

Correlates of quality of life in overweight or obese breast cancer survivors at enrollment into a weight loss trial

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Abstract

Objective: The purpose of this analysis was to examine the correlates of the physical and psychosocial domains of quality of life (QOL) in a cohort of breast cancer survivors participating in a weight loss intervention trial.

Methods: Correlates of QOL and psychosocial functioning were examined in 692 overweight or obese breast cancer survivors at entry into a weight loss trial. QOL was explored with three measures: Short-form 36 (SF-36), Impact of Cancer scale (IOC), and the Breast Cancer Prevention Trial (BCPT) symptom scales. Available data included information on weight and physical activity, as well as demographic and medical characteristics. Multivariate analyses were used to identify associations adjusted for other characteristics.

Results: In multivariate analysis, younger age was associated with higher negative impact scores ($p < 0.0001$). Hispanic, African-American, and Asian women had higher positive IOC impact scores compared with White non-Hispanic women ($p < 0.01$). Increased number of comorbidities was associated with lower physical and mental QOL scores ($p < 0.01$). Body mass index was not independently associated with QOL measures. Physical activity was directly associated with physical and mental QOL and IOC positive impact, and inversely related to IOC negative impact and Breast Cancer Prevention Trial symptom scales.

Conclusions: Quality-of-life measures in breast cancer survivors are differentially associated with demographic and other characteristics. When adjusted for these characteristics, degree of adiposity among overweight or obese women does not appear to be independently associated with QOL. Among overweight or obese breast cancer survivors, higher level of physical activity is associated with higher QOL across various scales and dimensions.

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Introduction

Breast cancer diagnosis and treatment is associated with adverse health effects in physical and psychosocial domains, and thus can have a negative impact on quality of life (QOL) [1]. Although most symptoms show improvement over time, some may be long term, lasting for up to 10 years after surgery and completion of treatment [2]. Among psychosocial correlates, depression and anxiety are often associated with poorer QOL either as indicators [3] or as determinants. Sleep problems and fatigue have also been identified as being associated with poorer QOL [4], as well as weight gain after treatment [5], and often, these symptoms are interrelated [6].

In a systematic review, Chopra and Kamal [7] concluded that age, ethnicity, and type of treatment influence different aspects of QOL. Similarly, differential effects of treatment on QOL have been noted for race/ethnicity and age [8–10]. Based on a comprehensive literature review, Yanez *et al.* [11] concluded that Latina survivors experience worse QOL than non-Latina Whites, but White *et al.* [12] caution that racial differences may be better explained by the variance in levels of engagement in healthy behaviors. Concerns and adverse effects may be particularly notable for younger survivors who report more adverse psychosocial and health outcomes [2,13]. Premature menopause is thought to exacerbate the effects of treatment among these younger women [14].

Obesity and weight gain, as indicated by high body mass index (BMI), have been associated with worse QOL among breast cancer survivors [13,15]. Post-diagnosis physical activity has been identified as a protective factor that may mitigate common side effects such as fatigue and weight gain [16] and improve overall QOL [17]. In a large randomized clinical trial of breast cancer survivors, participants who exercised at least 150 min/week of moderate-paced walking reported significantly higher levels of QOL independent of race/ethnicity [10].

The purpose of this analysis was to examine the correlates of QOL and psychosocial functioning in overweight or obese breast cancer survivors using data collected upon entry into a weight loss intervention trial. The multicenter Exercise and Nutrition to Enhance Recovery and Good Health for You (ENERGY) study is the largest weight loss study in this patient population to date, enrolling 692 overweight or obese women who had been diagnosed and treated for early stage breast cancer [18]. Within this large and well-characterized sample, different aspects of QOL were explored with three measures: the short-form 36 (SF-36) [19] as a general measure of physical and mental QOL; impact of cancer scale to assess QOL and both positive and negative aspects of cancer survivorship [9]; and the Breast Cancer Prevention Trial (BCPT) symptom scales to evaluate side effects of treatment [20]. We hypothesized that responses on the QOL measures would be differentially distributed across level of adiposity, as well as age, race/ethnicity, cancer stage and treatment, number of comorbidities, and level of physical activity.

Methods

Participants and study procedures

A total of 692 overweight or obese breast cancer survivors were enrolled into a randomized controlled trial of a weight loss intervention, the Exercise and Nutrition to Enhance Recovery and Good Health for You (ENERGY) trial, at four sites (San Diego, CA; Denver, CO; St. Louis, MO; and Birmingham, AL). Inclusion criteria were as follows: age ≥ 21 years; a history of breast cancer (stage I ≥ 1 cm), II, or III) diagnosed within the previous 5 years; completion of initial therapies not including endocrine therapy; BMI 25–45 kg/m²; and ability to comply with study procedures. Exclusion criteria included history of malignancies other than initial breast cancer with the exception of nonmelanoma skin cancer, serious psychiatric illness, and any medical condition substantially limiting moderate physical activity, such as severe orthopedic conditions. The study was reviewed and approved by the institutional review boards of all sites, and participants provided written informed consent. A detailed description of the study procedures and intervention has been published previously [18].

Measures

Demographic and other characteristics

Data included self-reported age, race/ethnicity, education level, marital status, and medical history (including comorbidities). Anthropometric measurements (height and weight) were conducted by trained study staff using standard procedures and were used to calculate BMI. Medical record review was conducted to obtain information on breast cancer diagnosis including stage and date of diagnosis and treatment and to verify eligibility.

Physical activity was measured using the modified Godin Leisure-time Exercise Questionnaire (GLTEQ) that has been validated previously in cancer research [21]. The modified GLTEQ consists of three questions regarding the frequency and duration of mild, moderate, and strenuous exercise performed during free time in a typical week.

Risk for depression was measured with the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D is composed of 20 items and assesses risk for depression in the general population [20]. Measures of internal consistency are high in the general population (0.85) and in psychiatric samples (0.90). Test-retest correlations are reported to be in the moderate range (0.45–0.70). Validity has been established with other self-report measures, correlations with clinical ratings of depression, and by construct validity [22]. It has also been used in other studies of cancer survivors [23].

Self-reported information on comorbidities was collected with a questionnaire modeled after the self-administered comorbidity questionnaire [24]. Number of reported comorbidities (e.g., heart disease, hypertension, lung disease, diabetes, ulcer or stomach disease, kidney disease, liver disease, anemia, depression, osteoarthritis, back pain, and rheumatoid arthritis) was summed.

Psychosocial quality-of-life measures

The SF-36 is a multipurpose, brief health survey, which is used as a general measure of physical and mental QOL [19,25]. It is composed of an 8-scale profile of functional health and well-being scores as well as psychometrically based physical and mental health summary measures. There is considerable evidence for the reliability of the SF-36 (Cronbach's $\alpha > 0.85$, reliability coefficient > 0.75) [25,26]. It has been used extensively with breast cancer survivors [4,5,23].

The Breast Cancer Prevention Trial (BCPT) symptom scales have been used to measure concurrent and late side effects of medical interventions to prevent and treat breast cancer [20]. Factor analysis with this instrument [20] has revealed eight symptom clusters corresponding to physical symptoms associated with cancer treatment, chemoprevention, menopause, and normal aging: hot flashes, nausea,

bladder control, vaginal problems, musculoskeletal pain, cognitive problems, weight problems, and arm problems.

The Impact of Cancer Scale (IOC) was developed specifically to measure the impact of cancer on aspects of QOL in long-term survivors (i.e., >5 years since diagnosis) [9,27,28]. Recent refinement of this instrument in a large sample of long-term breast cancer survivors [10] yielded a factor structure relating IOC items to psychosocial impact domains that exhibited high factor loadings (factor-item correlations of 0.59–0.94) and high internal consistency (Cronbach's $\alpha = 0.76$ –0.89). The scales consist of a Positive Impact Summary scale with four subscales (altruism and empathy, health awareness, meaning of cancer, and positive self-evaluation), a Negative Impact Summary scale with four subscales (appearance concerns, body change concerns, life interferences, and worry), and subscales for employment and relationship concerns.

Statistical analysis

For the five overall QOL outcome measures (summary scores for physical and mental QOL, IOC positive and negative impact scales, and mean severity averaged across all 18 symptoms on the BCPT questionnaire), bivariate analyses were used to examine associations with the *a priori* hypothesized influencing variables (BMI, age, race/ethnicity, cancer stage and treatment, number of comorbidities, and level of physical activity) and exploratory variables (education, marital status, and time since diagnosis). We hypothesized that greater degree of adiposity (higher BMI), younger age, higher stage, chemotherapy, and number of comorbidities would be associated with worse physical and mental QOL, higher IOC negative impact, and greater BCPT symptoms. We also hypothesized that higher physical activity would be inversely associated with these measures.

Continuous variables (age, BMI, number of comorbidities, weekly hours of moderate/vigorous activity, and CES-D score) were modeled in continuous analysis of variance (ANOVA). Categorical variables (race/ethnicity, cancer stage, chemotherapy, endocrine therapy, education, and marital status) were compared using categorical ANOVA where the first category was the referent. Implementing a conservative strategy, we used a significance level of $\alpha = 0.01$ for the bivariate models and $p \leq 0.05$ in the multivariate model, without further adjustment for multiple comparisons. All tests were two-sided.

Multivariate models for four of the main outcomes (physical and mental QOL and IOC positive and negative impact scales) used regression models to examine relationships between the predictors jointly and outcomes. The multivariate analyses included all variables that were *a priori* hypothesized predictors, as well as the eight BCPT symptom clusters, but did not include the exploratory variables. Dependent variables were log transformed to reduce skew in their distributions.

We also evaluated the four subscales each from the IOC positive and negative impact scales separately. We set significance at $p < 0.01$ for the subscale analyses. Analyses were conducted using SAS version 9.3 (Cary, NC).

Results

Participants were 692 overweight or obese breast cancer survivors with a mean (SD) age of 56 (9) years at enrollment. Characteristics of the study sample and distribution of scores across the QOL measures are shown in Tables 1 and 2. The majority of the sample was non-Hispanic White, and BMI at study entry was 31.4 (4.7) kg/m². On average, time since diagnosis was 2.7 years (range 0.25–5.8 years). A majority of the women had been diagnosed with stage II cancer (52%), and 30% and 18% had stage I and stage III cancer, respectively. We confirmed reliability of the IOC in this sample, observing high internal consistency (Cronbach's $\alpha = 0.77$ –0.92 for positive and negative scales and subscales).

In bivariate analysis, responses on the QOL measures were differentially distributed across categories of demographic characteristics, as shown in Table 1. QOL measures differed across age, BMI, and race/ethnicity categories. Compared with White, non-Hispanic participants, Hispanic, African-American, and Asian participants all reported higher scores on the IOC positive impact scale ($p < 0.01$). Responses on the QOL measures also were differentially distributed across categories of medical and cancer-related factors, as shown in Table 2. Having more comorbidities was associated with lower physical and mental QOL scores ($p < 0.01$).

Differential responses on the QOL measures across physical activity and CES-D score categories are shown in Table 3. Being moderately active, as is recommended for weight management, was associated with better scores on the physical and mental QOL scales ($p < 0.01$), and a dose–response effect was observed. Higher level of physical activity was associated with lower scores on the IOC negative impact scale ($p < 0.01$) and with lower scores on the BCPT symptom scales ($p < 0.01$). The reverse was true for those who had higher scores (≥ 16) on the CES-D. Those at higher risk for depression had lower scores on physical and mental QOL and higher scores on the BCPT symptom scales ($p < 0.01$).

Table 4 shows the associations for the *a priori* hypothesized variables when adjusted for other influencing variables in the multivariate models. Younger age was associated with higher IOC negative impact scale ($p < 0.0001$). Hispanic, African-American, and Asian women had higher scores on the IOC positive impact scale compared with White, non-Hispanic women, and African-American women scored lower on the IOC negative impact scale ($p < 0.01$). Number of comorbidities and several BCPT symptom clusters were associated with lower

Table 1. QOL measures within demographic and anthropometric categories ($N = 692$)^a

	N	QOL physical	QOL mental	IOC positive impact scale	IOC negative impact scale	BCPT symptom scales
Age at enrollment (years)						
<50	173	70.4 (19.5)	73.4 (19.2)	3.9 (0.5)*	2.9 (0.8)*	2.1 (0.6)*
50–64	372	71.8 (18.4)	76.0 (18.0)	3.8 (0.6)*	2.7 (0.7)*	2.1 (0.5)*
≥65	147	67.7 (17.8)	77.2 (16.4)	3.7 (0.5)*	2.4 (0.7)*	1.9 (0.5)*
Body mass index (kg/m ²)						
25–29.99	285	72.3 (17.9)*	75.9 (17.9)	3.8 (0.6)	2.7 (0.7)	2.0 (0.5)
30–34.99	243	70.5 (18.8)*	74.7 (18.5)	3.8 (0.6)	2.6 (0.7)	2.0 (0.5)
35–45	164	67.6 (19.2)*	76.3 (17.5)	3.8 (0.6)	2.6 (0.7)	2.1 (0.6)
Race/ethnicity						
White, non-Hispanic	547	70.8 (17.7)	75.9 (17.3)	3.8 (0.5)	2.7 (0.7)	2.0 (0.5)
Hispanic	46	68.9 (19.2)	70.3 (21.5)	4.0 (0.5)*	2.8 (0.7)	2.1 (0.6)
African-American	71	67.9 (24.3)	75.2 (21.1)	4.0 (0.6)*	2.5 (0.8)	2.2 (0.6)
Asian	11	76.8 (13.9)	82.1 (11.5)	4.3 (0.3)*	2.8 (0.6)	1.7 (0.3)
Mixed/other	15	74.1 (18.4)	76.3 (17.7)	3.9 (0.6)	2.7 (0.7)	1.9 (0.4)
Education						
Not a college graduate	282	70.6 (18.5)	76.0 (17.5)	3.9 (0.5)*	2.6 (0.7)	2.1 (0.5)
College graduate	410	70.5 (18.7)	75.3 (18.3)	3.7 (0.6)*	2.7 (0.7)	2.0 (0.6)
Marital status						
Married/partnered	463	72.0 (17.7)	77.1 (17.5)	3.8 (0.6)	2.7 (0.7)	2.1 (0.5)
Not married or partnered	228	67.6 (20.1)*	72.5 (20.4)*	3.8 (0.6)	2.7 (0.8)	2.0 (0.5)

QOL, quality of life; BCPT, Breast Cancer Prevention Trial; IOC, Impact of Cancer Scale; ANOVA, analysis of variance.

^aValues shown are mean (SD).

* $p < 0.01$; continuous variables (age and body mass index) were modeled in continuous ANOVA, and categorical variables were compared using categorical ANOVA where the first category was the referent.

physical and mental QOL ($p < 0.02$), when adjusted for other variables.

Contrary to our hypothesis, BMI was not independently associated with any of the QOL measures in the multivariate models. As hypothesized, level of physical activity was associated with physical and mental QOL ($p < 0.01$). Women with higher levels of depressive symptoms on the CES-D had significantly lower physical QOL, lower IOC positive impact scores, and higher IOC negative impact scores ($p < 0.001$).

As shown in Table 4, the BCPT symptom scale for nausea was inversely associated with both physical and mental QOL ($p < 0.01$). The BCPT scale for bladder control was inversely associated with mental QOL, and the musculoskeletal pain scale was inversely associated with physical and mental QOL ($p < 0.02$). Cognitive problems were inversely associated with mental QOL and directly associated with both IOC positive and negative impact scores. The BCPT symptom scale for weight problems was inversely associated with mental QOL and directly associated with the IOC negative impact scores ($p < 0.01$). The BCPT arm problems scale was inversely associated with physical QOL scores, meaning lower severity of arm problems was associated with better physical QOL scores, and directly associated with the IOC negative impact scale ($p < 0.001$). Two of the symptom scales (vasomotor and vaginal problems) were not significantly associated with any of the QOL outcomes.

Associations with the subscales of the IOC negative and positive impact scores also were examined (data not

shown), and cancer stage was directly associated with scores for each negative impact subscale ($p < 0.01$). In contrast, age and African-American ethnicity were inversely associated with every subscale score. Age was inversely associated with altruism and meaning of cancer subscale scores. African-American, Asian, and Hispanic race/ethnicity were all directly associated with health awareness and positive self-concerns subscales. In addition, being African-American was associated with greater meaning of cancer, while being Asian was associated with altruism. Chemotherapy was directly associated with scores for all four IOC positive impact subscales ($p < 0.01$ for all).

Discussion

We found that various dimensions and measures of QOL in breast cancer survivors are differentially associated with demographic and medical characteristics. After adjusting for these characteristics, contrary to our hypotheses, degree of adiposity had no relationship to any of the QOL outcomes in the multivariable models, although BMI was inversely associated with physical (but not mental) QOL when unadjusted for other influencing variables. However, we found that among overweight or obese breast cancer survivors, higher level of physical activity correlates with higher mental and physical QOL and does so in a dose-dependent manner.

This analysis presents a multifaceted approach to examining QOL in a large and geographically diverse sample

Table 2. QOL measures within medical and cancer-related categories (N = 692)^a

	N	QOL physical	QOL mental	IOC positive impact scale	IOC negative impact scale	BCPT symptom scales
Time since diagnosis						
< 1 year	76	66.1 (21.1)*	70.5 (21.2)*	3.9 (0.6)	2.7 (0.7)	2.1 (0.6)
1–2.9 years	325	69.5 (18.9)*	75.0 (17.6)*	3.8 (0.6)	2.7 (0.7)	2.1 (0.5)
≥ 3 years	291	72.9 (17.2)*	77.5 (17.2)*	3.8 (0.6)	2.6 (0.7)	2.0 (0.6)
Cancer stage						
I	210	73.3 (17.5)	77.2 (17.6)	3.7 (0.6)	2.5 (0.7)	2.0 (0.5)
II	358	70.7 (18.8)	75.4 (18.0)	3.8 (0.6)*	3.0 (0.7)*	2.1 (0.6)
III	124	65.4 (18.8)*	73.3 (18.4)	3.9 (0.5)	2.9 (0.7)*	2.1 (0.5)*
Chemotherapy						
No	165	73.5 (17.5)	76.6 (18.3)	3.6 (0.6)	2.5 (0.7)	1.9 (0.5)
Yes	527	69.6 (18.8)	75.3 (17.9)	3.9 (0.5)*	2.7 (0.7)*	2.1 (0.6)*
Endocrine therapy						
None	179	69.0 (19.6)	74.2 (19.3)	3.8 (0.6)	2.8 (0.8)	2.0 (0.5)
Antiestrogen only	147	71.5 (20.4)	75.4 (17.5)	3.9 (0.5)	2.7 (0.7)	2.1 (0.6)
Aromatase inhibitor	366	70.9 (17.3)	76.3 (17.5)	3.8 (0.6)	2.6 (0.7)	2.1 (0.6)
Comorbidities ^b						
None	253	75.7 (16.2)*	78.2 (16.0)*	3.9 (0.5)	2.6 (0.7)	2.0 (0.6)*
1	240	70.5 (18.2)*	76.2 (17.3)*	3.7 (0.6)	2.7 (0.7)	2.0 (0.5)*
2	119	67.5 (18.4)*	74.0 (18.6)*	3.8 (0.6)	2.6 (0.7)	2.9 (0.5)*
3 or more	80	59.0 (21.1)*	67.7 (22.2)*	3.8 (0.6)	2.7 (0.8)	2.2 (0.6)*

QOL, quality of life; BCPT, Breast Cancer Prevention Trial; IOC, Impact of Cancer Scale; ANOVA, analysis of variance.

^aValues shown are mean (SD).

^bComorbidities assessed are current treatment for heart disease, hypertension, lung disease, diabetes, ulcer or stomach disease, kidney disease, liver disease, anemia, depression, osteoarthritis, back pain, rheumatoid arthritis, and other conditions.

* $p < 0.01$; continuous variables were modeled in continuous ANOVA, and categorical variables (cancer stage, chemotherapy, and endocrine therapy) were compared using categorical ANOVA where the first category was the referent.

of overweight or obese breast cancer survivors. By utilizing several different measurement constructs, this study provides a global examination of the psychosocial and physical QOL associations in this target population. In particular, this is the first study, to our knowledge, to have used the IOC in shorter-term breast cancer survivors, along with the SF-36 and the BCPT symptom scales. In addition to the large sample, the diversity of the sample also allowed analysis of findings for various subgroups, such as older versus younger survivors or those with different racial/ethnicity and cancer characteristics.

The characteristics that were found to impact QOL in the current study can be compared with those reported in other studies with breast cancer survivors, and confirm and expand upon what has been observed in other reports. Using the SF-36, Bowen *et al.* [8] concluded that participants in the Health, Eating, Activity, and Lifestyle study were doing relatively well 2 years after diagnosis, even though some racial/ethnic and socioeconomic differences were identified as important determinants of QOL. Utilizing the BCPT symptom scales, Ganz *et al.* [1] noted that even though overall functioning improved after breast cancer treatment, those who received chemotherapy reported more severe physical symptoms such as vaginal and weight problems.

In this study, age at diagnosis and non-White race/ethnicity (Hispanic, African-American, or Asian) were identified as independently associated with QOL in breast cancer survivors, with younger women

experiencing more negative impact from the cancer and non-White women noting more meaning and positive impact from the cancer experience. This is consistent with other studies in the literature [29–31], although this study is notable for assessing these issues in a group of women earlier in the post-treatment phase of survivorship. Although younger participants noted some positive outcomes from their experience on the IOC measure (i.e., becoming more health aware and valuing their relationships more), our results suggest that their overall outlook on body changes was more negative, and they reported more health-related worries and treatment-related symptoms. This observation held true in IOC subscale analysis as well. In another sample of breast cancer survivors, Crespi *et al.* [9] also found younger women to have somewhat higher scores on both positive and negative IOC scores, and results from previous studies indicate that survivors <50 years of age report concerns about premature menopause and infertility, physiologic symptoms such as night sweats and hot flashes, weight gain, and adverse psychosocial outcomes, such as depressive symptoms [13,14]. Future studies that focus on identifying effective strategies to improve QOL in this vulnerable group of survivors are clearly warranted.

Racial/ethnic minority participants reported higher IOC positive and negative impact scores that may indicate willingness to see cancer as a positive life challenge, such as having more health awareness and positive self-concerns as identified by IOC subscale analysis. Other studies have

Table 3. QOL measures within strata of behavioral and psychosocial covariates (N = 692)^a

	N	QOL physical	QOL mental	IOC positive impact scale	IOC negative impact scale	BCPT symptom scales
Moderate/vigorous activity (h/week)						
None	284	65.9 (19.6)*	72.3 (19.0)*	3.8 (0.6)	2.7 (0.7)*	2.1 (0.5)*
0.1–0.9	70	69.0 (18.8)*	73.8 (17.0)*	3.8 (0.5)	2.9 (0.7)*	2.1 (0.6)*
1–2.9	208	73.6 (16.6)*	77.1 (16.7)*	3.8 (0.6)	2.6 (0.7)*	2.0 (0.5)*
3 or more	130	76.6 (16.8)*	81.3 (16.8)*	3.9 (0.6)	2.6 (0.7)*	1.9 (0.6)*
CES-D score						
Not depressed (0–15)	555	73.9 (16.6)*	81.0 (12.6)*	3.8 (0.6)	2.5 (0.6)*	1.9 (0.5)*
At risk for depression (≥16)	137	57.1 (20.1)*	53.7 (19.8)*	3.8 (0.6)	3.3 (0.8)*	2.5 (0.5)*

QOL, quality of life; BCPT, Breast Cancer Prevention Trial; IOC, Impact of Cancer Scale; CES-D, Center for Epidemiologic Studies Depression Scale.

^aValues shown are mean (SD).

* $p < 0.01$.

noted greater meaning and personal growth among African-American breast cancer survivors [29,32], and better QOL. Different levels of QOL for survivors with diverse racial and ethnic backgrounds have been identified in prior studies [11].

The association between degree of adiposity (reflected in the BMI) and better physical QOL in the bivariate analysis did not remain significant in the multivariate model, although at enrollment in this study, none of the participants was in the healthy weight range. In another sample of breast cancer survivors, higher BMI was associated with higher IOC negative impact and subscales [11], but that observation was not adjusted for other influencing factors as in the present study. There is evidence in the literature that maintaining a healthy weight is an independent factor for better prognosis of breast cancer [33], as well as for better overall physical functioning and management of treatment side effects such as sleep and mood problems [5]. However, results of this analysis suggest that in overweight or obese women, comorbidities and other factors are crucial determinants of QOL.

As in the present study, Ashing-Giwa and Lim [34] found that having fewer comorbidities was related to better mental and physical QOL in a diverse group of breast cancer survivors. This is an important finding because it suggests that overweight or obese breast cancer survivors who can lose enough weight to impact comorbidities, even if they do not achieve an optimal weight, may improve QOL. Ganz *et al.* [1] found that even though physical and social functioning improves after treatment, physical symptoms persist for those who have received chemotherapy for up to a year [23,29,35]. Similarly, in the current study, participants indicated experiencing lower mental and physical QOL in association with a myriad of symptoms such as nausea, bladder control issues, and musculoskeletal and arm problems. That these factors are contributing to lower mental and physical QOL is an important finding, and attention to symptom control could be important for improving QOL outcomes.

Multivariate models in this study revealed that more physical activity in these overweight or obese women was related to better overall QOL, having a more positive outlook on life, as well as having fewer health-related worries and treatment-related symptoms. In fact, our observations suggest that any amount of exercise is better than none. In contrast, higher depressive symptomatology scores were associated with lower physical QOL scores, as well as lower positive impact and higher negative impact IOC scores, as previously observed in this target population [11]. Although this analysis uses cross-sectional data that cannot imply causality, previous interventions have shown that exercise has positive impact on overall QOL [36] and also depressive symptoms [37,38] and fatigue [39]. Regular physical activity after breast cancer diagnosis and treatment also may mitigate common side effects of adjuvant therapy, such as weight gain and fatigue [36], depression, reduced QOL, and decreased muscular strength [40].

Results of this study present important evidence of symptom burden following treatment in overweight or obese breast cancer survivors. However, this study also has limitations. Even though the large sample size allowed for subgroup analysis, the study sample was nonetheless largely homogeneous, so results may not be entirely representative of the general population of breast cancer survivors. Nevertheless, most breast cancers are diagnosed in overweight or obese women, and our sample had more diversity than most other studies in this research area. It is important to examine these constructs in an even more diverse sample of breast cancer survivors, particularly among those across an even wider range of BMI, including lean women. Additionally, we have not addressed all potential confounding influences, such as income [34], location of treatment (e.g., academic centers, community-based, or hospital-based practices), or rural versus urban environment. Finally, the relationship between depression and QOL is not straightforward, and future research should examine the impact of these variables on QOL. Future research is needed to examine this complex

Table 4. Multivariate models for QOL measures in overweight or obese breast cancer survivors (N = 692)^a

	QOL physical R ^b = 0.43		QOL mental R ^b = 0.30		IOC positive impact scale R ^b = 0.11		IOC negative impact scale R ^b = 0.39	
	β coefficient	p-value	β coefficient	p-value	β coefficient	p-value	β coefficient	p-value
Age	-0.001	0.55	0.002	0.15	-0.004	0.12	-0.011	<0.0001
Body mass index	-0.003	0.20	0.003	0.28	-0.000	0.95	-0.009	0.08
Race/ethnicity								
African-American	0.002	0.94	-0.027	0.50	0.269	0.0002	-0.396	<0.0001
Asian	0.018	0.81	0.018	0.84	0.538	0.001	0.173	0.33
Hispanic	-0.003	0.94	-0.056	0.22	0.233	0.006	0.090	0.32
Cancer stage	-0.027	0.10	-0.013	0.49	-0.003	0.92	0.125	0.0008
Chemotherapy	0.022	0.40	0.037	0.22	0.233	< 0.0001	0.023	0.69
Any endocrine therapy	0.032	0.16	0.029	0.28	0.046	0.34	-0.092	0.08
No. of comorbidities	-0.040	< 0.0001	-0.032	0.006	-0.012	0.58	0.024	0.30
Moderate/vigorous activity	0.012	0.006	0.014	0.01	0.010	0.29	-0.002	0.82
CES-D score ^b	-0.009	< 0.0001	x	x	-0.012	0.001	0.031	< 0.0001
BCPT symptom scales								
Vasomotor	-0.005	0.55	0.002	0.84	0.015	0.44	0.010	0.63
Nausea	-0.083	0.002	-0.086	0.005	-0.061	0.27	0.031	0.60
Bladder control	0.011	0.36	-0.028	0.05	0.003	0.91	0.021	0.45
Vaginal problems	0.013	0.12	0.006	0.53	0.001	0.94	0.021	0.28
Musculoskeletal pain	-0.128	< 0.0001	-0.032	0.02	-0.001	0.96	0.048	0.09
Cognitive problems	-0.016	0.23	-0.124	< 0.0001	0.081	0.004	0.064	0.04
Weight problems	-0.006	0.54	-0.041	0.0009	-0.012	0.60	0.112	< 0.0001
Arm problems	-0.046	0.001	0.008	0.60	0.002	0.95	0.088	0.006

QOL, quality of life; BCPT, Breast Cancer Prevention Trial; IOC, Impact of Cancer Scale; CES-D, Center for Epidemiologic Studies Depression Scale.

Bold indicates significant p values.

^aValues shown are β coefficients and p-values for associations with each of the four outcomes, when controlled for all variables tabulated. QOL outcomes were log transformed

^bCES-D score was omitted as a predictor for QOL mental because of high correlation between the two ($\rho = -0.72$).

association in cancer survivors to determine if depression is an indicator or determinant of QOL.

These baseline findings set the stage for the longitudinal evaluation of QOL outcomes in this study sample. In future analyses, we can examine whether increased physical activity and weight loss have a positive impact on QOL and improve long-term functionality in this group of overweight or obese breast cancer survivors.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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