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Article

Factors Associated With Health-Related Quality of Life Among Cancer Survivors in the United States

Xuesong Han, PhD,[1] L. Ashley Robinson, MPH,[1,2,3] Roxanne E. Jensen, PhD,[4] Tenbroeck G. Smith, MA,[5] K. Robin Yabroff, PhD[1]

[1]Surveillance and Health Services Research Program, American Cancer Society, Atlanta, GA, USA, [2]Department of Biostatistics and Epidemiology, East Tennessee State University, Johnson City, TN, USA, [3]Division of Epidemiology, Biostatistics, and Environmental Health, School of Public Health, The University of Memphis, Memphis, TN, USA, [4]Division of Cancer Control and Population Sciences, National Cancer Institute, Rockville, MD, USA; and and [5]Behavioral and Epidemiology Research Group, American Cancer Society, Atlanta, GA, USA

*Correspondence to: Xuesong Han, PhD, American Cancer Society, 250 Williams St NW, Atlanta, GA 30303, USA (e-mail: xuesong.han@cancer.org).

Abstract

Background: With increasing prevalence of cancer survivors in the United States, health-related quality of life (HRQOL) has become a major priority. We describe HRQOL in a nationally representative sample of cancer survivors and examine associations with key sociodemographic, clinical, and lifestyle characteristics. **Methods:** Cancer survivors, defined as individuals ever diagnosed with cancer (N = 877), were identified from the 2016 Medical Expenditure Panel Survey-Experiences with Cancer Survivorship Supplement, a nationally representative survey. Physical and mental health domains of HRQOL were measured by the Global Physical Health (GPH) and Global Mental Health (GMH) subscales of the Patient-Reported Outcomes Measurement Information System Global-10. Multivariable linear regression was used to examine associations of sociodemographic, clinical, and lifestyle factors with GPH and GMH scores. All statistical tests were 2-sided. **Results:** Cancer survivors' mean GPH (49.28, SD = 8.79) and mean GMH (51.67, SD = 8.38) were similar to general population means (50, SD = 10). Higher family income was associated with better GPH and GMH scores, whereas a greater number of comorbidities and lower physical activity were statistically significantly associated with worse GPH and GMH. Survivors last treated 5 years ago and longer had better GPH than those treated during the past year, and current smokers had worse GMH than nonsmokers (all $\beta > 3$ and all $P < .001$). **Conclusions:** Cancer survivors in the United States have generally good HRQOL, with similar physical and mental health scores to the general US population. However, comorbidities, poor health behaviors, and recent treatment may be risk factors for worse HRQOL. Multimorbidity management and healthy behavior promotion may play a key role in maximizing HRQOL for cancer survivors.

There were 16.9 million cancer survivors in the United States in 2019 (1). More than two-thirds are long-term survivors, having lived 5 or more years since their cancer diagnoses (2). Cancer survivors often experience long-term and late effects of treatment, leading to impaired health-related quality of life (HRQOL) (3-7). Survivors prioritize optimizing HRQOL as a goal in their long-term care and life decisions (8,9). Oncology research increasingly uses HRQOL as an important outcome in observational studies, interventions, and health surveillance (10,11). Oncology practice increasingly uses patient-reported outcomes to identify cancer patients' needs related to symptoms, psychosocial needs, and HRQOL (10,11).

Previous research among selected populations of cancer survivors suggests that poor HRQOL is associated with low socioeconomic status, lack of private insurance, comorbid conditions, and intensive treatment (3,5,12-16). Poor HRQOL is also associated with lifestyle factors such as obesity and physical inactivity (6,13,17-19). Few studies (4,6,7) have examined HRQOL among nationally representative, population-based samples of cancer survivors, but they were based on older data before 2011. Advances in treatment may result in different symptoms and late effects from traditional therapies (20-23). Moreover, a number of efforts have been implemented to improve care of cancer survivors, including survivorship care plans highlighting discussions of late and long-term effects of treatment, the need for follow-up care, lifestyle recommendations, and emotional and social needs (24,25). Thus, a current evaluation of the HRQOL for US cancer survivors is needed.

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The Medical Expenditure Panel Survey (MEPS) has been collecting data on health status and health care use and expenditures among a nationally representative sample of the noninstitutionalized US population since 1996 (26). In 2016, a supplemental questionnaire designed to measure patient experiences with cancer was fielded to eligible MEPS participants self-reporting a history of cancer; it is referred to as the MEPS Experiences with Cancer Survivorship Supplement (MEPS-ECSS) (27). The MEPS-ECSS provides a nationally representative sample of cancer survivors who have provided HRQOL information using the Patient-Reported Outcomes Measurement Information System (PROMIS) measures of physical and mental health, making it well suited to investigate HRQOL among cancer survivors. Using information from the MEPS-ECSS, we examined HRQOL and its association with key sociodemographic, clinical, and lifestyle factors among cancer survivors.

Methods

Sample Population

Adult cancer survivors were identified from the 2016 MEPS-ECSS conducted by the Agency for Healthcare Research and Quality (26,27). The ECSS used a mailed questionnaire to collect data about cancer survivorship, health-care access, ability to participate in usual activities and work, health insurance, and quality of life. The response rate for 2016 MEPS was 46.0%, and the response rate for the ECSS was 81.2%, yielding an overall response rate of 37.4% (26). Because the MEPS data are deidentified and publicly accessible, the study does not constitute human participant research and an institutional review board approval was not required.

From the 1236 cancer survivors, after excluding individuals diagnosed solely with nonmelanoma skin cancer or skin cancer of unknown type (n = 267), who did not answer all HRQOL questions (n = 72), or who were uninsured (n = 20), due to small number and its high correlation with age, our analytic sample included 877 cancer survivors ages 18 years and older (Supplementary Figure 1, available online).

Outcome Variables

The MEPS-ECSS included 8 questions (Supplementary Table 1, available online) from the PROMIS Global Health 10, excluding the 2 questions on general health and satisfaction with social roles that do not contribute to scale scores (28). Four of the 8 items (physical health, physical function, fatigue, and pain interference) reflect different aspects of physical health and contribute to a Global Physical Health (GPH) score, and another 4 items (quality of life, mental health, social support, and emotional problems) reflect different aspects of mental health and contribute to a Global Mental Health (GMH) score (28). Higher scores represent better HRQOL. The PROMIS Global Health has been validated for use in research and clinical settings (28-30).

The GPH and GMH were our primary outcomes. Raw scores for GPH and GMH were converted into T-scores (Supplementary Table 2, available online; T-score distributions of both GPH and GMH are standardized such that 50 represents the mean for the US general population with a SD of 10) (31) and analyzed as continuous variables. A difference of 3.0-5.0 points is considered a meaningful difference (32). Ratings of 2 items measuring pain and fatigue (common symptoms in cancer survivors) were dichotomized and examined as secondary outcomes. For cancer pain interference, a score of 4 or higher on a 10-point scale indicated moderate or severe interference (33); for fatigue, we dichotomized the 5-point scale responses of "moderate," "severe," or "very severe" vs "mild" or "none" based on distribution (Supplementary Figure 2, available online) and for consistency with the pain dichotomization.

Sociodemographic, Clinical, and Lifestyle Characteristics

Self-reported independent variables were selected based on a priori knowledge on risk factors of HRQOL, including age (18-54 years, 55-64 years, 65-74 years, 75+ years), sex, race and ethnicity (non-Hispanic White or other), marital status (married or widowed, divorced, separated, or never married), education level (less than high school graduate, high school graduate, some college or more), family income level (low [<139% federal poverty level (FPL)], middle [139%-400% FPL], high [400%+ FPL]), health insurance coverage (any private, public only), and employment status (employed, retired, unable to work because of illness or disability or having a job to return to, not working for other reasons). As widely used by previous studies (34-36), comorbidities were measured using MEPS priority conditions, including arthritis, asthma, diabetes, emphysema, heart disease (angina, coronary heart disease, heart attack, other heart conditions or diseases), high cholesterol, hypertension, and stroke. The total numbers of comorbidities were also categorized for each respondent (0, 1, 2, 3, or 4+). Cancer types were grouped in the following categories: female breast, prostate, colorectal, cervical, melanoma, uterine, and other (including bladder, lung, lymphoma, and other less common cancer types). They were combined with sex and regrouped into female breast cancer only, prostate cancer only, female other, and male other to obtain stable estimation in modeling based on the sex differences in HRQOL (4,13) and distribution of cancer types in both sexes. Years since last treatment were categorized as less than 1, 1 to less than 5, 5 or longer, and never treated or missing. Weight status was categorized as normal weight (body mass index [BMI] = 18.5-24.9 kg/m^2), overweight (BMI = 25-29.9 kg/m^2), obese (BMI = 30+ kg/m^2), or other (BMI <18.5 kg/m^2 or unknown). Meeting physical activity guidelines (yes or no/unknown) was defined as currently spending 0.5 hour or more in moderate to vigorous physical activity at least 5 times per week, per the American Cancer Society physical activity guidelines for cancer survivors (37). Cigarette smoking status was measured as currently smoking (yes or no/unknown).

Statistical Analyses

Sample characteristics were summarized with descriptive statistics. Sample weights were used to estimate the size of the survivor population in the United States in each category. The distributions of the GPH and GMH raw scores and T-scores were calculated for the total sample (Supplementary Figure 2, available online). Generalized linear regression models were fitted to examine the associations of sociodemographic, clinical, and lifestyle factors with GPH and GMH T-scores; logistic regressions were used for pain and fatigue. Bivariable and multivariable regression models were fitted. Sex and cancer type were combined into 1 variable in multivariable models, employment status was excluded from multivariable models due to high collinearity with age, and number of comorbid conditions and exact comorbid conditions were included in the multivariable

models alternatively. *P* values for each level of independent variables were presented to indicate the HRQOL variation across different groups defined by each specific characteristic factor. A *P* value of less than .05 with parameter estimate of 3.0 or greater was considered a statistically significant and clinically meaningful difference. All statistical tests were 2-sided. Analyses were conducted with SAS 9.4 (Cary, NC). All analyses incorporated weighting to account for the complex survey design and survey nonresponse.

Results

Among the 877 cancer survivors, which represent 13.4 million survivors nationally, the majority were 65 years or older (59.9%), female (60.5%), non-Hispanic White (81.6%), married (58.3%), with at least high school education (86.4%), with any private insurance (66.0%), and not employed (65.0%) (Table 1). Nearly 90% had at least 1 comorbidity, and about one-half had 3 or more comorbidities. The most common comorbidities were hypertension, arthritis, and high cholesterol. Female breast cancer and prostate cancer were the most common types of cancer reported. A total of 43% were treated for their cancer within the past 5 years. Most survivors were overweight or obese (65.8%), did not meet physical activity guidelines (56.9%), and were not current smokers (89.1%), representing 8.9 million, 7.6 million, and 11.9 million survivors in the nation, respectively (Table 1).

The GPH and GMH T-scores of survivors in our sample (mean [SD] = 49.28 [8.79] and 51.67 [8.38], respectively) were similar to scores in the general population (ie, within 3 points of the general population means of 50) (Table 1). T-scores (mean [SD]) in subpopulations of cancer survivors indicated the worst physical HRQOL in those unemployed due to illness or disability (38.64 [7.75]) and those with comorbid emphysema (41.51 [8.12]) or stroke (41.92 [7.65]) and the worst mental HRQOL in those unemployed due to illness or disability (42.60 [7.47]) and current smokers (43.73 [8.26]). Employed survivors, those without comorbidity, and those meeting physical activity guidelines had the best HRQOL in both domains (all mean T-scores $\geq$53).

Table 2 shows associations of socioeconomic, clinical, and lifestyle factors with HRQOL from bivariate and multivariable models. In the bivariable models, most independent variables had statistically significant associations with GPH and GMH. In multivariable models, high family income was statistically significantly associated with better GPH ($\beta = 3.60$) and GMH ($\beta = 3.44$), having 2 or more comorbidities ($\beta = -4.50$, -4.89, and -9.80 for 2, 3, and 4+ comorbidities, respectively) and not meeting physical activity guidelines ($\beta = -4.42$) were associated with worse GPH, and having 3 or more comorbidities ($\beta = -3.30$ and -7.08 for 3 and 4+ comorbidities, respectively) and not meeting physical activity guidelines ($\beta = -3.38$) were associated with worse GMH (all $P < .001$). Moreover, survivors last treated 5 years or longer ago had better GPH than those treated during the past year ($\beta = 3.37$); older age was associated with better GMH ($\beta = 4.81$) and currently smoking was associated with worse GMH ($\beta = -4.99$) (Table 2, all $P < .001$). When including exact comorbid conditions instead of the number of comorbid conditions in the multivariable models, we found that emphysema and stroke were associated with poorer GPH ($\beta = -4.10$ and $\beta = -4.07$, respectively) and GMH ($\beta = -3.73$ and $\beta = -3.55$, respectively). Moreover, arthritis ($\beta = -4.07$) and diabetes ($\beta = -3.72$) were associated with poorer GPH (Table 3, all $P < .001$).

Cancer survivors treated 5 years or longer ago were statistically significantly less likely to report moderate or higher pain (odds ratio [OR] = 0.61, 95% confidence interval = 0.38 to 0.97) or fatigue (OR = 0.49, confidence interval = 0.32 to 0.75) compared with those treated during the past year. Survivors with 2 or more comorbidities (ORs > 2; $P < .05$) were more likely to report such symptoms (Supplementary Tables 3 and 4, available online).

Discussion

In this study, we analyzed sociodemographic, clinical, and lifestyle information from a cancer survivor questionnaire nested within a contemporary nationally representative survey. Higher family income, older age, and longer time since last treatment were associated with better HRQOL in physical and/or mental domains, whereas comorbidities, especially emphysema and stroke, and unhealthy lifestyle factors such as not meeting physical activity guidelines and smoking were statistically significantly associated with poorer HRQOL. Our findings highlight the importance of multimorbidity management and healthy behavior promotion for cancer survivors and providers who serve this growing population.

We found the number and type of comorbidities were strongly associated with survivors' HRQOL in both physical and mental health domains, consistent with recent findings (4). Having 3 or more comorbid conditions or having emphysema or stroke was associated with the poorest HRQOL scores. Comorbid conditions could develop independently as survivors age or might be late effects of cancer treatments (3,38). Medicare claims data showed that the common comorbid chronic conditions among elderly cancer patients include cardiovascular illness, metabolic illness, mental health problems, and musculoskeletal conditions (39), largely consistent with our data in cancer survivors. These comorbidities can cause pain and/or fatigue, 2 common symptoms that cancer survivors suffer from with detrimental effects to their physical, social, and emotional function (3,4,40-42). This suggests that those providing care to cancer survivors with comorbid conditions should be especially vigilant for debilitating cancer-related and other symptoms that may be impairing their health, functioning, and quality of life. Moreover, provider discussion and treatment of such symptoms may support improved quality of life and other health outcomes for survivors.

Lifestyle factors, including physical activity and smoking, showed strong associations with HRQOL in our study, consistent with previous research (13,17,18,43,44). In this nationally representative sample of cancer survivors, over one-half did not meet physical activity guidelines, and 10% were current smokers, representing 7.6 million and 1.5 million survivors in the nation respectively, suggesting the need for intervention. Improving healthy behaviors such as weight management, increasing physical activity, and smoking cessation are effective strategies to improve well-being, especially for cancer survivors (45-47). Physical activity can alleviate side effects and lasting effects of cancer treatments such as fatigue, insomnia, sexual dysfunction, metabolic syndrome, bone loss, and cognitive dysfunction (3). However, lasting behavior change can be challenging without professional intervention. In a recent study, less than 40% cancer survivors reported ever discussing lifestyle or health recommendations in detail with any provider at any time since cancer diagnosis (48). The Affordable Care Act has implemented multiple provisions to improve access to clinical preventive services by removing cost barriers and funding health promotion programs in workplaces and communities

Table 1. Characteristics and HRQOL of cancer survivors, MEPS 2016

Characteristic	Sample, No.	Weighted %	Weighted No. (million)	GPH T-score Mean (SD)	GMH T-score Mean (SD)
Total	877	100.0	13.4	49.28 (8.79)	51.67 (8.38)
Sociodemographic factors					
Age group, y					
18-54	186	19.9	2.7	48.49 (8.98)	49.74 (8.66)
55-64	170	20.1	2.7	51.51 (8.48)	53.08 (8.36)
65-74	252	29.4	3.9	49.31 (8.95)	51.21 (8.40)
≥75	269	30.5	4.1	48.29 (8.55)	52.47 (8.01)
Sex					
Male	337	39.5	5.3	50.06 (8.09)	51.84 (7.53)
Female	540	60.5	8.1	48.77 (9.24)	51.57 (8.95)
Race/ethnicity					
Non-Hispanic White only	594	81.6	10.9	49.75 (8.56)	52.30 (8.22)
All other race/ethnicities	283	18.4	2.5	47.21 (9.74)	48.93 (8.81)
Current marital status					
Married	473	58.3	7.8	50.37 (7.98)	52.86 (7.95)
Not married[a]	404	41.7	5.6	47.74 (9.74)	50.03 (8.81)
Educational attainment					
Less than high school graduate	159	13.6	1.8	43.48 (9.63)	46.73 (8.85)
High school graduate	254	28.2	3.8	47.76 (8.44)	50.02 (8.14)
Some college or more	462	58.2	7.8	51.34 (8.26)	53.58 (7.95)
Family income as percent of poverty line					
Low income <139%	224	19.3	2.6	44.39 (9.55)	47.48 ± 9.78
Middle income 139%-400%	323	34.0	4.5	47.18 (9.06)	49.77 ± 8.12
High income >400%	330	46.7	6.2	52.83 (7.26)	54.80 ± 7.21
Health insurance coverage[b]					
Any private	518	66.0	8.8	51.44 (7.88)	53.42 ± 7.85
Public only	359	34.0	4.5	45.08 (9.61)	48.30 ± 8.86
Employment status					
Employed	276	35.0	4.7	54.07 (7.15)	54.89 (7.43)
Retired	312	37.5	5.0	49.96 (7.35)	53.27 (6.96)
Unable to work because ill/disabled	150	13.9	1.9	38.64 (7.75)	42.60 (7.47)
Not working for other reasons	139	13.7	1.8	45.96 (10.31)	48.32 (10.13)
Clinical factors					
No. of comorbid conditions[c]					
0	88	10.4	1.4	55.00 (7.35)	55.53 (7.23)
1	166	18.1	2.4	54.48 (7.11)	54.39 (7.36)
2	167	21.3	2.9	50.81 (8.14)	53.45 (7.51)
3	188	20.5	2.7	49.20 (7.67)	51.89 (7.76)
≥4	268	29.7	4.0	43.05 (8.81)	47.24 (9.15)
Comorbid condition[c]					
Arthritis	504	58.3	7.8	46.75 (8.71)	50.15 (8.73)
Asthma	111	11.4	1.5	44.73 (11.18)	47.11 (10.18)
Diabetes	184	19.3	2.6	43.28 (9.48)	47.29 (8.55)
Emphysema	66	7.7	1.0	41.51 (8.12)	44.37 (8.12)
Heart disease	300	36.3	4.8	46.11 (9.02)	50.19 (9.16)
High cholesterol	488	56.0	7.5	47.98 (8.67)	50.85 (8.44)
Hypertension	550	59.6	8.0	47.12 (8.99)	50.14 (8.46)
Stroke	100	10.7	1.4	41.92 (7.65)	45.51 (9.23)
Cancer type					
Female breast	224	25.5	3.4	49.95 (9.94)	52.41 (9.27)
Prostate	155	16.8	2.2	51.38 (9.11)	54.29 (8.59)
Colorectal	83	9.0	1.2	47.76 (10.63)	50.28 (9.32)
Melanoma	69	9.9	1.3	50.39 (10.53)	54.04 (8.81)
Cervical	69	7.1	0.9	47.75 (10.05)	49.31 (9.67)
Uterus	56	6.6	0.9	49.17 (8.73)	52.64 (10.49)
Other	275	31.1	4.2	47.58 (10.83)	49.62 (10.32)
Years since last cancer treatment					
<1	209	23.9	3.2	46.31 (8.44)	49.88 (8.09)
1 to <5	173	19.1	2.6	48.67 (8.02)	50.74 (7.19)
≥5	379	44.5	5.9	50.89 (9.10)	52.79 (8.82)
Never treated/missing	116	12.5	1.7	50.17 (8.74)	52.60 (8.97)

(continued)

Table 1. (continued)

Characteristic	Sample, No.	Weighted %	Weighted No. (million)	GPH T-score Mean (SD)	GMH T-score Mean (SD)
Lifestyle factors					
BMI, kg/m^2					
18.5 to 24.9	242	28.5	3.8	51.78 (8.80)	53.13 (8.56)
25 to 29.9	283	32.3	4.3	51.25 (7.63)	53.41 (8.14)
≥30	304	33.5	4.5	46.00 (8.84)	49.29 (8.16)
<18.5 or unknown	48	5.8	0.8	44.93 (9.54)	48.66 (7.02)
Meeting physical activity guidelines[d]					
Yes	336	43.1	5.8	53.63 (7.65)	54.99 (7.52)
No/unknown	511	56.9	7.6	45.98 (8.63)	49.17 (8.42)
Current smoker					
Yes	104	10.9	1.5	43.88 (8.86)	43.73 (8.26)
No/unknown	773	89.1	11.9	49.94 (8.62)	52.65 (8.04)

[a]Not married includes widowed, divorced, separated, or never married.
[b]Public insurance includes Medicare, Medicaid, and/or other public hospital or physician coverage. TRICARE/CHAMPVA was treated as private coverage, as were employer-based, union-based, and other private insurance.
[c]Comorbid conditions include arthritis, asthma, diabetes, emphysema, heart disease (angina, coronary heart disease, heart attack, other heart condition/disease), high cholesterol, hypertension, and stroke.
[d]Meeting physical activity guidelines defined as currently spending one-half hour or more in moderate to vigorous physical activity at least 5 times per week.
BMI = body mass index; GMH = global mental health; GPH = global physical health; HRQOL = health-related quality of life; MEPS = Medical Expenditure Panel Survey.

Table 2. Factors associated with HRQOL among cancer survivors, MEPS 2016[a] multivariable model

	Global physical health				Global mental health			
	Bivariate model		Multivariable model		Bivariate model		Multivariable model	
Characteristic	β (SE)	P	β (SE)	P	β (SE)	P	β (SE)	P
Sociodemographic factors								
Age group, y								
18-54	Ref		Ref		Ref		Ref	
55-64	3.02 (0.78)	<.001	2.66 (0.66)	<.001	3.34 (0.84)	<.001	2.79 (0.75)	<.001
65-74	0.81 (0.63)	.20	2.99 (0.51)	<.001	1.47 (0.48)	.003	2.69 (0.44)	<.001
≥75	−0.21 (0.51)	.69	3.24 (0.51)	<.001	2.73 (0.49)	<.001	4.81 (0.47)	<.001
Sex								
Male	Ref				Ref			
Female	−1.29 (0.45)	.005	—	—	−0.27 (0.42)	0.52	—	—
Race/ethnicity								
Non-Hispanic White only	Ref		Ref		Ref		Ref	
All other race/ethnicities	−2.53 (0.47)	<.001	−1.76 (0.53)	.001	−3.37 (0.43)	<.001	−2.41 (0.39)	<.001
Current marital status								
Married	Ref		Ref		Ref		Ref	
Not married[a]	−2.63 (0.50)	<.001	1.02 (0.48)	.04	−2.83 (0.52)	<.001	−0.10 (0.57)	.86
Educational attainment								
Less than high school graduate	Ref		Ref		Ref		Ref	
High school graduate	4.28 (0.58)	<.001	1.00 (0.52)	.06	3.29 (0.66)	<.001	0.73 (0.55)	.19
Some college or more	7.86 (0.59)	<.001	1.82 (0.54)	<.001	6.86 (0.67)	<.001	1.88 (0.58)	.002
Family income as percent of poverty line								
Low income ≤138%	Ref		Ref		Ref		Ref	
Middle income 139%-400%	2.79 (0.62)	<.001	1.11 (0.58)	.06	2.29 (0.73)	.002	0.97 (0.57)	.09
High income >400%	8.44 (0.54)	<.001	3.60 (0.60)	<.001	7.32 (0.74)	<.001	3.44 (0.68)	<.001
Health insurance coverage[c]								
Any private	Ref		Ref		Ref		Ref	
Public only	−6.35 (0.52)	<.001	−2.70 (0.43)	<.001	−5.12 (0.41)	<.001	−1.68 (0.37)	<.001
Employment status								
Employed	Ref				Ref			
Retired	−4.10 (0.50)	<.001	—	—	−1.62 (0.48)	.001	—	—
Unable to work because ill/disabled	−15.42 (0.60)	<.001	—	—	−12.29 (0.62)	<.001	—	—
Not working for other reasons	−8.10 (0.81)	<.001	—	—	−6.58 (0.62)	<.001	—	—

(continued)

Table 2. (continued)

Characteristic	Global physical health				Global mental health			
	Bivariate model		Multivariable model		Bivariate model		Multivariable model	
	β (SE)	P	β (SE)	P	β (SE)	P	β (SE)	P
Clinical factors								
No. of comorbid conditions[d]								
0	Ref		Ref		Ref		Ref	
1	−0.52 (0.84)	.54	−0.72 (0.72)	.32	−1.14 (0.79)	0.15	−1.33 (0.83)	.11
2	−4.19 (0.74)	<.001	−4.50 (0.65)	<.001	−2.08 (0.74)	.006	−2.87 (0.78)	<.001
3	−5.80 (0.65)	<.001	−4.89 (0.58)	<.001	−3.64 (0.87)	<.001	−3.30 (0.81)	<0.001
≥4	−11.95 (0.69)	<.001	−9.80 (0.70)	<.001	−8.29 (0.75)	<.001	−7.08 (.77)	<.001
Comorbid condition[d]								
Arthritis	−6.07 (0.50)	<.001	—	—	−3.67 (0.45)	<.001	—	—
Asthma	−5.14 (0.67)	<.001	—	—	−5.16 (0.60)	<.001	—	—
Diabetes	−7.42 (0.62)	<.001	—	—	−5.43 (0.36)	<.001	—	—
Emphysema	−8.42 (0.75)	<.001	—	—	−7.92 (0.66)	<.001	—	—
Heart disease	−4.98 (0.50)	<.001	—	—	−2.33 (0.44)	<.001	—	—
High cholesterol	−2.95 (0.41)	<.001	—	—	−1.87 (0.39)	<.001	—	—
Hypertension	−5.34 (0.51)	<.001	—	—	−3.80 (0.44)	<.001	—	—
Stroke	−8.23 (0.59)	<.001	—	—	−6.90 (0.47)	<.001	—	—
Cancer type								
Female breast only	Ref		Ref		Ref		Ref	
Prostate only	1.52 (0.64)	.02	1.29 (0.40)	.002	1.63 (0.56)	.004	1.13 (0.43)	.009
Female other	−2.51 (0.51)	<.001	−0.54 (0.40)	.18	−1.66 (0.48)	<.001	0.44 (0.40)	.28
Male other	−1.31 (0.71)	.06	−0.96 (0.59)	.10	−2.18 (0.56)	.001	−1.69 (0.54)	.002
Years since last cancer treatment								
<1	Ref		Ref		Ref		Ref	
1 to <5	2.36 (0.63)	<.001	1.56 (0.52)	.003	0.86 (0.55)	.12	0.11 (0.43)	.81
≥5	4.58 (0.55)	<.001	3.37 (0.44)	<.001	2.92 (0.53)	<.001	1.86 (0.43)	<.001
Never treated/missing	3.86 (0.73)	<.001	3.95 (0.74)	<.001	2.72 (1.01)	.008	2.42 (1.00)	.01
Lifestyle factors								
BMI, kg/m^2								
18.5-24.9	Ref		Ref		Ref		Ref	
25-29.9	−0.53 (0.58)	.36	−0.61 (0.50)	.22	0.28 (0.62)	.65	0.10 (0.53)	.85
≥30	−5.78 (0.63)	<.001	−2.88 (0.46)	<.001	−3.85 (0.44)	<.001	−1.47 (0.39)	<.001
Meeting physical activity guidelines[e]								
Yes	Ref		Ref		Ref		Ref	
No/unknown	−7.65 (0.40)	<.001	−4.42 (0.34)	<.001	−5.81 (0.37)	<.001	−3.38 (0.32)	<.001
Current smoker								
No/unknown	Ref		Ref		Ref		Ref	
Yes	−6.06 (0.61)	<.001	−2.08 (0.67)	.002	−8.92 (0.42)	<.0001	−4.99 (0.48)	<.001

[a]Results from linear regression models. In multivariable models, sex and cancer type were combined into 1one variable, employment status was excluded due to high collinearity with age, and number of comorbid conditions and exact comorbid conditions were included in models alternatively. — = inapplicable as the variable was not included in the multivariable models; BMI = body mass index; HRQOL = health-related quality of life; MEPS = Medical Expenditure Panel Survey.
[b]Not married includes widowed, divorced, separated, or never married.
[c]Public insurance includes Medicare, Medicaid, and/or other public hospital or physician coverage. TRICARE/CHAMPVA was treated as private coverage, as were employer-based, union-based, and other private insurance.
[d]Comorbid conditions include arthritis, asthma, diabetes, emphysema, heart disease (angina, coronary heart disease, heart attack, other heart condition or disease), high cholesterol, hypertension, and stroke.
[e]Meeting physical activity guidelines defined by currently spending one-half hour or more in moderate to vigorous physical activity at least 5 times per week based on the American Cancer Society guideline.

(49). Moreover, by increasing health insurance coverage options (50-52), professional assistance for changing unhealthy behaviors (eg, obesity counseling, and smoking cessation counseling and medications) may be more accessible and affordable. Efforts are warranted to increase providers' awareness of health behavior services covered by health insurance to which patients and survivors can be referred and to increase provider-patient discussion of health behaviors, which could potentially improve healthy behaviors among survivors and lead to better HRQOL.

This study's strengths include a recent, large, nationally representative sample of cancer survivors; PROMIS Global Health scores, a well-tested and validated HRQOL measure; and examination of key risk factors for poor HRQOL. This study shares limitations of many survey-based studies: the data are cross-sectional, limiting our ability to make causal inferences from the results; information about behaviors and cancer types of associated factors are self-reported and may be subject to recall errors; and the overall MEPS-ECSS response rate was relatively low. Although we used MEPS sample weights in all analyses, and they incorporate adjustments for survey nonresponse and reduce potential survey nonresponse bias, these weights cannot eliminate it entirely. Survey sample weights reflect the

Table 3. Adjusted associations of comorbid conditions with HRQOL among cancer survivors, MEPS 2016[a]

	Global physical health		Global mental health	
Comorbid condition	β (SE)	P	β (SE)	P
Arthritis	−4.07 (0.41)	<.001	−2.74 (0.40)	<.001
Asthma	−1.49 (0.63)	.02	−2.05 (0.50)	<.001
Diabetes	−3.72 (0.56)	<.001	−2.82 (0.36)	<.001
Emphysema	−4.10 (0.83)	<.001	−3.73 (0.60)	<.001
Heart disease	−2.10 (0.36)	<.001	−0.39 (0.42)	.35
High cholesterol	0.12 (0.39)	.75	0.14 (0.39)	.72
Hypertension	−1.59 (0.44)	<.001	−1.42 (0.47)	.003
Stroke	−4.07 (0.60)	<.001	−3.55 (0.45)	<.001

[a]Multivariable linear regression models were adjusted for current age group, race or ethnicity, current marital status, education, family income, health insurance, cancer type, years since diagnosis, body weight status, meeting physical activity guidelines, and current smoking status. HRQOL = health-related quality of life; MEPS = Medical Expenditure Panel Survey.

assumption that nonrespondents are similar to respondents within all weighting classes. However, survey nonrespondents may differ from respondents in unmeasured ways. Nonetheless, the overall MEPS-ECSS response rate is consistent with other national and state surveys in the United States. We were unable to adjust for other clinical factors that may affect HRQOL, such as cancer stage, specific cancer treatments, and other comorbidities not systematically queried in the MEPS. Given small numbers of unknown values, we combined the unknowns with the "no" category of meeting physical activity guidelines and smoking, which may lead to an underestimation of the detrimental effects of unhealthy behaviors on HRQOL. Also, because the PROMIS questionnaire was only administered among cancer survivors and not all MEPS participants, we were not able to compare HRQOL and its associations with various factors between cancer survivors and individuals without a cancer history. Future studies are warranted to investigate the synergistic effects of cancer history, comorbidities, and lifestyle behaviors on HRQOL to inform tailored approaches for improving quality of life.

In conclusion, using a recent nationally representative survey of cancer survivors, we found that survivors with low family income, those with 3 or more comorbidities, and the recently treated were more likely to report poor HRQOL. These sociodemographic and clinical characteristics can be used to identify survivors at risk of poor HRQOL in clinical and public health settings. Moreover, poor HRQOL was strongly associated with greater comorbidity burden and unhealthy lifestyle behaviors, including not meeting physical activity guidelines and smoking, suggesting that multimorbidity management and healthy behavior promotion may play a key role in optimizing HRQOL for cancer survivors.

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Data Availability

Data are publicly accessible at https://meps.ahrq.gov/mepsweb/data_stats/download_data_files.jsp

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