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## Barriers to physical activity and healthy eating in young breast cancer survivors: modifiable risk factors and associations with body mass index

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### Abstract

**Background**—Physical activity (PA) and healthy eating (HE) are important behaviors to encourage in breast cancer survivors (BCS). We examined associations between various factors and barriers to PA (BPA) and barriers to HE (BHE), as well as relationships between barriers and body mass index (BMI) in younger BCS.

**Methods**—Self-reported data from 162 BCS (mean age 48 years) were used. BPA were assessed with a 21-item scale and BHE with a 19-item scale. Participants were classified as high or low on each scale. Sociodemographic, medical, and psychosocial characteristics were compared by high/low barriers. Correlates of continuous BPA and BHE were assessed as were associations between BHE, BPA and BMI.

**Results**—61% of participants were characterized as having low BHE and low BPA; 12% were high for both. High BHE/High BPA participants had the least favorable scores for depression, perceived stress, social support, fatigue, bladder control, and weight problems. Factors associated with BHE were lower education, higher perceived stress, and more severe weight problems.

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Factors associated with BPA were more severe bladder control problems and lower physical well-being. Higher BHE and BPA were significantly and uniquely associated with higher BMI, controlling for covariates.

**Conclusions**—Several biopsychosocial factors (e.g., depression, stress, fatigue) characterize young BCS who experience barriers to both HE and PA. The correlates of BHE and BPA are distinct. Both BHE and BPA are associated with BMI. These results should be considered in designing interventions for younger women with breast cancer.

### Keywords

breast cancer; survivorship; diet; physical activity; obesity

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## INTRODUCTION

Breast cancer survivors (BCS) constitute the largest segment of female cancer survivors [1]. Most early stage breast cancer patients have a life expectancy similar to age-matched women [2], and there is need to reduce their risk for comorbid conditions and secondary cancers. This is particularly true for younger BCS (i.e., 50 years or younger), for whom several decades of additional survival is anticipated. In a recent systematic review, we identified substantial rates of anxiety and depressive symptoms among younger BCS, along with fertility concerns, menopausal symptoms, and weight gain [3].

Weight gain is of particular concern for BCS, in that excess body weight is a risk factor for cancer recurrence [4]. Younger women may be at increased risk for weight gain as they are more likely to experience premature menopause, induced by adjuvant chemotherapy [5]. In addition, some evidence shows that the association between weight gain after diagnosis and breast cancer survival is greater in pre-menopausal women than in post-menopausal survivors [6].

A recent meta-analysis demonstrated that higher physical activity (PA) was associated with reduced breast cancer-specific mortality as well as overall mortality in BCS [7]. In a previous study in young BCS [8], we found an association between higher levels of PA and lower BMI and blood pressure, as well as higher physical functioning and energy levels. However, participants reported lower levels of PA than was shown in a similar sample of women without cancer, suggesting a need to help young survivors increase PA. In our systematic review [3], we also found that lack of PA and weight gain are common in young BCS. Research linking dietary intake to improved outcomes in survivors is less clear, though there is some evidence to show that reducing fat and alcohol consumption as well as increasing intake of fruits, vegetables, and other sources of dietary fiber such as whole grains may be beneficial [9,10].

Despite the importance of weight and PA as factors influencing mortality after breast cancer, little is known about the barriers to maintaining normal weight and increasing PA in this setting. We initiated the After Breast Cancer (ABC) study to identify behavioral and lifestyle risk factors for obesity and physical inactivity in younger BCS that would be relevant for future intervention development. This paper presents the results of a cross-

sectional survey that examined a variety of domains (health-related quality of life, medical and treatment variables, weight and health behaviors), in addition to perceived barriers to PA and healthy eating (HE). The specific questions addressed in this paper are: 1) What are the perceived barriers to HE and PA in young BCS and how do women vary by barrier status?; 2) How do the demographic, medical, and psychosocial factors associated with barriers for PA and HE differ?; and 3) Do the perceived barriers to HE and PA contribute to higher body mass index (BMI) independent of other factors related to high BMI in this population?

## METHODS

### Participants and Recruitment

Study recruitment began in 2009, using the UCLA Health System tumor registry to identify potentially eligible breast cancer patients diagnosed between 2003-2007. Eligibility criteria were: stage 1, 2, or 3 breast cancer diagnosed at age  $\geq 50$  years; currently alive and disease free;  $> 1$  year post-initial cancer diagnosis;  $> 6$  months after cancer treatment (i.e., completed chemotherapy and/or radiation, but could be receiving endocrine therapy); agreed to complete survey; ability to read and write English; female; provides informed consent.

Invitation letters were mailed to potential subjects, who were asked to return a mailed response form indicating their interest in participating. Trained research staff screened potential participants via telephone. Eligible participants were mailed consent forms and questionnaire packets to complete and return in postage paid envelopes, and reminder calls were made to return questionnaires. Non-respondents received a second mailing and additional contact by phone to explain the study and screen for eligibility. The study was approved by the UCLA Institutional Review Board and written consent was obtained from each participant.

### Measures

**Demographic and Medical Characteristics**—were assessed with questions used in prior studies [11,12] (see **Table 1** for all variables). Current chronic conditions were assessed using a checklist of 13 conditions. Current height (in feet and inches) as well as current weight and weight (lbs) at diagnosis were assessed via self-report. BMI was calculated in  $\text{kg}/\text{m}^2$ . Menstrual history was measured via a series of questions used previously [11].

**Quality of Life and Symptoms**—Depressive symptoms over the last week were assessed using the Center for Epidemiologic Studies Depression (CES-D) Scale [13]. Perceived stress over the last month was measured with the Perceived Stress Scale (PSS) 10-item version [14]. An 8-item version of the MOS Social Support Survey [15] was used to assess social support. Fatigue severity over the past week was measured with the Fatigue Symptom Inventory (FSI), which was developed for and validated in cancer patients [16-18]. Health-related quality of life (HRQL) over the past month was assessed with the MOS 12-Item Health Survey Short Form (SF-12)[19] yielding two subscales: Physical Component Summary (PCS) and Mental Component Summary (MCS), with normative data

available for the general population, and individuals with chronic conditions. These scales have been widely used in studies of BCS [3,8,11,12]. Breast cancer-related symptoms were measured with the Breast Cancer Prevention Trial (BCPT) Symptom Scales [20].

**Barriers to Physical Activity and Healthy Eating**—Perceived barriers to PA (BPA) were measured by a 21-item scale adapted and used by Rogers et al. in both breast cancer patients [21] and survivors [22]. Participants rated how often a list of barriers “interfered with your plan to exercise in the past month” and responses were: 1=Never, 2=Rarely, 3=Sometimes, 4= Often, or 5=Very Often. The individual items are listed in **Table 2**. A mean score was calculated by dividing the overall sum by the number of items, with a higher score indicating higher perceived BPA. Cronbach's alpha for the scale was 0.91.

Perceived barriers to HE (BHE) were assessed by a scale developed for this study to parallel the Rogers scale. A list of 19 barriers to HE were adapted from an existing intervention checklist [23], and used the same Likert scale format as the BPA scale, with the same instructions. The individual items are listed in Table 2. A mean score was calculated by dividing the overall sum by the number of items, with a higher score indicating higher BHE. Cronbach's alpha for the scale was 0.86.

## Data analysis

**Descriptive Comparisons**—With the goal of distinguishing between women for whom BHE and BPA were largely absent from those who experienced barriers with some regularity, we categorized participants as having “low” barriers if their mean response was 2.49 or lower (out of 5) on each scale, corresponding to a response of “never” or “rarely.” Conversely, “high” barriers were identified as a mean response of 2.5 or higher, corresponding to “sometimes,” “often,” or “very often.” Participants were then further grouped as: 1) Low BPA, Low BHE (or Low/Low), 2) High BPA, Low BHE, 3) Low BPA, High BHE, and 4) High BPA, High BHE (or High/High), and examined for relationships with medical, demographic or psychosocial characteristics. Participant characteristics were compared by barrier groupings using analysis of variance (ANOVA) for continuous variables with Tukey's test for post-hoc comparisons. Chi-square tests were conducted for categorical variables and post-hoc comparisons were explored for significant variables using chi-square tests comparing groups pairwise.

## Multivariable Modeling

**Correlates of BPA and BHE:** Psychosocial and HRQL measures were included in the model based on their bivariate relationships with either the BPA or BHE scale score. Pearson correlations were used for continuous variables and chi-square tests were used for categorical variables with the low vs. high categorizations of the 2 barrier scales. Independent variables were selected for inclusion in multivariate regression models if the Pearson correlation exceeded 0.30 or the chi-square test p-value was less than 0.10. Relevant medical and demographic covariates were selected as control variables in the models and included current age, ethnicity (white vs. not white), has children (yes vs. no), married or living as married (yes vs. no), four year college graduate or more (yes vs. no), comorbid conditions (yes vs. no), had radiation therapy only (yes vs. no), had chemotherapy only (yes

vs. no), had both radiation and chemotherapy (yes vs. no), and currently receiving endocrine therapy (yes vs. no). Multivariable models were built for BPA and BHE. If an independent variable was significantly associated with either BPA or BHE bivariate, it was included in the models for both BPA and BHE, so that potential predictors of the two scales could be compared.

The second set of multivariable models was created to assess whether BPA and/or BHE were associated with BMI. The same medical and demographic variables were included in the BMI models, and identical criteria were used for selection of potential psychosocial and quality life variables for inclusion in the models. For chi-square tests of bivariate associations, a categorization of normal weight (BMI<25) vs. overweight/obese (BMI ≥ 25) participants was used. Three separate multivariable models with BMI as the dependent variable were fitted: 1) BMI was regressed on BHE, controlling for relevant covariates; 2) BMI was regressed on BPA in a similar fashion; and 3) BMI was regressed on both BHE and BPA, and an F test was employed to test for the joint significance of including both BHE and BPA in the same model.

Statistical analyses were conducted using SPSS version 20 (IBM SPSS Statistics, Chicago: IBM Corporation).

## RESULTS

### Recruitment Results and Patient Characteristics

Study recruitment results are presented in **Figure 1**. Invitation letters were mailed to 476 potential participants, with contact available among 320 (67% of total), and 288 of 320 being eligible (90%). Among the eligible women, 233 (81%) were interested in participating and they were mailed the study questionnaire. 164 completed the questionnaires (57% of the eligible women), which is similar to response rates in previous studies [3,24]. There were no significant differences in current age, race/ethnicity, stage at diagnosis, type of surgery, or tumor characteristics between the responders (n=164) and non-responders (n=312) (data not shown). Of the 164 participants, 162 had complete responses for both the BHE and BPA scales and were included in analyses.

Table 1 provides demographic and medical characteristics of the study participants. The average age was 48 years (range 28-56), and most were white (69%). The average time since diagnosis was 3.4 years. Over half of the women received both chemotherapy and radiation, and 61% were receiving endocrine therapy at the time of survey. The majority were post-menopausal at survey and about half reported that they had become menopausal during the course of their cancer treatment. Nearly 40% were categorized as overweight or obese based on their current BMI.

### Barriers to Physical Activity and Barriers to Healthy Eating

Table 2 shows the individual items from each of the barrier scales. The frequency with which each item was endorsed is displayed in each row. The three most highly endorsed BHEs were “Holidays and special occasions are a problem,” “I feel like eating whatever I want,” and “High fat foods taste better.” These three barriers each had a mean score of 2.9

(out of 5). The three BPAs with the highest mean scores were “Lack of time” (3.2), “Lack of self-discipline (3.1), and “Fatigue (or lack of energy)” (3.0).

The mean sum of response on the BPA scale was 45.7 (SD 14.5) on the 21 items (minimum 21, max 93) corresponding to an average response of 2.2 per item. The mean sum of response on the BHE scale was 38.7 (SD 10.8) on the 19 items, (minimum 19, maximum 71), corresponding to a mean response of 2.0 per item. Sixty-one percent of the participants were classified as low BPA and low BHE, 18% as high BPA and low BHE, 9% as low BPA and high BHE, and 12% as high BPA and high BHE. The distribution of these groupings is graphically displayed in **Figure 2**. There was a strong correlation between BPA and BHE ( $r=0.44$ ,  $p<0.0001$ ).

Because little was known about which women might be most likely to report BPA or BHE, we first examined the relationship of key characteristics to BPA and BHE scores in the four groups (Table 1). No demographic differences were noted among the groups; however, women in the High/High group were more likely to be currently heavier ( $p=0.001$ ), and were heavier at diagnosis ( $p=0.002$ ). There was also a significant difference in menopausal status with the Low PA/High HE group having the highest percentage of pre-menopausal women.

Several of the HRQL and symptom scales were significantly associated with the barrier groupings including depression ( $p=0.008$ ) perceived stress ( $p=0.002$ ), emotional social support ( $p=0.01$ ), instrumental social support ( $p=0.006$ ), fatigue ( $p=0.01$ ), PCS ( $p=0.001$ ), MCS ( $p=0.01$ ), and symptoms related to bladder control ( $p=0.003$ ), cognitive problems ( $p=0.049$ ), weight problems ( $p=0.002$ ), and arm problems ( $p<0.001$ ). Post-hoc tests revealed that the majority of the significant differences were between the Low/Low group and the High/High group ( $p<0.05$ , Table 1). The High/High group had the least favorable scores for the majority of these variables. The Low BPA/High BHE group had the least favorable scores for the MCS and cognitive symptoms, and their scores for these variables were significantly different from the Low/Low group ( $p<0.05$ ). The Low BPA/High BHE group also was more likely to be premenopausal than the other 3 groups ( $p<0.05$ ). The High BPA/Low BHE group reported more arm problems, higher current BMI and higher BMI at diagnosis than the Low/Low group and also had lower PCS scores than the both the Low/Low group and the Low PA/High BHE group.

## Regression Analyses

**Table 3** shows the regressions of BPA and BHE on demographic characteristics, HRQL, symptoms, and cancer treatment. Model 1 shows the correlates of BHE ( $R^2=0.21$ ). There was a significant inverse relationship between BHE and having a four year college degree or more ( $p=0.02$ ) as well as a positive relationship between BHE and perceived stress ( $p=0.03$ ) and perceived weight problems ( $p=0.002$ ). Model 2 shows the correlates of BPA ( $R^2=0.34$ ). There was a significant positive relationship between BPA and experiencing bladder control issues ( $p=0.01$ ), as well as an inverse relationship between BPA and the PCS ( $p=0.003$ ). The bladder control difficulties were only associated with BPA in the bivariate analyses, and thus not included in the BHE model.

**Table 4** shows results of multivariate regression of BMI on BHE and BPA. Before BHE and BPA were included in the same model, BMI was regressed on BHE and BPA separately (data not shown). BHE was significantly positively associated with BMI ( $p=0.001$ ,  $R^2=0.22$ ). In addition, BPA was significantly positively associated with BMI ( $p=0.001$ ;  $R^2=0.22$ ). When both BPA and BHE were included together (Table 4), the F test showed joint significance ( $p=0.001$ ), indicating that the two variables together accounted for significant variation in BMI, after adjusting for the other variables in the model; furthermore, BHE and BPA were each independently associated with BMI when controlling for the other (both  $p<0.05$ ,  $R^2=0.24$ ).

## DISCUSSION

In this study sample, the most frequently reported barrier to PA was “lack of time” and the most frequently reported barriers to HE were “Holidays and special occasions are a problem,” “I feel like eating whatever I want,” and “High fat foods taste better.” Our analyses suggest that the correlates of BHE and BPA are distinct. Namely, the factors associated with higher BHE were being less educated, having higher perceived stress, and increased perceived severity of weight problems. In comparison, the factors associated with BPA were increased severity of bladder control problems and lower physical well-being. Several of the variables associated with higher BHE or higher BPA are amenable to intervention, such as management of perceived stress or improving physical functioning.

The regression model for BMI and BHE demonstrated that a one unit increase in barrier severity on the BHE scale corresponded to a 2.4 unit increase in BMI unadjusted for BPA and 1.7 unit increase adjusted for BPA. This one unit increase could be viewed as the difference between a participant responding “sometimes” (on average) vs. responding “often” to the set of barriers. Similarly, our results suggest that each 1 unit increase in response on the BPA scale corresponds to an increase of 2.1 units in BMI unadjusted for BHE and 1.4 adjusted for BHE. Considering that BMI had a standard deviation of 5.5 in this sample, such differences in BMI could be considered clinically significant. Finally, the two barrier scales are independently related to BMI when included in the same regression model.

To put our results into perspective, it is important to note that the levels of reported BPA and BHE were fairly low in the sample, with most women (61%) falling into the Low/Low category, indicating that they were most likely to respond that they “never” or “rarely” experienced the various barriers. This finding is consistent with a previous study by Rogers et al. (22) with breast cancer patients. Despite the overall low level of barriers reported, a small group of women (12%) reported relatively high barriers on both scales. Women in the High/High group were the most overweight and had more symptoms such as depression, perceived stress, fatigue, and lower physical functioning, all of which could be potentially modified with targeted interventions. Women in this group may need interventions that include treatment for depressive symptoms.

To our knowledge, our study is the first to examine correlates of barriers to PA as well as barriers to HE, and the intersection of the two sets of barriers. We identified 6 studies [22,25-29] that investigated barriers to PA in BCS, as well as 3 studies that evaluated



barriers to PA in breast cancer patients [21,30,31]. No studies were found that explored barriers to HE in BCS or patients. An additional 6 studies [32-37] reported on barriers to PA in other cancer patient or survivor populations, 3 of which [32,36,37] also reported on barriers to HE, but did not systematically explore correlates of perceived barriers or associations between perceived barriers and BMI.

Of the 6 studies that focused on barriers to PA in BCS, two were conducted with a group of survivors who had a mean age of 50 years or less [25,26]. One of these studies examined 64 BCS with a mean age of 43 years. The most influential barriers were “lack of time,” “inertia,” and “not in routine,” and an index developed to measure the barriers was accurate at predicting reported levels of PA [25]. Predictors of the barriers or associations with adiposity were not evaluated. In another study of 51 survivors ages 33 to 63, the authors report that lack of time was the main barrier to PA [26]. The remaining publications, conducted with older samples of women, focused on describing the most common barriers in survivors and/or evaluating whether the perceived barriers were associated with reported PA or self-efficacy for PA.

Our findings provide some insight into potentially modifiable risk factors that could be targeted for lifestyle interventions in younger BCS. The BHE scale was positively associated with perceived stress as well as weight problems (bothered by “weight gain” or “being unhappy with body appearance”). Interventions could target self-acceptance/self-esteem and perceived stress. Stress may contribute to BHE by prompting emotional eating or creating the perception of not enough time available to cook/eat healthfully. These factors may interrelate with some of the other psychosocial and physical concerns that are common in younger survivors [3]. Finally, given that educational attainment was inversely associated with BHE, interventions for women in this group may be valuable.

The correlates of BPA were concentrated in the physical domain. Specifically, interventions that help survivors to manage and improve their bladder control and overall physical functioning may be useful in reducing their barriers to PA. Though we found that the correlates of BHE and BPA are distinct, our results show that both sets of barriers are independently and positively related to BMI.

Our study findings are limited by the cross-sectional design, as well as the use of self-reported height and weight; however, we have previously demonstrated high concordance between self-report and measured height and weight in a similar population of young BCS [8]. We also do not have measures of actual dietary intake to correlate with perceived BHE; however, we did collect a self-report measure of PA (the Godin-leisure time physical activity scale), and found a significant inverse correlation with BPA ( $r=-0.36$ ,  $p<0.0001$ ). Future studies should include more rigorous, objective measures of PA as well as measures of actual dietary intake.

In conclusion, this study describes the correlates of perceived barriers to both PA and HE in young BCS and identifies potential targets for future interventions. Although most younger BCS did not report substantial barriers to either PA or HE, an important minority did and they would likely benefit from interventions designed to improve PA due to its benefit in

reduction of breast cancer events and overall mortality [38,39]. Identifying women who report perceived barriers to PA may be a first step in increasing PA.

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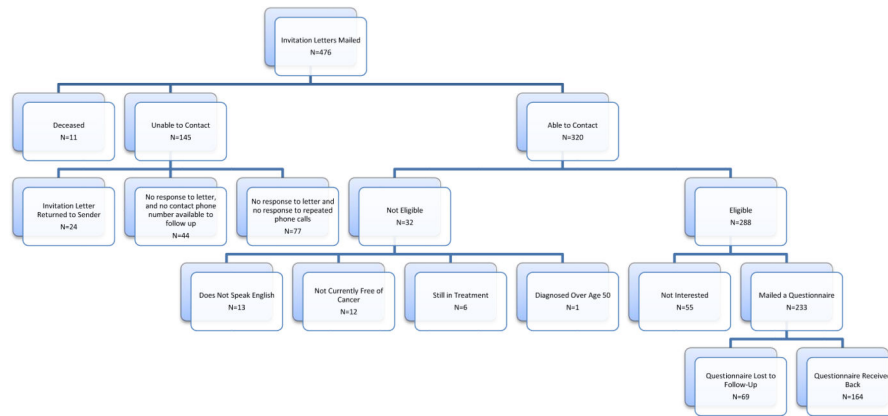
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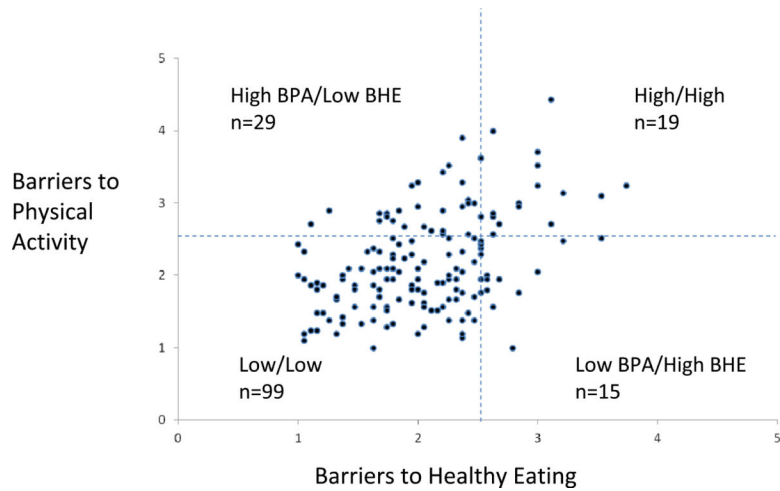
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**Figure 1.**  
ABC Study Recruitment Flow Chart



**Figure 2.**

Subgroups of young breast cancer survivors categorized by level of barriers to healthy eating and barriers to physical activity. Participants (n=162) are graphed according to their mean response on the barriers to physical activity scale (BPA) and the barriers to healthy eating scale (BHE). For each scale, the following categories apply: 1=never, 2=rarely, 3=sometimes, 4=often, 5=very often. A mean response of 2.5 or higher for each scale was classified as “high” whereas a response of less than 2.5 was classified as “low.”

**Table 1**

Descriptive characteristics of participants by responses to the Barriers to Healthy Eating (HE) and Barriers to Physical Activity (PA) scales<sup>1</sup>.

DEMOGRAPHIC CHARACTERISTICS	Total Sample n=162	Low Barriers PA, Low Barriers HE (n=99)	High Barriers PA, Low Barriers HE (n=29)	Low Barriers PA, High Barriers HE (n=15)	High Barriers PA, High Barriers HE (n=19)	P-value <sup>2</sup>
Age (years)	47.6 (5.6)	47.9 (5.7)	47.8 (6.0)	46.5 (5.2)	46.8 (4.7)	0.73
Ethnicity (n=162)						
White, non-Hispanic	111 (68.5%)	70 (70.7%)	19 (65.5%)	7 (46.7%)	15 (78.9%)	0.07
Hispanic	16 (9.9%)	7 (6.9%)	2 (6.9%)	6 (40.0%)	1 (5.3%)	
Black, non-Hispanic	9 (5.6%)	5 (5.1%)	3 (10.3%)		1 (5.3%)	
Asian	23 (14.2%)	15 (15.2%)	4 (13.8%)	2 (13.3%)	2 (10.5%)	
Other	3 (1.9%)	2 (2.0%)	1 (3.4%)			
<b>Marital Status</b>						
Married/living as married vs. single/divorced	122 (75.3%)	76 (76.8%)	22 (75.9%)	9 (60.0%)	15 (78.9%)	0.54
<b>Lives Alone</b> (percent yes)	24 (14.8%)	12 (12.1%)	5 (17.2%)	4 (26.7%)	3 (15.8%)	0.50
<b>Has Children</b> (percent yes)	109 (67.3%)	66 (66.7%)	20 (69.0%)	8 (53.3%)	15 (78.9%)	0.47
<b>Educational Attainment</b> (n=162)						0.35
High school grad, GED, or vocational or training school	9 (5.6%)	2 (2.0%)	4 (13.8%)	1 (6.7%)	2 (10.5%)	
Some college or AA	41 (25.3%)	23 (23.2%)	6 (20.7%)	6 (40.0%)	6 (31.6%)	
4 year college graduate	47 (29.0%)	32 (32.2%)	7 (24.1%)	3 (20.0%)	5 (26.3%)	
Some graduate school	24 (14.8%)	16 (16.2%)	5 (17.2%)	--	3 (15.8%)	
Completed graduate school	41 (25.3%)	26 (26.3%)	7 (24.1%)	5 (33.3%)	3 (15.8%)	
<b>Current Employment Status</b>						0.92
Full-time	86 (53.1%)	51 (51.5%)	16 (55.2%)	10 (66.7%)	9 (47.4%)	
Part-time	28 (17.3%)	18 (18.2%)	4 (13.8%)	1 (6.7%)	5 (26.3%)	
Full time homemaker, full or part time volunteer, student, or retired	31 (19.1%)	19 (19.2%)	6 (20.7%)	2 (13.3%)	4 (21.1%)	
Unemployed, on temporary medical leave, or permanently disabled	17 (10.5%)	11 (11.1%)	3 (10.3%)	2 (13.3%)	1 (5.3%)	
<b>Total Family Income</b> (n=157)						0.24
Under \$60,000	27 (17.2%)	17 (17.7%)	4 (13.8%)	2 (14.3%)	4 (22.2%)	

DEMOGRAPHIC CHARACTERISTICS		Total Sample n=162	Low Barriers PA, Low Barriers HE (n=99)	High Barriers PA, Low Barriers HE (n=29)	Low Barriers PA, High Barriers HE (n=15)	High Barriers PA, High Barriers HE (n=19)	P-value <sup>2</sup>
\$60,001-\$100,000		56 (35.7%)	27 (28.1%)	14 (48.3%)	8 (57.1%)	7 (38.9%)	
Over \$100,000		74 (47.1%)	52 (54.2%)	11 (37.9%)	4 (28.6%)	7 (38.9%)	
MEDICAL CHARACTERISTICS		Total Sample n=162	Low Barriers PA, Low Barriers HE (n=99)	High Barriers PA, Low Barriers HE (n=29)	Low Barriers PA, High Barriers HE (n=15)	High Barriers PA, High Barriers HE (n=19)	P-value <sup>2</sup>
Height (inches)		64.8 (2.8)	64.7 (2.8)	64.5 (2.9)	65.3 (2.6)	65.7 (2.2)	0.39
Current Weight (lbs)		151.0 (38.3)	143.3 <sup>a</sup> (30.5)	161.7 (47.7)	149.1 (30.1)	176.3 <sup>a</sup> (50.9)	0.002
Current BMI		25.1 (5.5)	24.0 <sup>b</sup> (4.3)	27.0 <sup>b</sup> (6.6)	24.5 (4.6)	28.6 <sup>c</sup> (7.8)	0.001
BMI at Diagnosis (n=158)		24.5 (5.5)	23.4 <sup>d</sup> (4.4)	26.4 <sup>d</sup> (7.2)	24.5 (4.7)	28.1 <sup>e</sup> (6.9)	0.002
Menopausal Status							0.03 <sup>f</sup>
Pre		54 (33.3%)	31 (31.3%)	8 (27.6%)	10 (66.7%)	5 (26.3%)	
Post		93 (57.4%)	60 (60.6%)	16 (55.2%)	4 (26.7%)	13 (68.4%)	
Unknown -- Hysterectomy		4 (2.5%)	--	2 (6.9%)	1 (6.7%)	1 (5.3%)	
Unknown -Treatment-related Amenorrhea		11 (6.8%)	8 (8.1%)	3 (10.3%)			
Count of co-morbidities (0 to 13, n=161)		1.2 (1.1)	1.1 (0.9)	1.2 (1.3)	0.9 (0.9)	1.8 (1.7)	0.07
Years since diagnosis		3.4 (1.5)	3.3 (1.5)	3.5 (1.5)	3.1 (1.5)	3.7 (1.4)	0.57
Type of surgery (n=161)							0.16
Mastectomy only		100 (62.1%)	68 (68.7%)	14 (48.3%)	7 (50.0%)	11 (57.9%)	
Lumpectomy only		61 (37.9%)	31 (31.3%)	15 (51.7%)	7 (50.0%)	8 (42.1%)	
Chemotherapy and/or Radiation							0.14
Had neither chemotherapy nor radiation		21 (13.0%)	15 (15.2%)	2 (6.9%)	2 (13.3%)	2 (10.5%)	
Had Chemotherapy only (percent yes)		40 (24.7%)	29 (29.3%)	3 (10.3%)	5 (33.3%)	3 (15.8%)	
Had Radiation only (percent yes)		15 (9.3%)	9 (9.1%)	2 (6.9%)	3 (20.0%)	1 (5.3%)	
Had both chemotherapy and radiation (percent yes)		86 (53.1%)	46 (46.5%)	22 (75.9%)	5 (33.3%)	13 (68.4%)	
Received Herceptin or other biotherapy (percent yes, n=157)		36 (22.9%)	22 (22.9%)	7 (25.0%)	3 (21.4%)	4 (21.1%)	0.99
Currently receiving endocrine therapy		98 (60.5%)	61 (61.6%)	19 (65.5%)	8 (53.3%)	10 (52.6%)	0.76



QUALITY OF LIFE AND SYMPTOMS	Total Sample n=162	Low Barriers PA, Low Barriers HE (n=99)	High Barriers PA, Low Barriers HE (n=29)	Low Barriers PA, High Barriers HE (n=15)	High Barriers PA, High Barriers HE (n=19)	P-value
CESD	14.1 (10.1)	12.2 <sup>a</sup> (8.7)	15.0 (12.4)	18.3 (11.9)	19.5 <sup>a</sup> (9.4)	<b>0.008</b>
PSS ( n=161)	16.7 (6.7)	15.2 <sup>b</sup> (6.1)	17.9 (6.9)	19.5 (7.0)	20.7 <sup>b</sup> (7.2)	<b>0.002</b>
MOS emotional social support (n=162)	75.1 (22.5)	79.6 <sup>c</sup> (19.5)	68.3 (26.1)	71.3 (22.6)	64.8 <sup>c</sup> (26.1)	<b>0.01</b>
MOS instrumental social support (n=161)	73.8 (27.0)	79.7 <sup>d</sup> (23.0)	65.3 (31.8)	65.8 (27.3)	62.5 <sup>d</sup> (31.7)	<b>0.006</b>
FSI Level of fatigue on the day felt most fatigued during the last week	6.3 (2.6)	5.8 <sup>e</sup> (2.7)	6.8 (2.5)	7.0 (2.4)	7.6 <sup>e</sup> (1.7)	<b>0.01</b>
SF-12 Physical Component (n=159)	47.9 (9.6)	49.5 <sup>f,s</sup> (8.7)	43.6 <sup>f,h</sup> (10.1)	51.7 <sup>h,i</sup> (8.0)	43.0 <sup>h,i</sup> (10.9)	<b>0.001</b>
SF-12 Mental Component (n=159)	47.1 (10.8)	49.1 <sup>j</sup> (9.4)	46.2 (13.5)	41.2 <sup>j</sup> (9.6)	42.8 (11.6)	<b>0.01</b>
<b>BCPT Symptom Scales</b>						
Hot flashes	1.4 (1.3)	1.4 (1.3)	1.4 (1.2)	1.5 (1.3)	1.4 (1.1)	1.0
Nausea	0.2 (0.4)	0.2 (0.4)	0.3 (0.4)	0.1 (0.2)	0.3 (0.5)	0.53
Bladder Control	0.5 (0.8)	0.4 <sup>k</sup> (0.7)	0.7 (0.8)	0.7 (1.1)	1.0 <sup>k</sup> (1.0)	<b>0.003</b>
Vaginal Problems	1.4 (1.4)	1.6 (1.4)	1.3 (1.4)	1.3 (1.3)	1.1 (1.4)	0.60
Musculoskeletal pain	1.6 (1.2)	1.4 (1.2)	1.9 (1.1)	1.3 (0.9)	1.9 (1.1)	0.13
Cognitive problems	1.5 (1.1)	1.4 <sup>l</sup> (1.1)	1.4 (0.9)	2.3 <sup>l</sup> (1.3)	1.7 (1.1)	<b>0.049</b>
Weight problems	1.7 (1.2)	1.4 <sup>m</sup> (1.2)	1.7 (1.2)	1.9 (1.3)	2.6 <sup>m</sup> (1.1)	<b>0.002</b>
Arm Problems	0.6 (0.8)	0.4 <sup>n</sup> (0.7)	1.2 <sup>n</sup> (1.1)	0.7 (0.9)	0.7 (0.8)	<b>&lt;0.001</b>

Superscripts a-n indicate pairs which differ significantly

<sup>1</sup>Barrier groups were created based on mean responses to each of the two scales. Participants were considered to have low barriers for each of the scales if they reported a mean response of less than 2.5 and to have high barriers if they reported a mean response of 2.5 or higher. Both BHE and BPA scale response options ranged from 1 to 5 with 1 representing "Never" and 5 representing "Very Often."

<sup>2</sup>Analysis of Variance (ANOVA) used to compare participants by barrier quadrants for continuous variables and chi-square tests for categorical variables.

Additional Scale and item descriptions: Currently receiving endocrine therapy: e.g. Tamoxifen, Femara, Aromasin, Arimidex, Lupron or Zoladex (percent yes); Depression: Center for Epidemiologic Studies Depression Scale, CES-D, higher=more depressed); Stress: (Perceived Stress Scale, PSS, higher=more perceived stress, n=161; Social support: MOS emotional social support, higher=more support, n=162; MOS instrumental social support, higher=more support, n=161; Well-being: Short Form Health Survey (SF-12); Physical Component, higher =higher functioning, Short Form Health Survey (SF-12); Mental Component, higher=higher functioning; Breast Cancer-Related Symptoms (Breast Cancer Prevention Trial Symptom Checklist) ,BCPT Symptom Scales, Scales range from 0-4 with higher indicating more symptoms.

<sup>l</sup>For menopausal status, the Low PA/High HE group differs significantly from all 3 other groups

**Table 2**  
 Frequency of responses to Barriers to Healthy Eating and Barriers to Physical Activity Scales

Barrier	Percent Response					Mean score	SD
	Never	Rarely	Sometimes	Often	Very Often		
<b>Healthy Eating</b>							
Holidays and special occasions are a problem	16.6	18.4	32.5	25.8	6.7	2.9	1.2
I feel like eating whatever I want	14.1	19.6	35.6	20.9	9.8	2.9	1.2
High fat foods taste better	16.6	20.9	33.7	17.8	11.0	2.9	1.2
I eat a lot of meals away from home	20.2	24.5	30.7	15.3	9.2	2.7	1.2
It's easier to grab another type of snack and eat it in my car	29.4	22.7	31.3	9.8	6.7	2.4	1.2
It takes too much planning to eat a healthier diet	36.8	14.7	33.1	9.8	5.5	2.3	1.2
High fat foods are a traditional part of my culture	35.0	31.3	17.2	13.5	3.1	2.2	1.1
Healthier foods are too expensive	45.4	20.9	24.5	4.9	4.3	2	1.1
There are no healthy food options at sporting events	53.4	16.0	16.6	8.6	5.5	2	1.2
I can't keep track of what I need to eat	43.6	30.1	21.5	3.1	1.8	1.9	1.0
Fruits and vegetables don't fill me up	44.2	28.8	21.5	1.8	3.7	1.9	1.0
Fruits and vegetables take too long to prepare	54.0	20.9	21.5	2.5	1.2	1.8	1.0
I don't know how to cook healthier meals	60.1	19.0	11.0	5.5	4.3	1.8	1.1
There are no healthier foods in vending machines	61.7	15.4	9.3	6.8	6.8	1.8	1.3
I don't like the taste of healthier foods	55.2	27.6	12.9	3.7	0.6	1.7	0.9
My family doesn't support me for eating more healthfully	66.9	20.2	9.2	1.8	1.8	1.5	0.9
I don't like the taste of fruits and vegetables	69.1	19.8	9.9	0.6	0.6	1.4	0.7
I don't know how to cook vegetables	71.8	19.0	6.1	1.8	1.2	1.4	0.8
I don't know where to find low fat foods	77.3	19.0	3.7	0.0	0.0	1.3	0.5
<b>Physical Activity</b>							
Lack of time	11.0	18.4	30.1	19.0	21.5	3.2	1.3
Lack of self-discipline	10.4	18.4	39.9	17.8	13.5	3.1	1.2
Fatigue (or lack of energy)	15.3	20.2	31.3	16.6	16.6	3.0	1.3
Procrastination	19.6	17.8	34.4	13.5	14.7	2.9	1.3
Lack of interest in exercise	16.6	25.8	35.0	11.0	11.7	2.8	1.2
Family responsibilities	24.5	20.2	25.2	19.0	11.0	2.7	1.3

Barrier	Percent Response					Mean score	SD
	Never	Rarely	Sometimes	Often	Very Often		
<b>Healthy Eating</b>							
Exercise not in routine	31.3	17.2	20.2	14.1	17.2	2.7	1.5
Pain or discomfort	33.7	20.2	25.2	9.2	11.7	2.5	1.3
Lack of enjoyment from exercise	32.5	25.8	22.1	9.2	10.4	2.4	1.3
Exercise is not a priority	36.2	23.3	23.3	11.0	6.1	2.3	1.2
Exercise is boring	43.2	25.9	15.4	8.6	6.8	2.1	1.2
Lack of company	46.6	25.2	14.7	7.4	6.1	2.0	1.2
Inconvenient exercise schedule	51.5	14.7	19.6	7.4	6.7	2.0	1.3
Weather	46.6	27.6	18.4	3.7	3.7	1.9	1.1
Lack of equipment	63.8	20.9	5.5	4.3	5.5	1.7	1.1
Cost of exercising	71.8	12.3	8.6	3.7	3.7	1.6	1.0
Lack of skills	71.8	16.6	7.4	3.1	1.2	1.5	0.9
No facilities or space to exercise	77.3	8.6	8.0	2.5	3.7	1.5	1.0
Fear of injury	69.3	17.2	9.2	2.5	1.8	1.5	0.9
Feeling nauseated	78.5	12.9	8.6	0.0	0.0	1.3	0.6
Lack of knowledgeable exercise staff	77.9	12.3	8.0	1.2	0.6	1.3	0.7

Note: Participants rated how often a list of barriers "interfered with your plan to exercise in the past month" and responses were: 1=Never, 2=Rarely, 3=Sometimes, 4= Often, or 5=Very Often.

Table 3

Multivariate regression of Barriers to Healthy Eating and Barriers to Physical Activity on Demographics, Quality of Life, Symptoms, and Cancer Treatment

Predictors	Model 1: BHE		Model 2: BPA	
	Coef (SE)	P-value	Coef (SE)	P-value
	<b>R<sup>2</sup>=0.21</b>		<b>R<sup>2</sup>=0.34</b>	
Current Age	-0.004	0.61	-0.01	0.26
Ethnicity (white vs. not white)	0.008	0.94	0.10	0.36
Has Children (yes vs. no)	0.03	0.79	0.12	0.30
Married or living as married (yes vs. no)	0.001	0.99	0.11	0.33
Four year college grad or more (yes vs. no)	-0.24	<b>0.02</b>	-0.09	0.38
Comorbid conditions (yes vs. no)	-0.05	0.60	-0.15	0.18
Had radiation only (yes vs. no)	-0.01	0.94	0.28	0.19
Had chemotherapy only (yes vs. no)	-0.25	0.10	-0.14	0.40
Had both radiation and chemotherapy (yes vs. no)	-0.09	0.53	0.21	0.16
Currently receiving endocrine therapy (yes vs. no)	-0.007	0.94	0.07	0.47
Perceived Stress	0.02	<b>0.03</b>	0.01	0.15
Level of fatigue on the day most fatigue of past week	0.02	0.34	0.02	0.30
BCPT Bladder Control			0.17	<b>0.01</b>
BCPT Weight Problems	0.13	<b>0.002</b>	0.07	0.15
Physical Component Well-Being	0.004	0.44	-0.02	<b>0.003</b>

Additional Scale and item descriptions: Currently receiving endocrine therapy: e.g. Tamoxifen, Femara, Aromasin, Arimidex, Lupron or Zoladex; Stress: Perceived Stress Scale; Physical Component Well-Being: Short Form Health Survey (SF-12); Level of Fatigue: FSI; Breast Cancer-Related Symptoms: Breast Cancer Prevention Trial Symptom Checklist, BCPT Symptom Scales

Table 4

Multivariate Regression of BMI on BHE and BPA

Predictors	BMI on BHE and BPA	
	Coef (SE)	P-value
	<b>R<sup>2</sup>=0.24</b>	
Current Age	0.19	<b>0.01</b>
Ethnicity (white vs. not white)	1.0	0.25
Has Children (yes vs. no)	-0.48	0.61
Married or living as married (yes vs. no)	0.69	0.49
Four year college grad or more (yes vs. no)	-1.97	<b>0.03</b>
Comorbid conditions (yes vs. no)	2.13	<b>0.02</b>
Had radiation only (yes vs. no)	0.08	0.96
Had chemotherapy only (yes vs. no)	0.65	0.63
Had both radiation and chemotherapy (yes vs. no)	1.40	0.27
Currently receiving endocrine therapy (yes vs. no)	-0.90	0.28
Barriers to Healthy Eating (BHE)	1.72	<b>0.03</b>
Barriers to Physical Activity (BPA)	1.40	<b>0.046</b>

\*P-value for test of joint significance=0.001

Additional Scale and item descriptions: Currently receiving endocrine therapy: e.g. Tamoxifen, Femara, Aromasin, Arimidex, Lupron or Zoladex; BPA: adapted from Rogers, BHE: developed by study team.

P 0.05 was deemed significant and is shown in bold.