an ostomy among some colorectal cancer survivors, a factor also associated with additional social limitations [3–7]. Although the various domains of HRQoL affected are similar among breast, prostate, and colorectal cancer survivors, these symptoms and effects vary according to type of surgery and treatment, stage at diagnosis, time since diagnosis, age, race, income, education, available social and emotional support, and health status [3,4].

Differences in HRQoL between individuals with and without a history of cancer

Population-based studies describing differences in HRQoL between cancer survivors and individuals without a history of cancer have reported less consistent findings. Studies from the USA and Australia found that breast cancer survivors reported more activity/role limitations and worse general/global health compared with individuals without a history of cancer [8–10]. However, disagreement between studies exists regarding disparities in physical and mental health [9–11]. Although two population-based studies found that prostate cancer survivors reported more activity/role limitations and worse general, physical, and mental health compared with individuals without a history of cancer [10,12], conflicting findings between these domains of HRQoL have been reported by other studies [9,11]. Likewise, several studies have reported consistent findings regarding activity/role limitations and worse general and physical health, but no differences in mental health of colorectal cancer survivors, compared with individuals without a history of cancer [8,9,11]. Yet, a longitudinal study observed disparities in mental health, but not physical health among colorectal cancer survivors, compared with individuals without a history of cancer [13].

Differences in HRQoL between cancer types and genders

Despite the fact that breast, prostate, and colorectal cancer survivors experience similarly affecting domains of HRQoL, little is known about the variation in severity of these detriments between survivors. Two studies that compared HRQoL between cancer types reported more activity limitations and worse general health among colorectal cancer

survivors, compared with breast and prostate cancer survivors; however, breast cancer survivors reported worse mental than prostate and colorectal cancer survivors [8,9].

Considerable research on HRQoL among individuals with various chronic diseases and serious health conditions have observed notable differences between genders [14–17]. However, studies of gender differences in HRQoL among cancer survivors have primarily been limited to survivors of colorectal and head and neck cancers. Findings from two studies of long-term colorectal cancer survivors found that women reported worse physical and mental health, and more sleep disturbances and fatigue than men [6,18]. Although cancer type cannot be controlled for when comparing breast and prostate cancer survivors, both cancers are gender and hormone-specific, predominantly occurring in individuals aged 65 years, and have relatively high 5-year survival rates (89% and 99.2%, respectively) compared with other cancers [1]. Therefore, if a pattern of differences in HRQoL between breast and prostate cancer survivors was similar to those observed between female and male colorectal cancer survivors, it would suggest that the differences are a function of gender.

Statement of the problem and study aims

The differences in findings reported by studies comparing HRQoL between cancer survivors and individuals without a history of cancer may be attributable to differences in sample size, sample selection (age, short-term or long-term survivors only, and country of origin), and study design (matched case–control comparison or no matching). Studies that utilized a comparison group matched on few variables and therefore may have not completely eliminated the observed differences in characteristics between cancer survivors and non-cancer controls. Moreover, work by Harrop *et al.* has highlighted that vast majority of published research regarding the HRQoL of cancer survivors has focused on breast cancer survivors [19]. Consequently, the association between a history of cancer, cancer type, gender, and HRQoL among breast, prostate, and colorectal cancer survivors remains unclear.

Therefore, the primary goal of this study was to determine the unique health care needs of cancer survivors by comparing a range of HRQoL outcomes among short and long-term breast, prostate, and colorectal cancer survivors to groups of non-cancer controls matched to each cancer type on many important variables, between cancer types, and genders using a large and nationally representative US sample. Specific study aims were as follows: (i) to compare the prevalence of HRQoL outcomes, specifically life satisfaction, perceived level of emotional support, activity limitations, perceived general health, perceived physical health, perceived mental health, and sleep quality between breast, prostate, female colorectal, and male colorectal cancer survivors to their non-cancer controls matched on age, gender, race/ethnicity, income, insurance status, and region of the USA using propensity scores; (ii) to compare the odds of specific HRQoL outcomes for each cancer type to their non-cancer controls by fitting adjusted logistic regression models stratified by time since diagnosis (1–5 and >5 years) to determine changes in HRQoL over the course of the cancer survivorship continuum; and (iii) to compare the odds of specific HRQoL outcomes between cancer types (breast cancer vs. female colorectal and prostate vs. male colorectal) and gender (female vs. male colorectal and breast vs. prostate) to determine differences in HRQoL associated with cancer type and gender.

Methods

Study design

This study used a retrospective, cross-sectional matched case–control design. Breast, colorectal, and prostate cancer survivors were matched on various categories of age, gender, race/ethnicity, income, insurance status, and region of the USA.

Data

Cancer survivors and controls were derived from the Centers for Disease Control’s national 2009 Behavioral Risk Factor Surveillance System (BRFSS) survey [20]. The BRFSS is an annual, state-based telephone survey administered to non-institutionalized citizens aged 18 years and older in all 50 states, the District of Columbia, Puerto Rico, the US Virgin Islands, and Guam. The survey collects information pertaining to disease prevalence, risky health behaviors, preventive health care utilization, perceived health status, access to health care services, sociodemographic, and environmental characteristics. The core component is a standard set of questions administered to all states and territories. In 2009, the response rate was 52.5%, resulting in a total sample size of 432,607 [21,22]. Optional modules collect additional information on selected topics and are administered on a state by state basis. This study only utilized data from the core component file, excluding responses from Puerto Rico, the US Virgin Islands, and Guam.

Study sample

Cancer survivors—Breast, prostate, and colorectal cancer survivors were identified by the following questions in the Cancer Survivors section of the core module: “Have you ever been told by a doctor, nurse, or other health professional that you had cancer?” and “What type of cancer was it?” The question, “At what age were you told that you had cancer?” allowed for the calculation of time since diagnosis by subtracting the age at diagnosis from the currently reported age. The question “How many different types of cancer have you had?” allowed for the identification of primary cases of breast, prostate, or colorectal cancers. Inclusion criteria were survivors of a primary case of breast, prostate, or colorectal cancer only, (cases of colon and rectal cancer combined), age >18 years at the time of diagnosis, and survivors >1 year post diagnosis to avoid the competing interest of possible ongoing treatment. Male breast cancer survivors and individuals with a missing response for any HRQoL outcome were excluded from the sample. Questions regarding the stage at diagnosis, type of treatment received, or presence of an ostomy among colorectal cancer survivors were not asked in the survey and therefore could not be controlled for in this study. The final sample consisted of 6393 breast, 3636 prostate, 1111 female colorectal, and 824 male colorectal cancer survivors.

Controls—Similar to survivors, non-cancer controls selected were age >18 years and without missing responses for any dependent variables. Logistic regressions generated propensity scores for survivors and potential non-cancer controls conditional upon the probability of the individual having had cancer and belonged to various categories of age, gender, race/ethnicity, income, insurance status, and region of the USA. A 3:1 ratio of controls to survivors was matched without replacement using the greedy algorithm, also

known as nearest neighbor matching. In this algorithm, the first control that is matched to a case is the one with the most similar propensity score to the case. All cases are matched to a first set of controls, followed by a second and third round of matching. After matching, Chi-square tests were performed to determine covariate balance between survivors and non-cancer controls. Balance was achieved between survivors and controls for all covariates adjusted for in the matching process. Additionally, there was no difference in marital and metro statuses between survivors and non-cancer controls. However, breast cancer survivors are more frequently reported being a college/technical school graduate than their non-cancer controls (36.5% vs. 32.1%) ($p < .000$) and prostate cancer survivors more frequently reported being unemployed than their non-cancer controls (76.2% vs. 73.1%) ($p = .049$).

Measures

Dependent variables—Measures of HRQoL consisted of the following: (i) general health (excellent/very good, good, fair/poor); (ii) activity limitations (yes or no) because of physical, mental, or emotional problems; (iii) number of days physical health was not good during the past 30 days (none, 1–15 days, 16–30 days); (iv) number of days mental health was not good during the past 30 days (none, 1–15 days, 16–30 days); (v) number of days did not get enough sleep during the past 30 days (none, 1–15 days, 16–30 days); (vi) how often received social support (always/usually, sometimes, rarely/never); and (vii) life satisfaction (very satisfied/satisfied or dissatisfied/very dissatisfied).

Independent variables—This study was conceptualized using Ronald M. Andersen's Behavioral Model of Health Services Use framework to examine the association between health care environment, predisposing, enabling, need factors, and HRQoL outcomes. Andersen's model is often used to guide studies of health behaviors and health outcomes [23]. Under this theory, an individual's health care use and outcomes, in our case HRQoL, are influenced by his or her predisposing characteristics including age, gender, race/ethnicity (White, African American, Latino, and Other), education, and time since diagnosis (1–5 and >5 years); and enabling resources including marital status, employment status (employed and unemployed, where for this study “employed” = employed for wages or self-employed, and “unemployed” = out of work >1 year, out of work <1 year, homemaker, student, retired, or unable to work), insurance status, income, and usual source of care. The BRFSS assesses whether an individual has a usual source of care by asking, “Do you have one person you think of as your personal doctor or health care provider?” The external health care environment factors included metro status (metro or non-metro) and region of the USA. (Northeast, Midwest, West, and South), as defined by the US Census [24]. Need factors were presence of cancer and specific health conditions that 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 arthritis, asthma, diabetes (diabetes, gestational diabetes, or borderline diabetes), hypertension, high cholesterol (adults who had their blood cholesterol checked and told it was high), heart disease (myocardial infarction, angina or coronary heart disease), and stroke.

Statistical methods

Chi-square tests compared significant differences in HRQoL measures by predisposing, enabling, need, and external health care environment factors between survivors and non-cancer controls, with significance set at $p = .05$. Odds ratios for HRQoL measures were estimated using adjusted binary and multinomial logistic regressions. Binary logistic regression was used to model life satisfaction (very satisfied/satisfied) and activity limitations (yes). Multinomial logistic regression was used to model level of emotional support (rarely/never and sometimes), perceived general health (fair/poor and good), perceived physical health (>15 days and 1–15 days), perceived mental health (>15 days and 1–15 days), and sleep quality (>15 days and 1–15 days). Outcomes modeled are shown in parenthesis.

Regressions comparing survivors to non-cancer controls were stratified by time since diagnosis (1–5 years and >5 years). All models were adjusted for predisposing, enabling, need, and external healthcare environment factors. Adjusted odds ratios (AOR) and corresponding 95% confidence intervals (CI) of cancer compared with non-cancer controls, cancer type, and gender are presented in tables. All analyses were conducted using survey procedures in SAS version 9.2 software (SAS Institute Inc., Cary, NC, USA), to account for the complex sample design of the BRFSS. This study was conducted using de-identified, secondary data and meets West Virginia University Internal Review Board requirements for protocol approval exemption as “not human subjects research”. All investigators have been Human Subjects Research and Health Insurance Portability and Accountability Act certified through the Collaborative Institutional Training Initiative.

Results

Description of cancer survivors

Table 1 provides a description of survivors by their predisposing, enabling, and external health care environment characteristics. The majority of survivors were living >5 years post diagnosis (58.8–71.1%). The mean years since diagnosis for breast, female colorectal, male colorectal, and prostate cancers were 11.9, 11.5, 10.1, and 8.1 years, respectively. Most were 65 years of age and older (54.0–76.4%), white (78.6–83.3%), married (56.4–77.1%), unemployed (63.8–76.6%), and insured (95.7–97.9%).

HRQoL of cancer survivors compared with non-cancer controls

Prevalence comparisons of HRQoL outcomes between survivors and their non-cancer controls are presented in Table 2. All cancer types reported more activity limitations and poorer general health than non-cancer controls; however, male and female colorectal cancer survivors reported the greatest prevalence of activity limitations [(39.4% vs. 23.9%) ($p < .000$) and (37.0% vs. 28.4%) ($p = .003$)] and poorer general health [(28.7% vs. 21.2%) ($p < .000$) and (34.8% vs. 23.3%) ($p < .000$)] compared with their non-cancer controls. Additionally, male colorectal cancer survivors reported more bad physical health days ($p = .004$) and less life satisfaction ($p = .025$) than their non-cancer controls, whereas female colorectal cancer survivors reported more bad mental health days ($p = .039$) than their non-

cancer controls. Prostate cancer survivors reported more days of not enough sleep ($p = .021$) than their non-cancer controls.

Odds of HRQoL outcomes for short and long-term cancer survivors compared with their non-cancer controls are presented in Table 3. Among short-term survivors, male colorectal cancer survivors were 2.62 times more likely (95% CI: 1.72–3.99) to report activity limitations compared with their non-cancer controls, followed by female colorectal (AOR = 2.25, 95% CI: 1.45–3.51) and breast cancer survivors (AOR = 1.41, 95% CI: 1.11–1.80). Male and female colorectal cancer survivors were 3.67 (95% CI: 2.09–6.47) and 3.51 (95% CI: 2.09–5.92) times more likely to perceive their general health as fair/poor versus excellent/very good compared with their non-cancer controls, followed by breast (AOR = 3.26, 95% CI: 2.43–4.37) and prostate cancer survivors (AOR = 1.72, 95% CI: 1.26–2.35). Female colorectal cancer survivors were 1.64 times more likely (95% CI: 1.06–2.54) to report bad physical health 1–15 days versus none in the past month, whereas male colorectal cancer survivors were 2.00 times more likely (95% CI: 1.17–3.42) to report bad mental health 1–15 days versus none in the past month than their non-cancer controls. Prostate cancer survivors were more likely to report bad mental health 1–15 days versus none in the past month (AOR = 1.40, 95% CI: 1.01–1.93), rarely/never versus always/usually receiving emotional support (AOR = 1.5, 95% CI: 1.01–2.16), and not enough sleep >15 days versus none in the past month (AOR = 1.61, 95% CI: 1.13–2.29) than their non-cancer controls.

Among long-term survivors, male colorectal (AOR = 1.70, 95% CI: 1.23–2.36) and breast cancer survivors (AOR = 1.18, 95% CI: 1.04–1.35) were still more likely to report activity limitations than their non-cancer controls. Male and female colorectal cancer survivors were both 1.91 times more likely (95% CI: 1.26–2.90 and 1.30–2.79, respectively) to perceive their general health as fair/poor versus excellent/very good compared with their non-cancer controls. Long-term male colorectal cancer survivors were also 1.77 times more likely (95% CI: 1.23–2.55) to report bad physical health 1–15 days versus none than their non-cancer controls.

HRQoL comparisons by cancer type and gender

Odds of HRQoL outcomes by cancer type and gender are presented in Table 4. Between cancer types, breast cancer survivors were 0.68 times less likely (95% CI: 0.50–0.93) to perceive their general health as fair/poor versus excellent/very good than female colorectal cancer survivors. Prostate cancer survivors were 0.63 times less likely (95% CI: 0.45–0.88) to perceive their general health as fair/poor versus excellent/very good, 0.70 times less likely (95% CI: 0.51–0.95) to report bad physical health 1–15 days versus none in the past month, and 0.61 times less likely (95% CI: 0.45–0.83) to report activity limitations than male colorectal cancer survivors.

Comparing genders within the gender-neutral (colorectal cancer), women were 0.67 times less likely (95% CI: 0.45–0.98) to perceive their general health as good versus excellent/very good and 0.63 times less likely to report activity limitations (95% CI: 0.45–0.87) and were more than twice as likely to be very satisfied/satisfied with their life (AOR = 2.20, 95% CI: 1.11–4.35) than male colorectal cancer survivors. Yet, women were 1.86 times more likely (95% CI: 1.16–2.98) to report bad mental health 1–15 days versus none in the past month,

3.17 times more likely (95% CI: 1.76–5.71) to report rarely/never versus always/usually receiving emotional support, and 1.53 times more likely (95% CI: 1.06–2.21) to report not enough sleep 1–15 days versus none in the past month.

Between the gender-specific cancers (breast and prostate), breast cancer survivors were 1.35 (95% CI: 1.13–1.63), 1.58 (95% CI: 1.28–1.94), 2.12 (95% CI: 1.58–2.84), and 1.49 (95% CI: 1.26–1.77) times more likely to report bad physical and mental health 1–15 days versus none in the past month, rarely/never versus always/usually receiving emotional support, and not enough sleep 1–15 days versus none in the past month, respectively, than prostate cancer survivors.

Discussion

HRQoL comparisons to non-cancer controls

The current study of a large population-based sample of breast, prostate, and colorectal cancer survivors found that all cancer types reported more activity limitations and worse general health compared with individuals without a history of cancer matched on many important characteristics. However, colorectal cancer survivors reported the most activity limitations and worst general and physical health compared with their non-cancer controls and with breast and prostate cancer survivors. Other associations between a history of cancer and HRQoL varied according to time since diagnosis, cancer type, and gender.

Among short-term cancer survivors, prostate and colorectal cancer survivors reported the most domains of HRQoL to be adversely affected compared with their non-cancer controls. This was especially so among prostate and male colorectal cancer survivors. Albeit, male and female colorectal cancer survivors had the highest odds for activity limitations and fair/poor general health compared with controls, a finding most likely associated with the invasive nature of colorectal surgery, treatment effects, and the likelihood of a stoma. However, short-term prostate and male colorectal cancer survivors reported additional disparities in HRQoL life specific to emotional support, mental health, and sleep, the majority of which do not persist into the long-term survivorship period. A recent study demonstrated the association between social/emotional support and improved psychological well-being among short-term prostate cancer survivors, independent of disease and treatment-related factors [25]. However, research has shown that women engage in more coping behaviors and seek more social/emotions support than men do [26,27]. Men may avoid seeking social/emotional support because they view the behavior as conflicting with traditional ideals of gender and masculinity. Moreover, their psychological distress may be compounded by the sexual dysfunction experienced by prostate and male colorectal cancer survivors, another stress to their ideals of masculinity [12,28–30].

Among long-term survivors, male colorectal cancer survivors reported worse outcomes on more measures of HRQoL compared with their non-cancer controls, than the other cancer types, reporting more activity limitations, poorer general health, poorer physical health, and less life satisfaction. A similar trend was also observed among long-term female colorectal cancer survivors. Likewise, a recent 10-year longitudinal study of HRQoL among German colorectal cancer survivors found that survivors reported poorer HRQoL for most measures

compared with controls, with disparities in HRQoL worsening over time [13]. Persistent or worsening disparities in HRQoL between short and long-term colorectal cancer survivors may be due to the unmet continuation of bothersome symptoms and effects such as constipation, diarrhea, pain, fatigue, and dyspnea, and unmet expectations for improvements in treatment-related outcomes over time [13,31–33]. Colorectal cancer patients are often treated with surgical proctectomy resulting in a temporary ostomy. However, these ostomies become permanent for many colorectal cancer survivors, especially survivors of lower rectal cancer, with rates of permanent ostomy as high as 50% [34].

HRQoL comparisons by cancer type and gender

Between cancer types, breast cancer survivors reported better general health than female colorectal cancer survivors, and prostate cancer survivors reported less activity limitations, better general health, and physical health than male colorectal cancer survivors. Similar to the differences in HRQoL observed between colorectal cancer survivors and non-cancer controls, these HRQoL differences between breast and prostate compared with colorectal cancer survivors are most likely due to treatment-related physical symptoms and outcomes specific to colorectal cancer [13,31,34].

Between genders, women reported poorer HRQoL outcomes specific to psychosocial well-being. Female colorectal cancer survivors reported less emotional support, poorer mental health, and less sleep than male colorectal cancer survivors. Likewise, breast cancer survivors also reported less emotional support, poorer physical health, poorer mental health, and less sleep than prostate cancer survivors. Similar findings were found in several studies of gender differences among colorectal cancer survivors with ostomies. Women reported higher rates of depression, anxiety, poor sleep quality, and fatigue than men [6,7,35]. What is more, a recent study comparing symptom prevalence across multiple types of cancers found that breast cancer survivors reported depression, anxiety, and difficulty sleeping at almost twice the rate of prostate cancer survivors [36]. Comparable differences in HRQoL between genders have also been observed among individuals with other chronic diseases, such as coronary heart disease and HIV/AIDS [14,37]. However, this disparity in mental health between genders is not limited to individuals with chronic disease, as women in general the general population demonstrate higher rates of depression, anxiety, and sleep disturbances than men [38].

Despite the fact that women reported worse mental health, men cancer survivors reported more activity limitations and less life satisfaction than women. In similar fashion, men experiencing chronic pain from fibromyalgia also report greater physical-role limitations than women [39]. Among the general population, men consistently report higher rates of leisure-time physical activity than women do. Furthermore, physical activity has been positively associated with life satisfaction in men [40–42]. What is more, many prostate and male colorectal cancer survivors experience sexual dysfunction and may perceive it as a threat to their masculinity [30,43]. Hence, if male cancer survivors in this study felt unable to return to the same level of physically demanding and/or sexual activity they had engaged in prior to their cancer diagnosis, it may explain why they reported more activity limitations and less life satisfactions than women.

This study was conducted using a large sample of data from a recent population-based survey. Cancer survivors represented a diverse range in age and time since diagnosis. The method of propensity score matching used to match cases to controls was chosen to provide rigorous control of confounding bias. This study compared a variety of HRQoL outcomes that encompassed the physical, mental, emotional domains, as well as functional and symptomatic outcomes. These measures were compared with matched non-cancer controls for each cancer type and between cancer types and genders. Moreover, this study was also able to compare short and long-term survivors to non-cancer controls. However, this comparison of short and long-term survivors was not able to be conducted in a longitudinal nature but rather by division of point-in-time measures among a cross-sectional sample. Furthermore, information regarding stage at diagnosis and type of treatment received were not available in the 2009 BRFSS; therefore, their effects could not be controlled for they have shown to be important predictors of HRQoL outcomes among cancer survivors and are worth noting. Individuals diagnosed with more advanced stages of cancer are often limited to more invasive and intense treatment options that are associated with more severe symptoms and side effects. Studies comparing outcomes between breast cancer survivors who underwent breast conserving surgery versus mastectomy have shown that mastectomy is associated with decreased upper body functioning, satisfaction with body image, sexual, role, and emotional well-being [44–46]. Prostate cancer survivors diagnosed at an advanced stage, who underwent radical prostatectomy versus external beam radiation, or received androgen deprivation therapy, experience worse mental health, emotional and social well-being, and sexual and urinary dysfunction, whereas bowel dysfunction is more common among men who underwent external beam radiation therapy [28,47,48]. Similarly, colorectal cancer survivors diagnosed at an advanced stage report worse HRQoL outcomes; however, the severity of bowel and urinary dysfunction, mental health, emotional and social well-being, and sexual dysfunction vary according to type of treatment received and presence or absence of a permanent ostomy [29,49]. Another limitation of the current study is that it was conducted using self-reported data that may contain responder bias. Finally, HRQoL of survivors who have died could not be included in the study. It remains unknown how their HRQoL would have impacted the study findings.

Conclusions

Although the proportion and association of stage and diagnosis among this sample are unknown, this study has demonstrated that a large population-based sample of survivors of breast, colorectal, and prostate cancers experience a diminished HRQoL throughout the survivorship continuum. Yet, it is evident that the HRQoL among breast, prostate, and colorectal cancer survivors is differentially associated with type of cancer, time since diagnosis, and gender. All cancer survivors reported more activity limitations and perceived their general health to be worse than their non-cancer controls, with prostate and male colorectal cancer survivors experiencing worse HRQoL in the short term, and colorectal cancer survivors, especially the men, continuing to experience worse HRQoL in the long term. Among cancer types, colorectal cancer survivors experience a worse HRQoL than breast and prostate cancer survivors, with respect to activity limitations, and general and physical health. Yet, regardless of cancer type, female survivors experience worse

psychosocial outcomes compared with men, whereas men perceived themselves to be more limited, of worse general health, and less satisfied with their lives. Perceptions of gender roles and masculinity associated with coping behaviors may explain differences in HRQoL between genders.

The majority of research concerning health interventions among cancer survivors has focused on modifying lifestyle factors. Although physical activity may be helpful for improving physical functioning and fatigue, it may not be as effective for improving other aspects of HRQoL such as mental health, social/role functioning, sexual functioning, and emotional coping. The National Cancer Institute's *Facing Forward* to education cancer survivors how to manage treatment side effects and their affects on various domains of HRQoL, as well as stress management coping strategies, may be a step in the right direction towards improving HRQoL among cancer survivors [50]. Yet, the effectiveness of such an intervention could be improved by building upon these educational points by addressing the unique needs of different types of cancer survivors and genders, particularly coping mechanisms. Furthermore, health care providers may not be as prepared to handle the HRQoL aspects of survivorship care, as they are the clinical aspects [51]. Educational information targeted to health care providers may better equip them to initiate the HRQoL care process with their patient and either provide or direct them to appropriate the appropriate resources.

As the population of cancer survivors continues to grow, so will the need for monitoring and management of the HRQoL among cancer survivors. Whether follow-up care is received from oncology specialists or primary care physicians, it is important that all health care providers recognize the declines in HRQoL experienced by cancer survivors and how they may differ from one another with respect to cancer type and/or gender to provide individual care tailored according to the unique needs of each survivor. Cancer survivors may be furthermore empowered by being provided information and resources for the management adverse treatment effects and coping mechanisms.

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	BC			BC controls			CC (female)			CC controls			CC (Male)			CC controls			PC			PC controls					
	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %			
	6393	25.0	19179	75.0	3333	75.0	1111	25.0	3333	75.0	824	25.0	2472	75.0	3636	25.0	10908	75.0	3636	25.0	10908	75.0	3636	25.0	10908	75.0	Sig. <i>p</i> value
All																											
<HS	445	6.4	1762	8.8			142	15.2	415	13.9			99	11.7	287	11.4			385	9.7	1235	10.5					
HS Grad	2008	29.6	6537	31.9			414	36.4	1256	33.6			264	30.5	747	28.8			979	25.4	3151	26.7					
Some Col/TS	1832	27.5	5297	27.2			324	26.6	836	25.6			193	25.5	557	21.0			795	22.7	2382	22.5					
Col/TS Grad	2108	36.5	5583	32.1			231	21.9	826	26.9			268	32.3	881	38.9			1477	42.1	4140	40.3					
Employment status																											0.049 *
Employed	1935	33.1	6054	35.5			216	23.9	747	26.8			248	36.2	736	36.9			795	23.8	2662	26.9					
Unemployed	4458	66.9	13125	64.5			895	76.1	2586	73.2			576	63.8	1736	63.1			2841	76.2	8246	73.1					
Family income																											0.993
<\$25,000	1884	24.9	5658	24.6			442	31.9	1331	34.6			245	26.2	738	28.3			798	19.5	2383	19.7					
\$25,000–\$35,000	849	10.9	2545	12.1			150	12.2	454	13.1			114	13.4	342	11.7			501	12.1	1492	11.6					
\$35,000–\$50,000	932	14.6	2788	14.6			136	12.5	402	12.2			124	14.7	370	12.8			641	17.5	1934	17.2					
\$50,000–\$75,000	758	12.0	2267	13.1			96	12.6	288	10.6			112	16.8	336	14.2			575	15.7	1694	15.5					
>\$75,000	1084	22.8	3253	22.8			117	13.5	348	15.3			158	22.1	476	25.7			776	25.0	2312	25.8					
Missing/DK	886	14.8	2668	12.7			170	17.3	510	14.2			71	6.9	210	7.3			345	10.2	1093	10.2					
Insurance status																											0.790
Insured	6156	95.8	18482	96.0			1076	95.7	3221	95.9			789	96.0	2374	95.5			3557	97.9	10697	98.0					
Uninsured	237	4.2	697	4.0			35	4.3	112	4.1			35	4.0	98	4.5			79	2.1	211	2.0					
Usual source of care																											0.000 ***
Yes	6151	96.0	18007	93.2			1078	94.9	3169	94.0			776	94.6	2238	89.2			3498	96.4	10099	93.2					
No	236	4.0	1149	6.8			33	5.1	157	6.0			48	5.4	231	10.8			132	3.6	795	6.8					
Region of the USA																											0.170
Northeast	1235	22.0	3710	20.4			198	21.0	594	20.1			153	16.4	454	17.7			615	19.6	1861	18.0					
Midwest	1609	24.1	4825	23.8			319	25.2	953	24.5			213	24.3	632	23.7			893	23.4	2670	22.4					
South	1972	33.8	5926	34.3			373	36.9	1125	37.4			271	40.3	818	39.0			1156	36.2	3522	39.8					
West	1577	20.1	4718	21.5			221	16.8	661	18.0			187	19.0	568	19.5			972	20.8	2855	19.9					
Metro status																											0.274
Metro	4264	82.1	12525	80.5			693	77.9	2099	80.2			516	79.1	1570	79.4			2368	81.0	7119	79.8					
Non-metro	2106	17.9	6562	19.5			414	22.1	1216	19.8			303	20.9	893	20.6			1253	19.0	3739	20.2					

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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.

Asterisks represent significant differences compared with the reference group.

 $p < .001$.
**
 $p < .01$.
*
 $p < .05$.

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Table 2

Comparison of health-related quality of life of cancer survivors and non-cancer controls behavioral risk factor surveillance system, 2009.

	BC			BC controls			CC (female)			CC controls			CC (male)			CC controls			PC			PC controls			Sig. <i>p</i> value	
	N	Wt. %		N	Wt. %		N	Wt. %		N	Wt. %		N	Wt. %		N	Wt. %		N	Wt. %		N	Wt. %			
All	6393	25.0	19179	75.0			1111	25.0	3333	75.0			824	25.0	2472	75.0			3636	25.0	10908	75.0				
Life satisfaction																									0.377	
Very satisfied/satisfied	5713	94.8	17147	95.5			968	95.9	2949	95.3			717	92.7	2188	95.9			3239	96.5	9783	97.0				
Dissat/very dissat	299	5.2	825	4.5			45	4.1	141	4.7			32	7.3	106	4.1			141	3.5	317	3.0				
Receive needed emotional support																									0.196	
Always/usually	353	6.0	1228	6.8			73	6.2	237	8.4			87	12.7	253	10.7			404	10.2	1264	11.9				
Sometimes	725	11.7	2190	12.3			137	13.8	411	12.1			111	16.2	304	12.1			411	12.8	1173	11.5				
Rarely/never	4934	82.3	14554	80.9			803	80.0	2442	79.5			551	71.0	1737	77.2			2565	77.0	7663	76.6				
Activity limitations																									0.005**	
Yes	2043	30.6	5401	25.6			389	37.0	1011	28.4			296	39.4	720	23.9			1117	29.3	2972	25.2				
No	4328	69.4	13702	74.4			716	63.0	2305	71.6			524	60.6	1742	76.1			2505	70.7	7896	74.8				
Perceived general health																									<0.001***	
Excellent/very good	2426	41.7	8976	52.8			333	32.3	1364	44.9			243	31.8	1038	48.5			1260	38.1	4534	46.1				
Good	2162	36.5	5531	29.1			351	32.9	990	31.7			266	39.5	700	30.4			1238	38.9	3419	33.8				
Fair/poor	1424	21.8	3465	18.1			329	34.8	736	23.3			240	28.7	556	21.2			882	23.1	2147	20.2				
Days perceived physical health bad in past month																									0.712	
None	3505	59.4	11229	62.0			546	52.1	1858	58.3			461	60.5	1529	68.7			2205	67.0	6931	68.3				
1–15	1746	28.7	4697	27.2			298	32.6	835	28.7			184	28.2	474	20.1			781	22.4	2113	21.4				
>15	761	11.9	2046	10.8			169	15.3	397	13.0			104	11.3	291	11.2			394	10.6	1056	10.3				
Days perceived mental health bad in past month																									0.118	
None	4248	69.9	13061	70.0			734	67.2	2299	72.6			609	79.5	1885	82.0			2813	82.9	8624	85.2				
1–15	1367	23.5	3855	24.2			210	24.5	644	23.0			103	15.8	291	12.9			438	13.5	1103	11.2				
>15	397	6.5	1056	5.9			69	8.3	147	4.4			37	4.7	118	5.1			129	3.6	373	3.6				
Days did not get enough sleep in past month																									0.021*	
None	2594	41.0	7941	40.6			469	41.0	1505	46.7			397	50.7	1234	51.6			1908	55.8	6049	59.4				

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	BC			BC controls			CC (female)			CC controls			CC (male)			CC controls			PC			PC controls			Sig. <i>p</i> value
	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	N		Wt. %	
	6393	25.0	43.5	19179	75.0	44.3	1111	25.0	42.3	3333	75.0	39.4	824	25.0	34.8	2472	75.0	36.6	3636	25.0	33.4	10908	75.0	32.1	
All																									
1–15	2540			7710			379			1206			245			779			1116			3202			32.1
>15	878			2321			165			379			107			281			356			849			8.4

Asterisks represent significant differences compared with the non-cancer controls based on chi-square tests.

BC, breast cancer; CC, colorectal cancer; PC, prostate cancer; Dissat, dissatisfied.

p < .001.

**
001 *p* < .01.

*
.01 *p* < .05.

Table 3

Adjusted odds ratios and 95% confidence intervals for cancer type from binary and multinomial logistic regressions on health-related quality of life by time since diagnosis behavioral risk factor surveillance system, 2009.

	Breast cancer			Colorectal cancer (female)			Colorectal cancer (male)			Prostate cancer		
	AOR	95% CI	Sig.	AOR	95% CI	Sig.	AOR	95% CI	Sig.	AOR	95% CI	Sig.
Activity limitations												
Yes	1-5 years	1.41	[1.11, 1.80]	**	2.25	[1.45, 3.51]	***	2.62	[1.72, 3.99]	***	1.09	[0.83, 1.43]
	>5 years	1.18	[1.04, 1.35]	*	1.23	[0.89, 1.70]		1.70	[1.23, 2.36]	**	1.17	[0.97, 1.40]
Life satisfaction												
Very satisfied/satisfied	1-5 years	0.89	[0.58, 1.36]		3.32	[1.21, 9.13]	*	1.78	[0.62, 5.10]		0.96	[0.54, 1.73]
	>5 years	0.96	[0.71, 1.28]		0.62	[0.36, 1.04]		0.33	[0.17, 0.65]	**	0.97	[0.65, 1.46]
Receive needed emotional support												
Rarely/never	1-5 years	0.89	[0.57, 1.38]		1.41	[0.69, 2.87]		0.93	[0.45, 1.95]		1.48	[1.01, 2.16]
	>5 years	1.21	[0.91, 1.60]		1.10	[0.67, 1.81]		0.70	[0.41, 1.20]		1.01	[0.79, 1.28]
Sometimes	1-5 years	0.69	[0.42, 1.13]		1.15	[0.49, 2.71]		1.20	[0.52, 2.76]		1.78	[1.08, 2.95]
	>5 years	1.17	[0.84, 1.61]		1.22	[0.68, 2.18]		0.99	[0.53, 1.85]		0.98	[0.71, 1.35]
Perceived general health												
Fair/poor	1-5 years	3.26	[2.43, 4.37]	***	3.51	[2.09, 5.91]	***	3.67	[2.09, 6.47]	***	1.72	[1.26, 2.35]
	>5 years	1.38	[1.15, 1.65]	***	1.91	[1.30, 2.79]	***	1.91	[1.26, 2.90]	**	1.21	[0.96, 1.53]
Good	1-5 years	2.42	[1.91, 3.06]	***	2.04	[1.19, 3.49]	**	1.81	[1.05, 3.13]	*	1.52	[1.17, 1.97]
	>5 years	1.44	[1.23, 1.68]	***	1.25	[0.89, 1.76]		2.24	[1.59, 3.17]	***	1.27	[1.05, 1.54]
Days perceived physical health bad in past month												
>15	1-5 years	1.31	[0.94, 1.83]		1.05	[0.58, 1.90]		1.57	[0.85, 2.91]		0.95	[0.63, 1.44]
	>5 years	1.09	[0.90, 1.32]		1.36	[0.91, 2.04]		1.00	[0.63, 1.60]		1.00	[0.77, 1.31]
1-15	1-5 years	1.17	[0.93, 1.46]		1.64	[1.06, 2.54]		1.56	[0.95, 2.55]		0.97	[0.75, 1.25]
	>5 years	1.05	[0.90, 1.22]		1.21	[0.87, 1.70]	*	1.77	[1.23, 2.55]	**	1.06	[0.86, 1.30]
Days perceived mental health bad in past month												
>15	1-5 years	1.18	[0.75, 1.85]		0.91	[0.44, 1.89]		1.06	[0.55, 2.05]		1.41	[0.79, 2.52]
	>5 years	1.03	[0.80, 1.34]		1.58	[0.92, 2.70]		1.27	[0.62, 2.60]		0.68	[0.44, 1.03]
1-15	1-5 years	1.00	[0.79, 1.26]		0.88	[0.54, 1.43]		2.00	[1.17, 3.42]	*	1.40	[1.01, 1.93]
	>5 years	0.99	[0.84, 1.15]		1.31	[0.87, 1.98]		1.16	[0.75, 1.80]		1.13	[0.89, 1.45]

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	Breast cancer			Colorectal cancer (female)			Colorectal cancer (male)			Prostate cancer		
	AOR	95% CI	Sig.	AOR	95% CI	Sig.	AOR	95% CI	Sig.	AOR	95% CI	Sig.
Days did not get enough sleep in past month												
>15	1.25	[0.92, 1.69]		1.54	[0.83, 2.86]		1.24	[0.69, 2.23]		1.61	[1.13, 2.29]	**
>5 years	0.99	[0.81, 1.21]		1.23	[0.81, 1.86]		1.28	[0.84, 1.96]		1.12	[0.84, 1.48]	
1-5 years	1.16	[0.93, 1.46]		1.22	[0.78, 1.91]		1.09	[0.70, 1.69]		1.25	[0.99, 1.58]	
>5 years	0.93	[0.81, 1.07]		1.23	[0.91, 1.67]		1.04	[0.73, 1.48]		0.98	[0.81, 1.17]	

Reference categories for dependent variables are as follows: activity limitations (No), life satisfaction (very dissatisfied/dissatisfied), received needed emotional support (usually/always), perceived general health (excellent/very good), days perceived physical health bad in past month (0 days), days perceived mental health bad in past month (0 days), and days did not get enough sleep in past month (0 days).

AOR, adjusted odds ratios; CI, confidence intervals.

 $p < .001$.

**
 $p < .01$.

*
 $p < .05$.

Table 4

Adjusted odds ratios and 95% confidence intervals for cancer type from binary and multinomial logistic regressions on health-related quality of life among cancer survivors by cancer type and gender behavioral risk factor surveillance system, 2009.

	Breast cancer versus colorectal (female)			Prostate cancer versus colorectal (male)			Colorectal cancer (female) versus colorectal (male)			Breast cancer versus prostate		
	OR	95% CI	Sig.	OR	95% CI	Sig.	OR	95% CI	Sig.	OR	95% CI	Sig.
Activity limitations												
Yes	0.89	[0.69,1.15]		0.61	[0.45, 0.83]	**	0.63	[0.45,0.87]	**	0.96	[0.80,1.14]	
Life satisfaction												
Very satisfied/satisfied	0.90	[0.57,1.40]		1.68	[0.85,3.31]		2.20	[1.11,4.35]	*	1.03	[0.71,1.50]	
Receive needed emotional support												
Rarely/never	0.95	[0.60,1.49]		1.38	[0.88,2.18]		3.17	[1.76,5.71]	***	2.12	[1.58,2.84]	***
Sometimes	0.87	[0.53,1.43]		0.99	[0.57,1.70]		1.91	[0.99,3.69]		1.56	[1.08,2.24]	*
Perceived general health												
Fair/poor	0.68	[0.50,0.93]	*	0.63	[0.45,0.88]	**	0.79	[0.53,1.17]		0.81	[0.65,1.01]	
Good	1.06	[0.77,1.46]		0.79	[0.57,1.09]		0.67	[0.45,0.98]	*	0.87	[0.72,1.05]	
Days perceived physical health bad in past month												
>15	0.79	[0.57,1.09]		0.89	[0.59,1.36]		1.27	[0.81,1.99]		1.05	[0.81,1.36]	
1–15	0.80	[0.59,1.07]		0.70	[0.51,0.95]	*	1.18	[0.82,1.70]		1.35	[1.13,1.62]	**
Days perceived mental health bad in past month												
>15	0.89	[0.55,1.44]		0.91	[0.49,1.70]		1.39	[0.77,2.53]		1.43	[0.96,2.11]	
1–15	0.81	[0.55,1.19]		0.94	[0.65,1.35]		1.86	[1.16,2.98]	**	1.58	[1.28,1.94]	***
Days did not get enough sleep in past month												
>15	0.84	[0.59,1.20]		0.88	[0.59,1.33]		1.14	[0.73,1.76]		1.33	[1.04,1.70]	*
1–15	0.89	[0.65,1.21]		0.98	[0.73,1.32]		1.53	[1.06,2.21]	*	1.49	[1.26,1.77]	***

Reference categories for dependent variables are as follows: activity limitations (no), life satisfaction (very dissatisfied/dissatisfied), received needed emotional support (usually/always), perceived general health (excellent/very good), days perceived physical health bad in past month (0 days), Days perceived mental health bad in past month (0 days), and days did not get enough sleep in past month (0 days).

Asterisks represent significant differences compared with the reference group.

*** $p < .001$.

** $p < .01$.

* $p < .05$.