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Mental and Physical Health-Related Quality of Life among US Cancer Survivors: Population Estimates from the 2010 National Health Interview Survey

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Abstract

Background—Despite extensive data on health-related quality of life (HRQOL) among cancer survivors, we do not yet have an estimate of the percent of survivors with poor mental and physical HRQOL compared to population norms. HRQOL population means for adult-onset cancer survivors of all ages and across the survivorship trajectory also have not been published.

Methods—Survivors (n=1,822) and adults with no cancer history (n=24,804) were identified from the 2010 National Health Interview Survey. The PROMIS® Global Health Scale was used to assess HRQOL. Poor HRQOL was defined as one standard deviation or more below the PROMIS population norm.

Results—Poor physical and mental HRQOL were reported by 24.5% and 10.1% of survivors, respectively, compared to 10.2% and 5.9% of adults without cancer (both p<.0001). This represents a population of approximately 3.3 million and 1.4 million US survivors with poor physical and mental HRQOL. Adjusted mean mental and physical HRQOL scores were similar for breast, prostate, and melanoma survivors compared to adults without cancer. Survivors of cervical, colorectal, hematologic, short-survival, and other cancers had worse physical HRQOL; cervical and short-survival cancer survivors reported worse mental HRQOL.

Conclusion—These data elucidate the burden of cancer diagnosis and treatment among US survivors and can be used to monitor the impact of national efforts to improve survivorship care and outcomes.

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Impact—We present novel data on the number of US survivors with poor HRQOL. Interventions for high-risk groups that can be easily implemented are needed to improve survivor health at a population level.

Keywords

cancer; survivors; health-related quality of life; pain; fatigue

Introduction

The remarkable progress made in the past few decades in early detection and effective treatment of cancer is leading to a steady increase in the number of long term cancer survivors. Cancer incidence declined by approximately 1% per year during the period between 2003 – 2007, while cancer mortality has been slowly declining since the 1990s(1). The result is that there are now an estimated 12.6 million cancer survivors in the United States alone, and these figures are expected to continue rising largely due to the aging of the population(2). While many survivors report good health-related quality of life (HRQOL) after cancer, there appears to be a vulnerable subgroup of the survivor population that continues to experience poor HRQOL. It is critical to quantify the variation of cancer's impact on survivors' HRQOL if we are to understand the true burden of cancer on the population and, importantly, measure the effect of cancer control efforts on optimizing the health and well-being of cancer survivors(3). Understanding the risk factors associated with below-population-average, or poor, HRQOL will help identify these individuals and aid in planning interventions for this group.

Previous research suggests that cancer survivors, relative to those without a cancer history, have poorer HRQOL on average. In particular, survivors report more functional impairment(4, 5), poorer health(5–7), greater psychological distress(8), and more mental health needs(9). While older age and greater likelihood of co-morbid conditions exhibited by survivors contribute to these differences, studies that match individuals with and without cancer history on these factors also find decreased HRQOL among cancer patients (10). Importantly, many of the prior population-based HRQOL studies conducted among survivors utilized sources such as the Medicare Health Outcomes Survey that were restricted to Medicare beneficiaries 65 years of age and older (e.g.,10, 11), while others have lacked a comprehensive HRQOL measure(e.g.,7, 9).

Identifying who in the survivor population is at risk for poor HRQOL and the associated risk factors for this status are important first steps in efforts to develop and appropriately target interventions with the potential to reduce the individual and social burden of cancer. The current study used a US population-based sample to: 1) compare the physical and mental HRQOL of cancer survivors to those without a cancer history by examining means and estimating the proportion who experience poor or below population-average physical and mental HRQOL; and 2) identify the general and cancer-specific characteristics that may put survivors at risk for experiencing poor physical and mental functioning.

Methods

Participants

Data came from the 2010 National Health Interview Survey (NHIS)(12), an annual, in person, nationwide survey that tracks trends in illness and disability in the United States. The NHIS utilizes a complex sampling framework involving clustering, stratification, and multistage sampling to derive a representative sample of the civilian, non-institutionalized population. Blacks, Hispanics, and Asians are oversampled. Data are collected by trained

census interviewers during household interviews using computer-assisted personal interviewing (CAPI). One adult per family was randomly chosen to complete the Sample Adult questionnaire which contained the Cancer Control Supplement. The Cancer Control Supplement, developed and co-funded by the National Cancer Institute and the Centers for Disease Control and Prevention, is fielded approximately every five years and includes questions on cancer risk factors, health behaviors, cancer screening, and cancer survivorship.

The 2010 NHIS sample included 27,157 persons 18 years of age and older for the Sample Adult survey; the overall response rate was 60.8%. Data for the current analysis were drawn from the Person, Sample Adult, and Cancer Control Supplement files(12).

Measures

Demographic and disease variables—Sociodemographic variables included self-reported age, education (classified as <high school, high school or GED, some college or 2 year degree, or 4 year degree), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, or other), marital status (married or living with a partner vs others), sex, poverty status (defined relative to the poverty index using the NHIS imputed files(13)- <100%, 100–199%, 200–399%, and 400%), and employment status (full-time, part-time, retired, or not currently employed). In multivariate analyses we chose to use education rather than poverty status because of significant collinearity between these predictors (χ^2 p -value= <.0001). The Sample Adult file contained information on self-reported cancer history (including site and age at diagnosis), as well as other comorbid health conditions. We grouped hematologic malignancies (leukemias, lymphomas, and other blood cancers), as well as cancers with a short survival time (esophagus, liver, lung, pancreas, and stomach) to create categories for most recent cancer type. As in prior studies, short-survival cancers were defined as those with a 5-year relative survival of less than 25%(5). For analyses including only cancer survivors, we used breast cancer as the reference group since the quality of life of these survivors has been well characterized in the research literature. Time since cancer diagnosis was calculated by subtracting age at first cancer diagnosis from the participant's age at interview. A small number of individuals (n= 54) possibly misunderstood the age at cancer diagnosis question and reported cancer types and corresponding ages that were extremely unlikely (e.g., prostate cancer at the age of 3). Following the methodology of Yabroff and colleagues(5), we considered the time since diagnosis and cancer site to be missing for these cases. Adults who reported a history of cancer were also asked about current treatment status (in active treatment, received treatment in the last 12 months [recent], no current or recent treatment), types of treatments received for the most recent cancer (surgery, radiation, chemotherapy, hormonal and bone marrow/stem cell transplant treatments), and cancer recurrence. We examined the prevalence of ever being diagnosed with non-cancer comorbid health conditions (hypertension, heart disease, stroke, diabetes, lung disease), using definitions from previous NHIS research(5, 14). We defined heart disease as reporting coronary heart disease, angina, myocardial infarction, or any other heart condition. Lung disease included chronic bronchitis, emphysema, and current asthma. We added arthritis to the comorbidities because of its important impact on health-related quality of life. We summed the comorbidities for use in multivariate modeling.

Health-related quality of life (HRQOL)—The 10-item Patient-Reported Outcomes Measurement Information System® (PROMIS®) Global Health Scale (PROMIS Global 10) was used to assess key HRQOL domains including pain, fatigue, mental health, physical health, social health, and overall health. Prior psychometric work suggests the presence of two 4-item factors: global physical health (overall physical health, physical functioning, pain, and fatigue) and global mental health (quality of life, mental health, satisfaction with social activities, and emotional problems)(15). The general health and satisfaction with

social roles items were examined as single items, as were the pain and fatigue items because these are important symptoms among long-term cancer survivors. The physical and mental health summary scores were scored according to PROMIS instructions (16) and transformed to T-score distributions with a mean of 50 and a standard deviation of 10. The PROMIS T-score metric was set based on a sample that is representative of the US adult population(17). Higher PROMIS scores represent better HRQOL.

Analytic Plan

We conducted weighted analyses using SUDAAN (Version 9) to account for the unequal probability of selection resulting from the complex survey design of the NHIS. The incorporation of sampling weights is necessary to avoid biased estimates of model parameters and variances. First, we examined mean HRQOL outcomes for adults without cancer and cancer survivors (stratified by most recent cancer type), in both unadjusted and adjusted ordinary least squares regression models including sociodemographic and health characteristics (age, sex, race/ethnicity, education, marital status, and non-cancer comorbidities). We also examined time since most recent cancer diagnosis as a predictor of HRQOL, combining across cancer types. Survivors 1 year, 2–5 years, 6–10 years, and 11+ years were compared to adults without cancer in both unadjusted and adjusted models to assess HRQOL impact across the cancer trajectory.

Next, we calculated population estimates for the proportion of survivors and adults without cancer that report PROMIS mental and physical health HRQOL scores more than one standard deviation below the population mean of 50 (PROMIS T-score <40). Standardized values for clinically important differences have not yet been identified for the PROMIS summary scales, so we chose to use the conservative one standard deviation criterion which is commonly used as a definition for impairment in functioning. This standard would be expected to identify the 15% of individuals in the population with the worst HRQOL. Population estimates for the number of US cancer survivors with poor HRQOL were calculated by multiplying the proportion of the population by the sum of the population weights.

Finally, we also examined multivariable logistic regression models stratified by cancer history with poor HRQOL (defined as a PROMIS score <40) as the outcome. Age, race/ethnicity, sex, marital status, education, number of non-cancer comorbidities were included as covariates for both groups; most recent cancer site, time since diagnosis, recurrence, treatment recency, and number of cancers were included as covariates only for cancer survivors.

Results

Sample

In the 2010 NHIS, a total of 2,333 adults reported a history of cancer. We excluded persons who reported a history of exclusively non-melanoma skin or “unknown” skin cancers (n=494) and those who did not answer questions about cancer type (n=17), resulting in an analytic sample of 1,822 cancer survivors. The comparison population included 24,804 adults without a history of cancer. The percent of the total sample missing HRQOL data was 8.6%. Older persons and those with less education were more likely to be missing mental and physical HRQOL data. Black and Asian adults were more likely to be missing mental HRQOL data compared to non-Hispanic whites.

As found in previous analyses, adult cancer survivors were older, less likely to be racial and ethnic minorities, more likely to be female, reported higher incomes, and had more non-cancer comorbidities compared to adults without a history of cancer (see Table 1). Cancer

specific characteristics of survivors are shown in Table 2. Almost 12% of the survivors reported that they had a recurrence of their cancer.

Health-Related Quality of Life in Survivors and Individuals without a History of Cancer

In unadjusted models (shown in Supplementary Table S1), the overall effect of both cancer site and time since last cancer diagnosis was statistically significant for all HRQOL outcomes. In multivariate adjusted models, most recent cancer type was a significant predictor of HRQOL outcomes (see Table 3); time since most recent cancer diagnosis was significantly associated with only physical, general health, and pain HRQOL. Breast, prostate, and melanoma cancer survivors had HRQOL estimated marginal means that were not statistically different from or exceeded those of adults without a history of cancer. In contrast, survivors of colorectal, cervical, hematologic, short-survival, and “other” cancers had significantly poorer physical HRQOL and fatigue compared to adults without cancer (all $p < .05$). Survivors of cervical and short-survival cancers also reported significantly poorer mental HRQOL and general health. Worse pain was reported by survivors of cervical, hematologic, and “other” malignancies.

In multivariate adjusted models, the overall effect of time since diagnosis (with adults without cancer as a comparison group) was significant for physical HRQOL, fatigue, pain, and general health, but not mental HRQOL or satisfaction with social functioning (see Table 3). Survivors who were less than 2 years from their most recent cancer diagnosis reported lower physical HRQOL, fatigue, and pain scores, but were not significantly different from adults without cancer on mental HRQOL, general health, and satisfaction with social roles. Survivors 2 to 5 years since their most recent cancer diagnosis reported significantly lower physical and mental HRQOL, general health, and fatigue scores than adults without cancer. The groups that were 6–10 and 11 years from their last cancer diagnosis reported significantly lower physical HRQOL and fatigue scores (only for the 6–10 year survivors) than adults without cancer.

Population Estimates for Poor HRQOL among Cancer Survivors

Approximately 24.5% of cancer survivors reported physical HRQOL more than one standard deviation below the population mean (i.e. a T-score < 40); while 10.1% reported poor mental HRQOL (see Table 4). This represents an estimated population of approximately 3.3 and 1.4 million US cancer survivors with poor physical and mental HRQOL, respectively. Prevalence of poor HRQOL in adults without a history of cancer was significantly lower compared to the survivor sample, 10.2% for physical HRQOL and 5.9% for mental HRQOL ($X^2 = 142.5$ & 23.4 , respectively, $p < .0001$). Seven percent of survivors, representing a population of almost 973,000 US adults reported both physical and mental HRQOL < 40 .

Predictors of Poor HRQOL in Survivors and Adults without Cancer

Physical health—We stratified multivariate models by cancer history and adjusted for age, sex, race/ethnicity, marital status, education, and number of comorbidities (Table 5), as well as time since diagnosis, treatment recency, number of cancers, recurrence, and most recent cancer site for the survivors. There was no linear trend for age category with increasing risk for poor physical HRQOL in either survivors or adults without cancer. Adults without cancer who were 50–64 were the only group with significantly increased risk compared to the youngest age groups. Less education and having more than one non-cancer comorbidity were also independently associated with poor physical HRQOL among both groups. Females without cancer were at increased risk for poor physical HRQOL, but this was not true among survivors. There were no significant race/ethnicity differences in

physical HRQOL among cancer survivors; among adults without cancer. Asian adults were significantly less likely than non-Hispanic whites to report poor physical HRQOL.

Compared to survivors with breast cancer, survivors with cervical, hematologic, short-survival, and less common “other” cancers were more likely to report poor physical HRQOL. Survivors of prostate cancer were significantly less likely to report poor physical HRQOL. Neither cancer recurrence, nor time since most recent cancer diagnosis was a significant predictor of poor physical HRQOL. Survivors currently receiving cancer treatment (excluding maintenance hormonal therapies) were significantly more likely to report poor physical HRQOL compared to survivors who did not receive treatment in the past 12 months. Survivors with more than one cancer diagnosis were not more likely to report poor physical HRQOL.

Mental health—Younger, unmarried, less educated, and persons with more non-cancer comorbidities were at greater risk for poor mental HRQOL in both the cancer survivor and general adult populations. Hispanic and Asian adults without cancer were less likely than non-Hispanic whites to report poor mental HRQOL; there were no race/ethnicity differences among cancer survivors.

There were few site differences among cancer survivors. Compared to survivors with breast cancer, only survivors with short-survival cancers were significantly more likely to have poor mental HRQOL. Survivors with a recurrence were more likely to report poor mental HRQOL. Neither time since diagnosis nor treatment recency was associated with likelihood of poor HRQOL. Surprisingly, survivors with multiple cancers were significantly less likely to report poor mental HRQOL.

Discussion

Overall, these data suggest resilience among many long-term survivors. In general we found that after adjustment for sociodemographic differences, long-term survivors of many of the most common cancers in the survivor population (breast, prostate, and melanoma) were doing as well or better than adults without a history of cancer. However, not all survivors report they are thriving. This study adds to the literature on HRQOL after cancer by specifying that 25% and 10% of cancer survivors report poor physical and mental HRQOL, respectively compared to only 10% and 6% of the adults without cancer. We estimate that more than 3.6 million cancer survivors report mental and/or physical HRQOL more than one standard deviation below the population mean.

The higher rates of poor HRQOL among cancer survivors observed in this study are consistent with findings suggesting higher prevalence of poor physical and mental health outcomes among survivors relative to adults without cancer (8, 18, 19). Predictors of poor mental and physical HRQOL identified in this study, such as lower socioeconomic status and a greater number of non-cancer comorbidities, have also been identified in prior population and clinic-based samples (11, 20). Younger current age was also a correlate of poor mental health, consistent with prior research (19, 21). Interventions to promote well-being among vulnerable populations of survivors are needed to improve HRQOL at a population level. For example, both cognitive behavioral therapy and physical activity interventions have been shown to improve physical and mental health quality of life in cancer survivors (22–24). The increasing availability of these kinds of interventions via telephone (25, 26) or internet (27, 28) platforms will increase the scalability and reach of effective interventions. Given the very high prevalence of non-cancer comorbidities in this population, as well as the importance of comorbidities on HRQOL, it is essential to address

both prevalent comorbid disease, as well as risk factors for poor health as a part of comprehensive cancer-related follow-up care.

In contrast to other population-based studies of cancer survivors (29, 30), we did not observe any race/ethnicity differences in mental or physical HRQOL among the cancer survivor sample. There is considerable heterogeneity in the research literature regarding racial and ethnic difference in HRQOL after cancer (for review see 31). Differences in the HRQOL measures used, as well as the sample characteristics (e.g., single cancer site vs multiple cancers, population-based vs clinic samples), may account for the different findings. It is possible that disease-specific measures of HRQOL may be more sensitive to racial/ethnic differences in the experience of cancer.

In addition, our finding regarding the lower risk for poor mental health among survivors with multiple cancers contrasts with recent population studies reporting worse physical and mental health outcomes for survivors of multiple cancers, compared to survivors with a single primary cancer (32, 33). This difference may be due to the specific outcomes examined (HRQOL vs mental distress, comorbidities, and disability) or the analytic strategy used for describing the effect. Burris & Andrykowski (32, 33) treated multiple cancers as a distinct group, comparing them to both single primary survivors and no-cancer controls. In contrast, we used single/multiple cancers as a covariate in multiple regression models that also controlled for site of most recent cancer diagnosis.

Interestingly, the PROMIS[®] Global Health Scale scores in our sample were somewhat higher than those observed in the PROMIS[®] validation sample(34). We observed an unadjusted mean of 53.3 and 53.9 for physical and mental health respectively in our adults without cancer compared to 49.8 and 49.0 in the overall validation sample. In addition the unadjusted means for our cancer survivors were higher than those reported for the cancer subgroup of the PROMIS[®] validation sample (47.3 for mental and 43.6 for physical). We also observed that a smaller proportion of our participants had scores that were one standard deviation below the population mean than would be expected based on comparison to the normal curve. It is difficult to explain the observed differences because both the PROMIS[®] validation and NHIS samples were weighted to reflect 2000 U.S. Census data. There were differences in both the sampling strategy and mode of PROMIS[®] data collection. The PROMIS[®] validation sample used a commercial internet polling panel (17), whereas NHIS data are collected in-person by trained census workers using a geographic sampling strategy. Prior studies have suggested that telephone administration tends to yield more positive HRQOL scores compared to mail completion(35), and in-person administration as used in NHIS may have a similar effect. Ongoing studies of PROMIS[®] are collecting population-based data on cancer survivors with the goal to estimate population norms for cancer survivors.

Limitations of this study include the lack of recommended cut points for clinically significant impairments or minimally important differences in HRQOL. Further work will be needed to confirm the clinical significance of various cut points for the PROMIS[®] Global 10 items. Further, because of the large number of cancer sites included in this study and the heterogeneity in treatments received by cancer site, we were unable to examine treatment influences on HRQOL. Site-specific studies are more appropriate to answer the important question of how treatment influences long-term HRQOL, particularly if they include cancer-specific measures of HRQOL. As a generic HRQOL measure, the PROMIS[®] Global 10 is suitable to compare survivors to other adults, but may not fully capture all domains of HRQOL relevant to cancer, such as sexual functioning. In addition, all data, including cancer history, were based on self-report. Although prior studies have suggested that there is good concordance between self-reported cancer and registry or medical record confirmed

cases, misreporting may be a particular concern for male survivors(36) and women with endometrial and cervical cancers(36, 37). Our cancer survivor sample was 58% female compared with 54% female reported in the NCI SEER complete prevalence estimate(1) which may be evidence of under-reporting by males. Participants may also have had a hard time distinguishing between recurrence (either local or distal) and second cancers and between invasive cancer and precancerous conditions like cervical dysplasia. Finally, the NHIS did not include cancer survivors living in institutions such as nursing homes or those too ill to participate who may have had worse HRQOL.

In conclusion, we present unique data on the HRQOL of long-term cancer survivors in the US and the proportion and number with self-reported levels of HRQOL that may be of clinical concern. This study builds on prior research by examining the prevalence of poor HRQOL, rather than just average HRQOL scores, in a population-based sample of US cancer survivors that includes both younger and older survivors. Cancer survivors were significantly more likely than adults without cancer to report poor HRQOL, with 24.5% reporting poor physical HRQOL and 10.1% reported poor mental HRQOL. Most concerning, 7.2% of survivors reported both poor mental and physical HRQOL. These data are useful for comparing the representativeness of other clinic and state-based samples, identifying potentially vulnerable populations of survivors for clinic and public health interventions, guiding the implementation of plans for survivorship care with the potential to improve HRQOL, and determining progress towards national goals of enhancing life after cancer for the growing population of cancer survivors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Demographic Characteristics of Cancer Survivors and Adults without a History of Cancer from the 2010 National Health Interview Survey

Table 1

Characteristic	Cancer survivors N=1,822		No cancer diagnosis N=24,804	
	Raw N	Weighted %	Raw N	Weighted %
Grouping				
Current Age Group, years				
<50	353	20.8	14586	61.5
50-64	555	31.9	5951	24.4
65-79	599	32.5	3121	10.6
80+	315	14.7	1146	3.5
Race/Ethnicity				
White	1340	83.2	13734	66.9
Black	245	8.2	4250	12.4
Hispanic	169	5.9	4977	14.8
Asian	54	1.8	1668	5.0
Other	14	0.9	175	0.8
Male	682	42.0	11063	48.8
Female	1140	58.0	13741	51.2
Marital status				
Married/Living with partner	881	63.0	12448	60.9
Not Married	940	37.0	12310	39.1
Education				
< High school	308	14.0	4292	14.5
High school or GED	495	28.6	6540	26.9
Some college or 2 year degree	544	30.5	7338	30.5
4 Year degree	465	26.9	6522	28.0
Poverty status, % of Federal Poverty Level[#]				
<100%	244.6	9.1	4572.0	13.8
100-199%	425.8	20.7	5291.8	19.2
200-399%	573.2	33.1	7226.2	30.1
400%+	578.4	37.1	7714.0	36.9
Non-cancer comorbid conditions, % yes				
Hypertension	909	47.0	6436	24.0
Heart disease	480	25.9	2697	10.5
Stroke	128	6.9	687	2.4
Diabetes	343	18.1	2352	8.4
Lung disease	329	17.3	2765	11.2

	Cancer survivors N=1,822		No cancer diagnosis N=24,804	
	Raw N	Weighted %	Raw N	Weighted %
Number of non-cancer comorbid conditions				
Arthritis	872	46.4	5323	20.5
0	415	24.9	13479	55.9
1	488	27.1	5691	23.4
2+	903	48.0	5485	20.6
Employment				
Full-time	448	27.5	11963	50.5
Part-time	161	9.4	2659	11.8
Retired	768	41.0	3741	12.9
Not employed	433	22.1	6229	24.8

All descriptive characteristics with the exception of marital status and education were significantly different between survivors and adults without a history of cancer (chi-square p-value <0.0001). Weighting incorporates design, ratio, non-response, and post-stratification adjustments.

2010 Federal Poverty Level was \$22,050 for a family of 4. Raw Ns include decimal places for this variable due to multiple imputation procedures applied by the National Center for Health Statistics.

Table 2

Cancer Related Characteristics of Survivors in the 2010 National Health Interview Survey(n=1,822)

		Raw N	Weighted %
Site of Most Recent Cancer	Female Breast	398	19.8
	Prostate	261	15.5
	Melanoma	153	10.5
	Cervix	143	7.8
	Colorectal	143	7.6
	Hematologic Malignancies	106	6.6
	Short Survival Cancers	102	5.6
	Other	427	24.5
	Unknown [#]	35	2.1
	Missing [¥]	54	
Time Since Last Diagnosis, years	1	256	15.7
	2-5	440	28.5
	6-10	347	20.3
	11+	611	35.5
Ever had a recurrence	Yes	185	11.8
	No	1463	88.2
Treatment Status	Current	109	6.3
	Within the past 12 months	154	9.5
	Not in the past 12 months	1389	84.2
Number of Cancers	1	1633	89.6
	2	189	10.4
Treatments Received (% Yes)	Surgery	1145	69.8
	Radiation	449	26.8
	Chemotherapy	422	25.6
	Hormonal Therapy	113	7.0
	Bone Marrow/Stem Cell Transplant	8	0.5
	None	98	5.9

Numbers may not sum to 1,822 due to missing data for some variables.

[#] Last cancer site "unknown" was either due to multiple cancers diagnosed in the same calendar year or missing data on year of diagnosis for one or more reported cancers.

[¥] 54 cases were defined as missing on cancer site and time since diagnosis due to improbable combinations of cancer site and age at diagnosis.

Table 3

Adjusted Marginal Means for Health Related Quality of Life as Measured by the PROMIS Global 10 by Cancer Site and Time Since Most Recent Cancer Diagnosis from the 2010 National Health Interview Survey

	Physical HRQOL		Mental HRQOL		General Health		Satisfaction with Social Roles		Fatigue		Pain	
	T-score mean (SE)	T-score mean (SE)	T-score mean (SE)	T-score mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Adults without cancer(n=22,370 [#])	53.2 (0.07)	53.9 (0.07)	3.9 (0.01)	3.8 (0.01)	4.1 (0.01)	4.1 (0.01)	3.8 (0.01)	3.8 (0.01)	4.1 (0.01)	4.1 (0.01)	4.1 (0.01)	4.1 (0.01)
Cancer Type(most recent diagnosis)	13.3, p<.0001	4.42, p<.0001	4.98, p<.0001	3.14, p=.002	8.61, p<.0001	7.00, p<.0001						
Overall effect [Wald F (8 df)]												
Breast (n=356)	52.7 (0.51)	54.5 (0.52)	4.0 (0.06)	3.9 (0.07)	4.1 (0.05)	4.1 (0.06)	3.9 (0.07)	3.9 (0.07)	4.1 (0.05)	4.1 (0.05)	4.1 (0.06)	4.1 (0.06)
Prostate (n= 229)	54.8 (0.62)	54.8 (0.72)	4.0 (0.08)	3.9 (0.07)	4.21 (0.06)	4.4 (0.07)	3.9 (0.07)	3.9 (0.07)	4.21 (0.06)	4.21 (0.06)	4.4 (0.07)	4.4 (0.07)
Melanoma (n= 139)	52.5 (0.74)	53.8 (0.65)	4.0 (0.08)	3.7 (0.08)	4.0 (0.08)	4.1 (0.08)	3.7 (0.08)	3.7 (0.08)	4.0 (0.08)	4.0 (0.08)	4.1 (0.08)	4.1 (0.08)
Cervix (n= 135)	49.3 (0.77)	50.2 (0.83)	3.6 (0.09)	3.5 (0.11)	3.8 (0.10)	3.7 (0.10)	3.5 (0.11)	3.5 (0.11)	3.8 (0.10)	3.8 (0.10)	3.7 (0.10)	3.7 (0.10)
Colorectal (n= 122)	50.7 (0.88)	53.3 (0.88)	3.8 (0.10)	3.7 (0.12)	3.9 (0.09)	4.1 (0.10)	3.7 (0.12)	3.7 (0.12)	3.9 (0.09)	3.9 (0.09)	4.1 (0.10)	4.1 (0.10)
Hematologic (n= 93)	48.5 (1.07)	51.7 (1.17)	3.7 (0.14)	3.5 (0.13)	3.7 (0.11)	3.9 (0.10)	3.7 (0.14)	3.5 (0.13)	3.7 (0.11)	3.7 (0.11)	3.9 (0.10)	3.9 (0.10)
Short-Survival (n= 90)	47.5 (1.44)	50.9 (1.30)	3.5 (0.14)	3.5 (0.17)	3.6 (0.13)	3.9 (0.15)	3.5 (0.17)	3.5 (0.17)	3.6 (0.13)	3.6 (0.13)	3.9 (0.15)	3.9 (0.15)
All other tumor sites (n=386)	50.4 (0.59)	52.9 (0.58)	3.7 (0.07)	3.7 (0.07)	3.9 (0.06)	3.9 (0.06)	3.7 (0.07)	3.7 (0.07)	3.9 (0.06)	3.9 (0.06)	3.9 (0.06)	3.9 (0.06)
Time Since Most Recent Cancer Diagnosis	12.0, p<.0001	2.2, p=.07	3.0, p=.02	1.4, p=.25	9.2, p<.0001	2.8, p=.03						
Overall effect[Wald F (3 df)]												
< 2 year (n=226)	49.0(0.87)	52.4 (0.83)	3.7 (0.10)	3.7 (0.09)	3.7 (0.09)	3.9 (0.09)	3.7 (0.09)	3.7 (0.09)	3.7 (0.09)	3.7 (0.09)	3.9 (0.09)	3.9 (0.09)
2–5 years (n=396)	51.1 (0.54)	52.7 (0.49)	3.7 (0.06)	3.7 (0.06)	3.9 (0.05)	4.0 (0.06)	3.7 (0.06)	3.7 (0.06)	3.9 (0.05)	3.9 (0.05)	4.0 (0.06)	4.0 (0.06)
6–10 years (n=312)	52.0 (0.56)	53.5 (0.63)	3.9 (0.07)	3.8 (0.08)	4.0 (0.06)	4.0 (0.07)	3.8 (0.08)	3.8 (0.08)	4.0 (0.06)	4.0 (0.06)	4.0 (0.07)	4.0 (0.07)
11+ years (n=553)	52.0 (0.41)	53.7 (0.43)	3.9 (0.05)	3.8 (0.05)	4.1 (0.04)	4.0 (0.05)	3.8 (0.05)	3.8 (0.05)	4.1 (0.04)	4.1 (0.04)	4.0 (0.05)	4.0 (0.05)

All scales were coded so that higher scores indicate better HRQOL. Adjusted marginal means incorporate design, ratio, non-response, and post-stratification adjustments and are adjusted for age, sex, race/ethnicity, education (< high school, high school or GED, some college), marital status (married or living with partner vs not married), education, and non-cancer comorbidities (0, 1, or 2). Bold means are statistically significant(p <.05) for the comparison between the cancer site or time since diagnosis category group and adults without cancer.

[#] ns shown are for the physical health summary score model. The subgroup ns vary slightly for the other models because of differences in missing data.

Table 4

Population Estimates for Poor Health-Related Quality of Life among Cancer Survivors from the 2010 National Health Interview Survey as Measured by the PROMIS Global 10.

	Weighted Prevalence Adults without Cancer	Weighted Prevalence Cancer Survivors	Population Estimate for Cancer Survivors (SE)
Physical Health Score < 1 SD below US Population Mean	10.2%	24.5%	3,278,000(184,000)
Mental Health Score < 1 SD below US Population Mean	5.9%	10.1%	1,356,000 (122,000)
Physical and Mental HRQOL < 1 SD below US Population Mean	3.5%	7.2%	973,000 (99,000)

1 SD score below pop mean = 40 on the PROMIS T-score metric. The comparison between survivors and adults without cancer is statistically significant for all comparisons (p<.0001)

Table 5

Multivariate Predictors of Poor Health Related Quality of Life in Cancer Survivors and Adults without a History of Cancer from the 2010 National Health Interview Survey using the PROMIS© Global 10

Characteristic	Grouping	Physical HRQOL t-score <40		Mental HRQOL t-score <40	
		Cancer Survivors OR (95% CI)	No Cancer OR (95% CI)	Cancer Survivors OR (95% CI)	No Cancer OR (95% CI)
Current age, years	<50	Ref	Ref	Ref	Ref
	50–64	1.40(0.85–2.31)	1.51 (1.32–1.73)	0.99 (0.58–1.67)	0.95(0.81–1.12)
	65–79	0.76 (0.46–1.28)	0.95 (0.80–1.13)	0.30 (0.15–0.60)	0.39 (0.31–0.49)
	80+	1.01 (0.49–2.08)	1.23 (0.98–1.54)	0.37 (0.10–1.29)	0.42 (0.31–0.58)
Race/Ethnicity	<i>Linear trend</i>	p= .61	p=.67	p=.03	p<.0001
	White	Ref	Ref	Ref	Ref
Sex	Black	1.56 (0.95–2.55)	1.26 (1.08–1.46)	0.71(0.38–1.31)	0.96(0.80–1.15)
	Hispanic	1.08 (0.59–1.97)	1.19 (1.00–1.43)	1.19 (0.62–2.30)	0.78 (0.64–0.93)
	Asian	1.88 (0.69–5.09)	0.69 (0.50–0.94)	1.45(0.41–5.12)	0.65 (0.44–0.98)
	Other	0.98(0.25–3.85)	0.89 (0.52–1.54)	1.35 (0.26–6.92)	1.08(0.61–1.90)
Marital Status	Male	Ref	Ref	Ref	Ref
	Female	0.95(0.62–1.45)	1.42 (1.25–1.61)	0.90(0.50–1.61)	1.10 (0.97–1.26)
Education	Married	Ref	Ref	Ref	Ref
	Not married	1.12 (0.81–1.56)	1.27 (1.12–1.43)	1.66 (1.09–2.51)	2.25(1.95–2.61)
	<High School	4.36(2.42–7.83)	4.73 (3.77–5.94)	3.59 (1.80–7.15)	4.33(3.37–5.56)
	High School	2.01(1.24–3.27)	2.78 (2.25–3.45)	2.85 (1.49–5.45)	2.36 (1.86–2.99)
Non-cancer, comorbid conditions	Some College	2.43 (1.47–4.00)	2.10 (1.72–2.56)	1.70 (0.82–3.49)	1.87 (1.49–2.35)
	4 year degree	Ref	Ref	Ref	Ref
	<i>Linear trend</i>	p<.0001	p<.0001	p<.0001	p<.0001
	0	Ref	Ref	Ref	Ref
Site of Last Cancer	1	3.28(1.84–5.85)	3.11(2.60–3.72)	2.37(1.17–4.80)	2.17(1.79–2.62)
	2+	11.22(6.65–18.93)	11.60(9.84–13.68)	4.48(2.26–8.90)	5.41(4.52–6.48)
	Female Breast	Ref	Ref	Ref	Ref
Site of Last Cancer	Prostate	0.44 (0.19–0.99)	Ref	0.78(0.23–2.60)	Ref
	Melanoma	1.35 (0.67–2.74)	Ref	0.49(0.15–1.61)	Ref
	Cervix	2.16 (1.12–4.16)	Ref	1.67 (0.73–3.84)	Ref
	Colorectal	1.49(0.76–2.93)	Ref	1.89(0.76–4.67)	Ref

Characteristic	Grouping	Physical HRQOL t-score <40		Mental HRQOL t-score <40	
		Cancer Survivors OR (95% CI)	No Cancer OR (95% CI)	Cancer Survivors OR (95% CI)	No Cancer OR (95% CI)
Time Since Last Diagnosis, years	Hematologic	2.51(1.28–4.95)		1.87 (0.77–4.51)	
	Short Survival	3.43(1.62–7.25)		4.63(1.83–11.70)	
	Other	1.97 (1.20–3.23)		1.56 (0.83–2.91)	
Ever had a recurrence	<2	Ref		Ref	
	2–5	1.27 (0.71–2.28)		0.75 (0.37–1.49)	
	6–10	0.67 (0.35–1.29)		0.51 (0.24–1.09)	
	>10	0.91 (0.47–1.77)		0.63 (0.30–1.32)	
Treatment Status	No	Ref		Ref	
	Yes	1.45 (0.89–2.37)		2.44 (1.32–4.53)	
	No recent	Ref		Ref	
	Recent [#]	1.01 (0.53–1.91)		0.78 (0.36–1.68)	
Number of Cancers	Current	4.02(1.96–8.26)		1.14 (0.48–2.71)	
	1 (ref)	Ref		Ref	
	2	1.09 (0.62–1.91)		0.25 (0.09–0.65)	

Estimates shown in bold are statistically significant, $p < .05$. Non-cancer comorbid conditions included hypertension, heart disease, stroke, diabetes, lung disease, and arthritis.

[#]Recent treatment was defined as report of treatment in the last 12 months, but not currently receiving treatment.