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Socioeconomic Disparities in Health-Related Quality of Life Among Colorectal Cancer Survivors

Jean A. McDougall, PhD, MPH^{1,2}, Cindy K. Blair, PhD^{1,2}, Charles L. Wiggins, PhD^{1,2}, Michael B. Goodwin, MA³, Vi K. Chiu, MD, PhD^{1,2}, Ashwani Rajput, MD^{1,4}, Anita Y. Kinney, PhD, RN⁵

¹University of New Mexico Comprehensive Cancer Center, Albuquerque, New Mexico;

²University of New Mexico School of Medicine, Department of Internal Medicine, Albuquerque, New Mexico

³University of New Mexico, Department of Economics, Albuquerque, New Mexico

⁴University of New Mexico School of Medicine, Department of Surgery, Albuquerque, New Mexico

⁵Rutgers, The State University of New Jersey, School of Public Health, New Brunswick, NJ

Abstract

Purpose: Improvements in colorectal cancer (CRC) prevention, early detection, and treatment have resulted in substantial gains in survival. However, the health-related quality of life (HRQoL) of CRC survivors often depends on access to supportive care, which differs by survivors' socioeconomic characteristics. The purpose of this study was to investigate the relationship between socioeconomic characteristics and HRQoL in a diverse group of CRC survivors.

Methods: We conducted a population-based, cross-sectional study to examine the association between socioeconomic factors (household income, health literacy, and insurance status) and HRQoL domains of pain interference, fatigue, physical function, sleep disturbance, anxiety, and depression. PROMIS[®] Short Forms v.2.0 were used to assess domains of HRQoL. Linear regression modeling was used to estimate the coefficient representing the average HRQoL domain score and its 95% confidence interval (CI).

Results: Three-hundred-one CRC survivors participated in the survey. Low-income (< \$30,000) CRC survivors had, on average, a 4.70-point (95% CI 1.10-8.28) higher pain interference score, a 7.02-point (95% CI 3.27-10.77) higher fatigue score, a 5.13-point (95% CI -8.56 to -1.71) lower physical function score, and a 4.44-point (95% CI 1.40-7.49) higher depression score than CRC survivors with an income ≥ \$70,000. Survivors with Medicaid insurance reported significantly greater pain interference and worse physical function than privately-insured survivors. Survivors

Corresponding author: Jean A. McDougall, PhD, MPH, Address: 1 University of New Mexico, MSC105550, Albuquerque, NM 87131-0001, Telephone: 505-925-1215 Fax: 505-925-4459, jamcdougall@salud.unm.edu.

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with low health literacy reported significantly greater pain interference compared to survivors with high health literacy.

Conclusions: Substantial socioeconomic disparities in HRQoL were observed in this diverse population of CRC survivors.

Implications for Cancer Survivors: Designing supportive care interventions to improve HRQoL among low-income and Medicaid-insured CRC survivors is critical for eliminating disparities in CRC outcomes.

Keywords

Colorectal; cancer; disparities; survivorship; income; insurance

INTRODUCTION

There are 1.5 million colorectal cancer (CRC) survivors in the United States [1]. Improvements in CRC prevention, early detection, and treatment have resulted in substantial gains in survival, and individuals diagnosed with localized and regional disease have a relative five-year survival probability of 90% and 71%, respectively [2]. However, the diagnosis of CRC and the physical, psychological, and financial effects of treatment may still result in substantial hardships for survivors and their families. As CRC treatment continues to improve, increased attention to the quality of life of CRC survivors is warranted.

CRC survivors tend to report poorer health-related quality of life (HRQoL) than individuals without a history of cancer [3–6]. The long-term physical and mental well-being of CRC survivors is influenced by their treatments received, age, time since diagnosis, and social and environmental factors [7]. In addition, an individual's economic experience with cancer, and the resources that they have to cope successfully with that experience, directly impact HRQoL [8, 9]. Access to supportive care is important in preventing distress and morbidity [10, 11]. Defined by the National Cancer Institute as care given to improve the quality of life of patients who have a serious or life-threatening disease, the goal of supportive care is to prevent or treat as early as possible the symptoms of a disease, side effects caused by treatment of a disease, and psychological, social, and spiritual problems related to a disease or its treatment.[12] However, socioeconomic inequalities in access to supportive care may result in disparities in HRQoL. While lower income is associated with poorer HRQoL in several prior studies of CRC survivors [8, 13, 14], the relationship between other socioeconomic factors, such as insurance and health literacy, and HRQoL have not been comprehensively examined.

Understanding the relationship between multiple socioeconomic factors and HRQoL among CRC survivors is critical for developing effective interventions to improve CRC survivorship. Moreover, addressing the unmet needs of low-income CRC survivors has outstanding potential to reduce widening socioeconomic disparities in cancer mortality [15]. The objective of this study was to investigate associations between socioeconomic factors, including annual household income, health literacy, and insurance and patient-reported

HRQoL in a population-based, ethnically and geographically diverse sample of CRC survivors.

METHODS

We conducted a cross-sectional survey of CRC survivors in New Mexico. Study methods and financial-related outcomes have been published previously [16]. This study was conducted after approval by the Institutional Review Board of the University of New Mexico Health Sciences Center.

Study Participants

Individuals aged 30-75 years with a diagnosis of localized or regional (locally advanced) cancer of the colon or rectum between 2004 and 2012 were ascertained by the New Mexico Tumor Registry (NMTR), a member of the National Cancer Institute's Surveillance Epidemiology and End Results Program. We oversampled Hispanic and rural cancer survivors with the goal of achieving approximately equal numbers of rural and urban and Hispanic and non-Hispanic White subjects. Rural residence was classified using Rural-Urban Commuting Area (RUCA) codes [17].

Eligible individuals were mailed a paper copy of the survey (English or Spanish), with a postage paid return envelope, and a \$2 bill as an incentive to participate. Those that did not return the completed survey within three weeks were contacted by telephone and asked to complete the survey with a bilingual interviewer. Participants completing the survey by mail or phone were sent an additional \$25 merchandise card.

Measures

Annual household income was ascertained from a single survey question with six categorical response choices, ranging from <\$15,000 to \$100,000. After evaluating the frequency of responses, these categories were collapsed into 3 categories: <\$30,000, \$30,000-\$69,999, and \$70,000 for analysis. Household size was included as a covariate in all multivariable models.

Participants were also asked about their current health care coverage. Primary insurance type was categorized as private, Medicare, Medicaid, other government (including military or Veterans Administration coverage), or uninsured. Health literacy was measured using a single validated measure asking participants, "How confident are you filling out medical forms by yourself?" [18, 19]. Responses (*all of the time, most of the time, some of the time, a little of the time or none of the time*) were dichotomized into low (*a little of the time or none of the time*) or high (*all of the time, most of the time, some of the time*) health literacy following the recommendation of Chew et al. [17]. The highest level of education completed was categorized as 'high school, some college, and college degree'.

Additional covariates elicited from the survey included race, ethnicity, primary language spoken, marital status, primary employment status, and comorbidities. Comorbidities assessed included participant self-reported ever being told by a health professional that they had prediabetes, diabetes, asthma, arthritis, depression, hypertension, heart attack or

congestive heart failure, and chronic obstructive pulmonary disease or chronic bronchitis. Each comorbidity was combined into a composite variable and categorized by the number of comorbidities reported (0,1, 2, 3). Data on age, sex, and zip code of residence (to match with RUCA codes) at the time of cancer diagnosis were collected from NMTR records, as was clinical data on the date of diagnosis, tumor stage, and the first course of therapy. First course of therapy, including data on receipt of surgery, radiation therapy, and chemotherapy was collected by NMTR medical record abstractors in accordance with the Surveillance Epidemiology and End Results Program Coding and Staging Manual and coded as received (*yes, no, missing/unknown*) [20].

Specific PROMIS® Short Forms v.2.0 were used to evaluate physical and mental health domains of HRQoL, including pain interference, fatigue, physical function, sleep disturbance, anxiety, and depression [21]. Each form contains four questions and each question has five response options ranging in value from one (low) to five (high). Raw PROMIS® scores were obtained by summing the values of the response to each question on the Short Form and the total raw score was converted into a T-score using a scoring manual with a mean of 50 and a standard deviation (SD) of 10. A higher PROMIS® T-score represents more of the concept being measured.

Statistical Analysis

All statistical analyses were performed using STATA SE Version 14.2 (Cary, North Carolina). Descriptive statistics were calculated for demographic and clinical characteristics, including means, standard deviations (SD), and frequencies.

Mean PROMIS® scores and SDs were calculated for the cohort overall and by selected sociodemographic characteristics. To test the significance of differences in mean scores, we conducted a nonparametric test for trend across ordinal categorical demographic variables. A test for equality of means across groups of nominal categorical variables, such as race/ethnicity and insurance, was performed and heterogeneity was assessed using the Wilks' lambda test statistic. Statistical significance was evaluated at the $p < 0.05$ level.

Multivariable linear regression was used to evaluate the relationship between socioeconomic factors and each PROMIS® domain score. All multivariable models contained the *a priori* covariates age and time since CRC diagnosis (modeled continuously), comorbidity score, and first course of therapy including surgery, radiation, and or chemotherapy (modeled categorically). Categorical interaction terms between income and race/ethnicity, and income and rural versus urban residence were tested using a likelihood ratio (LR) test comparing nested models with and without the interaction terms. Health literacy, insurance, rural versus urban residence, marital status, and race/ethnicity were also investigated as potential confounders of the association between income and HRQoL. Demographic and clinical characteristics that were associated with both income and mean PROMIS® score at the $p < 0.2$ level in bivariate analyses were entered into multivariable models. A Bonferroni correction was implemented using the *mtest* command in STATA to adjust for multiple testing. The goodness of fit of the final multivariable models was assessed using LR tests of nested models to evaluate the contribution and parameterization of each covariate. Robust standard errors were used to calculate the 95% confidence interval (CI), and the variance

inflation factor (VIF) and tolerance ($1/\text{VIF}$) were estimated from the regression model to check for multicollinearity between terms in the final model. A tolerance value <0.1 , comparable to a VIF of 10, was used as the threshold for unacceptable collinearity [22]. Through this process of regression diagnostics, we found that no variables in the final regression models had a tolerance value <0.1 .

RESULTS

A total of 855 eligible individuals were identified from NMTR. We were unable to contact 363 patients and 191 contacted patients refused to participate. 301 CRC survivors completed the survey and are included in this analysis (cooperation rate: 61%; response rate 35%). Non-respondents were more likely to be Hispanic residents of rural areas than individuals who completed the survey (22% v. 15%).

The mean age of the 301 study participants was 63 years ($\text{SD}=8$) and the mean time since diagnosis was 6 years ($\text{SD}=3$) (Table 1). Hispanics comprised 42% of the study population and 15% of all participants spoke Spanish (4%) or a mixture of English and Spanish (11%) as their primary language. Thirty-nine percent lived in rural areas, 28% had a high school education, and 26% reported low health literacy. Thirty-seven percent had private medical insurance. Only 6 individuals ($<1\%$) were uninsured. Although included in all models, estimates for the uninsured group are not reported separately in the analytic models given the small number of uninsured participants.

Overall, physical and mental HRQoL PROMIS scores did not differ substantially from the general population mean of 50 ($\text{SD}=10$) (Table 2). However, statistically significant variations ($p<0.05$) in the mean PROMIS scores were observed by indicators of socioeconomic position with the highest HRQoL consistently observed among the highest income and most educated groups respectively.

In multivariable models, no heterogeneity in the relationship between income and PROMIS® scores was observed by either race/ethnicity or rural versus urban residence, our hypothesized effect modifiers. The model building and regression diagnostics resulted in different exposure variables being retained in each model, as shown in Tables 3 and 4.

After adjustment for sociodemographic and clinical characteristics, low-income ($\leq \$30,000$) CRC survivors had, on average, a 4.70-point (95% CI 1.10-8.28) higher pain interference score, a 7.02-point (95% CI 3.27-10.77) higher fatigue score, and a 5.13-point (95% CI $-8.56 - -1.71$) lower physical function score, compared to CRC survivors with an income $\geq \$70,000$ (Table 3). Additionally, low income CRC survivors reported 4.44-point (95% CI 1.40-7.49) higher depression scores.

Low health literacy was associated with an average 4.24-point (95% CI 1.70-6.77) higher pain interference score and a 3.28-point (95% CI 0.71-5.68) higher sleep disturbance score (Table 3). In addition, health literacy was associated with an average 2.89-point (95% CI 0.42-5.37) higher depression score, while education was inversely associated with anxiety (Table 4).

CRC survivors with Medicaid insurance had pain interference scores that were 7.59-points (95% CI 3.18-12.0) higher on average than those with private insurance Table 3). In addition, physical function scores for Medicaid-insured survivors were 6.94-points (95% CI -10.6--3.18) lower than privately-insured survivors. The physical PROMIS measure scores for CRC survivors with Medicare or other other government insurance did not differ significantly from those with private insurance.

DISCUSSION

This analysis contributes to our understanding of the considerable variation in specific physical and mental domains of HRQoL among CRC survivors, and documents the substantially poorer HRQoL experienced by survivors with lower incomes, Medicaid insurance, or low health literacy. In addition to finding a consistent association between income and HRQoL, similar to several prior studies [8, 23, 5], we were able to simultaneously examine associations between insurance status and health literacy levels and HRQoL. The diversity of the patient population was an important factor in our ability to investigate these indicators of socioeconomic position, given the lack of multicollinearity between income, insurance, and health literacy in this study population, confirmed by VIF and tolerance values [22]. The socioeconomic disparities in HRQoL among CRC survivors observed in our study often reached clinical significance, as defined by minimally important differences between 2 - 4 PROMIS T-score points [24–26].

The relationship between poor HRQoL and lower income observed in this study is consistent with previous findings [23, 8, 14]. Specifically, low-income adult survivors of childhood cancers were 2-times as likely to report functional impairment and 40% more likely to report pain than their higher-income peers in an analysis of the Childhood Cancer Survivor Study [23]. Moreover, CRC survivors with low socioeconomic position from a large European cohort were 50% more likely to report clinically significant anxiety and depression [8]. In addition, a recent study of Latino cancer survivors found combined household income to be positively correlated with HRQoL [14].

A lack of material resources, including income, may be a direct consequence of CRC diagnosis and treatment [27], a phenomenon that is increasingly described in terms of treatment-related financial hardship or financial toxicity [28]. We have previously published evidence of a relationship between treatment-related financial hardship and nonadherence to surveillance colonoscopy in this cohort [16], and Kent et al. reported that cancer survivors with financial problems were significantly more likely to report delaying (18.3% vs 7.4%) or forgoing overall medical care (13.8% vs 5.0%) than those without financial problems [29]. The increasing evidence of the long-term financial consequences of cancer treatment, and its disproportionately negative impact on individuals of low socioeconomic position, has recently been shown to impact both the physical and mental HRQoL and symptom management in CRC cancer survivors [30]. Overall, these findings suggest that targeted efforts to improve HRQoL and symptom management among CRC survivors of low socioeconomic position are warranted. Failure to intervene may exacerbate widening socioeconomic disparities in cancer mortality [15].

Our finding that health literacy is associated with several HRQoL domains is consistent with recent literature linking low health literacy to lower HRQoL in the general population [31]. However, our study is among the first to observe this association in CRC survivors. We previously published evidence of a strong association between low health literacy, financial hardship, and surveillance colonoscopy among CRC survivors [16], suggesting that health literacy may have independent effects on survivors ability to access supportive care and cope with the economic, physical, and psychosocial burden of a cancer diagnosis and its treatment. Developing and adapting existing effective interventions to improve chronic illness self-management among low-income and low health literacy populations, such as those described by Shaffler et al. [32], may be an important strategy for improving HRQoL among CRC survivors.

Medicaid insurance, compared to private insurance, is often associated with poorer CRC outcomes, including later stage at diagnosis, higher tumor recurrence, and lower survival [33–35]. In this study, Medicaid-insured CRC survivors reported substantially higher pain interference and lower physical function than their privately-insured peers. Differences in access to and reimbursement of supportive care services between Medicaid and private insurance may drive some of this difference. Future research to understand the supportive care needs of Medicaid-insured cancer survivors are needed.

This study's findings should be interpreted in context of its limitations. The cross-sectional design precludes the ability to determine the temporal sequence of exposures and outcomes. Low-socioeconomic position could be a cause, a consequence, or perhaps both, of the poor HRQoL and suboptimal management of symptoms reported by study participants. While patient reported outcomes (PROs) are increasingly accepted as valid measures of the physical and mental health domains [36, 37], it is also possible that reporting differs by factors associated with survey participation, resulting in selection bias. Finally, income measured at one point in time, is an imperfect proxy for the complex and dynamic factors that impact socioeconomic position. Future longitudinal studies that treat socioeconomic factors as time-varying exposures are needed. Despite these limitations, this study has several noteworthy strengths, including the ethnically, geographically, and socioeconomically diverse study population.

In conclusion, the socioeconomic disparities in HRQoL observed in this study highlight the need for intervention research to improve the quality of life among CRC survivors. Moreover, this study demonstrates that multiple indicators of socioeconomic position, including income, insurance, and health literacy are all independently associated with HRQoL, which suggests that there may be several possible avenues for intervention

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Table 1.

Patient Characteristics

Characteristic	N=301	%
Age (years)		
Minimum, Maximum	31, 75	
Mean (SD)	62.8 (7.7)	
Time since diagnosis (years)		
Mean (SD)	5.9. (2.5)	
Sex		
Male	158	52%
Female	143	48%
Race/ethnicity		
Non-Hispanic White	165	55%
Hispanic	126	42%
Other *	10	3%
Primary language spoken		
English	254	84%
Spanish	12	4%
A mix of English and Spanish	34	11%
Another language	1	<1%
Residence		
Urban	184	61%
Rural	117	39%
Marital status		
Married	193	64%
Divorced, separated, widowed	83	28%
Never married	23	8%
Missing	2	1%
Highest level of education		
High school	83	28%
Some college	112	37%
College degree	104	35%
Missing	2	1%
Health literacy		
Low	77	26%
High	222	74%
Missing	2	1%
Annual income		
<\$30,000	88	29%
\$30,000 - \$69,999	111	37%
\$70,000	85	28%
Missing	17	6%

Characteristic	N=301	%
Insurance		
Private	112	37%
Medicare	101	34%
Medicaid	34	11%
Other government	43	14%
Uninsured	6	2%
Missing	5	2%
Stage at diagnosis		
Localized	162	54%
Regional	139	46%
First course of therapy		
Surgery	283	94%
Chemotherapy	128	43%
Radiation	70	23%
Comorbidities		
0	57	19%
1	77	26%
2	61	20%
3	105	35%

* Other includes non-Hispanic African American, American Indian, and Asian.

Table 2.
Mean Physical and Mental Health-Related Quality of Life PROMIS Scores by Selected Demographic Characteristics

	Pain Interference			Fatigue			Physical Function			Sleep Disturbance			Anxiety			Depression		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Overall	296	52.1	9.7	284	48.7	10.3	281	48.3	9.3	270	49.4	9.0	287	49.4	9.0	289	48.9	8.6
Income																		
<\$30,000	88	55.2	10.4	79	52.0	11.0	85	43.8	10.1	77	51.8	9.4	81	51.8	9.9	83	51.7	9.8
\$30,000 - \$69,999	110	52.9	9.1	105	49.5	9.3	103	48.8	8.5	100	50.9	8.8	108	49.4	9.0	109	49.4	8.3
\$70,000	85	48.2	8.5	85	44.8	9.8	78	52.4	7.5	78	48.1	8.2	85	47.2	8.1	84	45.9	7.0
		p<0.001			p<0.001			p<0.001			p=0.011			p=0.002			p<0.001	
Health literacy																		
Low	76	56.1	9.3	70	50.6	10.1	71	45.5	9.3	67	53.4	8.8	70	52.7	9.3	73	52.5	9.0
High	218	50.6	9.4	212	48.1	10.3	209	49.3	9.2	201	49.3	8.7	215	48.4	8.7	214	47.7	8.2
		p<0.001			$p=0.069$			p=0.003			p=0.001			p=0.001			p<0.001	
Highest level of education																		
High school	80	54.6	10.0	73	51.1	10.2	78	45.5	10.2	73	52.1	9.9	73	52.5	9.4	75	51.7	9.6
Some college	111	52.5	9.5	109	49.4	10.0	106	47.4	9.1	98	50.5	9.2	109	48.7	9.5	111	48.6	8.6
College degree	104	49.6	9.2	101	46.1	10.2	96	51.6	8.1	98	48.8	7.4	104	48.1	7.8	102	47.2	7.5
		p<0.001			p=0.001			p<0.001			p=0.013			p=0.003			p=0.002	
Insurance																		
Private insurance	110	50.3	8.9	110	48.8	10.9	103	52.1	7.5	103	50.6	8.5	111	48.9	8.4	109	47.7	7.8
Medicare	101	51.7	9.3	95	47.5	10.0	96	47.0	9.3	90	48.6	8.6	99	48.8	8.8	101	48.6	8.7
Medicaid	33	59.6	10.6	28	54.1	9.1	32	40.8	9.1	30	54.0	10.1	29	52.3	9.8	30	54.1	9.0
Other government	42	52.5	8.9	40	48.4	8.9	39	47.5	8.8	36	51.3	8.5	38	50.1	10.2	40	49.0	9.7
		p<0.001			p=0.029			p<0.001			$p=0.053$			$p=0.394$			p=0.009	
Residence																		
Rural	116	53.1	9.8	112	50.2	10.3	110	46.8	9.7	102	50.6	9.1	113	49.9	9.6	114	50.0	9.2
Urban	180	51.5	9.6	172	47.7	10.1	171	49.2	9.0	168	50.2	8.7	174	49.1	8.7	175	48.1	8.1
		$p=0.167$			p=0.049			p=0.035			$p=0.673$			$p=0.459$			$p=0.070$	
Race/ethnicity																		
Non-Hispanic White	165	50.7	9.5	161	47.7	10.3	155	49.5	8.6	152	49.4	8.5	162	48.2	8.4	162	48.0	8.2

	Pain Interference			Fatigue			Physical Function			Sleep Disturbance			Anxiety			Depression		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Hispanic	121	54.1	9.6	114	50.5	10.1	116	46.4	10.0	109	51.3	9.2	115	51.5	9.7	117	50.2	9.2
Other	10	50.6	10.4	9	44.0	9.21	10	51.1	8.1	9	55.0	8.2	10	46.1	6.5	10	47.7	7.9
		p=0.011			p=0.031			p=0.014			p=0.056			p=0.006			p=0.095	
Marital status																		
Married	190	51.9	9.3	182	48.0	10.1	176	48.8	9.0	172	50.1	8.9	185	48.7	8.8	186	48.3	8.6
Divorced, separated, widowed	81	51.2	10.2	78	49.0	10.7	80	48.7	9.5	76	50.2	9.1	79	50.7	9.1	79	49.9	8.5
Never married	23	55.8	10.5	22	52.4	10.0	23	44.6	9.4	20	53.1	7.4	21	51.5	10.5	22	50.3	9.0
		p=0.135			p=0.164			p=0.117			p=0.346			p=0.164			p=0.252	
Comorbidities																		
0	56	48.6	8.3	53	44.4	8.6	54	25.7	5.0	49	48.3	8.1	55	47.5	8.8	56	45.9	7.6
1	76	49.2	8.4	72	45.6	9.9	73	26.3	5.9	69	48.3	8.4	71	47.6	7.9	74	47.6	7.8
2	59	52.2	8.7	58	47.9	8.6	56	28.9	6.0	54	50.3	8.1	59	48.0	7.9	57	47.4	8.0
3	104	56.0	10.3	100	53.6	10.2	97	31.7	7.9	97	52.7	9.3	101	52.7	9.7	101	52.7	9.7
		p<0.001			p<0.001			p<0.001			p=0.004			p<0.001			p<0.001	
First course of therapy																		
Surgery																		
Yes	278	52.1	9.6	269	48.8	10.2	264	28.6	7.1	253	50.5	8.9	270	49.5	9.1	272	49.0	8.7
No	13	49.8	9.6	12	44.5	11.1	12	28.1	5.3	13	47.7	6.7	13	48.8	9.0	13	46.7	7.7
		p=0.390			p=0.159			p=0.804			p=0.279			0.793			p=0.352	
Chemotherapy																		
Yes	127	51.8	9.4	122	48.1	10.2	122	29.2	7.2	111	50.6	8.9	124	49.3	8.9	124	48.6	8.6
No	159	52.3	9.9	155	48.9	10.1	149	28.1	6.9	150	50.0	8.6	154	49.6	9.1	156	49.1	8.5
		p=0.659			p=0.470			p=0.248			p=0.591			p=0.787			p=0.594	
Radiation																		
Yes	69	51.8	9.5	66	47.0	10.6	67	29.2	7.7	61	51.4	9.0	67	50.3	9.1	68	49.4	9.3
No	222	52.1	9.7	215	49.1	10.1	209	28.4	6.8	205	50.1	8.8	216	49.3	9.1	217	48.8	8.5
		p=0.800			p=0.136			p=0.458			p=0.286			p=0.416			p=0.607	

Bold text represents statistical significance at the p<0.05 level

Table 3.
Multivariable adjusted linear regression models of the relationship between socioeconomic factors and physical health PROMIS scores

Characteristic	Pain Interference			Fatigue			Physical Function			Sleep Disturbance		
	Coefficient for PROMIS Item Score *	95% CI Lower Bound	95% CI Upper Bound	Coefficient for PROMIS Item Score *	95% CI Lower Bound	95% CI Upper Bound	Coefficient for PROMIS Item Score *	95% CI Lower Bound	95% CI Upper Bound	Coefficient for PROMIS Item Score *	95% CI Lower Bound	95% CI Upper Bound
Income												
<\$30,000	4.70	1.10	8.28	7.02	3.27	10.77	-5.13	-8.56	-1.71	2.80	-0.057	6.19
\$30,000 - \$69,999	3.94	1.21	6.66	4.23	1.48	6.97	-2.22	-4.82	0.38	1.99	-0.44	4.42
\$70,000	Reference	-	-	Reference	-	-	Reference	-	-	Reference	-	-
Highest level of education												
High school	0.45	-2.36	3.27				0.32	-2.65	3.30	-0.46	-3.71	2.78
Some college	-0.74	-3.69	2.21				2.33	-0.70	5.36	-0.89	-4.22	2.43
College degree	Reference	-	-				Reference	-	-	Reference	-	-
Health literacy												
Low	4.24	1.70	6.77				-1.91	-4.48	0.66	3.28	0.71	5.86
High	Reference	-	-				Reference	-	-	Reference	-	-
Insurance												
Private insurance	Reference	-	-	Reference	-	-	Reference	-	-	Not included in model		
Medicare	-0.23	-3.31	2.83	-3.29	-6.85	0.27	-1.60	-4.64	1.42			
Medicaid	7.59	3.18	12.0	0.88	-3.59	5.35	-6.94	-10.6	-3.18			
Other government	0.76	-2.83	4.36	-1.63	-5.35	2.09	-2.59	-6.00	0.81			

Bold text represents statistical significance at the p<0.05 level

* Coefficient additionally adjusted for age, time since diagnosis, comorbidities, marital status, rural/urban residence, and first course of therapy (surgery, radiation, and/or chemotherapy)

Table 4. Multivariable adjusted linear regression models of the relationship between socioeconomic factors and mental health PROMIS scores

Characteristic	Coefficient for PROMIS Item Score *	Anxiety 95% CI Lower Bound	95% CI Upper Bound	Coefficient for PROMIS Item Score *	Depression 95% CI Lower Bound	95% CI Upper Bound
Income						
<\$30,000	3.08	0.01	6.15	4.44	1.40	7.49
\$30,000 - \$69,999	0.82	-1.67	3.32	1.89	-0.32	4.11
\$70,000	Reference	-	-	Reference	-	-
Health literacy						
Low	2.04	-0.56	4.66	2.89	0.42	5.37
High	Reference	-	-	Reference	-	-
Highest level of education						
High school	-3.27	-6.44	-0.09	-2.32	-4.59	1.39
Some college	-1.57	-4.81	1.66	-1.59	-1.21	0.88
College degree	Reference	-	-	Reference	-	-

Bold text represents statistical significance at the p<0.05 level

* Coefficient additionally adjusted for age, time since diagnosis, comorbidities, race/ethnicity, and first course of therapy(surgery, radiation, and/or chemotherapy)