Breast Cancer Res Treat (2013) 142:423–433
DOI 10.1007/s10549-013-2749-x

EPIDEMIOLOGY

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

Emily E. Ventura · Patricia A. Ganz · Julienne E. Bower · Liana Abascal · Laura Petersen · Annette L. Stanton · Catherine M. Crespi

Received: 1 October 2013 / Accepted: 21 October 2013 / Published online: 1 November 2013

Abstract 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. 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 among BHE, BPA, and BMI. 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. 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. Several bio-psychosocial factors (e.g., depression, stress, and 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

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

E. E. Ventura · P. A. Ganz (✉) · L. Petersen · A. L. Stanton · C. M. Crespi
Cancer Prevention and Control Research, Jonsson Comprehensive Cancer Center, University of California, Los Angeles, 650 Charles Young Drive South, Room A2-125 CHS, Los Angeles, CA 90095-6900, USA
e-mail: pganz@mednet.ucla.edu

P. A. Ganz
Department of Health Policy & Management, Fielding School of Public Health, University of California, Los Angeles, Los Angeles, CA, USA

P. A. Ganz
Department of Medicine, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, CA, USA

J. E. Bower · A. L. Stanton
Department of Psychology, University of California, Los Angeles, Los Angeles, CA, USA

J. E. Bower · A. L. Stanton
Cousins Center for Psychoneuroimmunology, Semel Institute, University of California, Los Angeles, Los Angeles, CA, USA

L. Abascal
Department of Psychiatry, University of California, San Diego, San Diego, CA, USA

C. M. Crespi
Department of Biostatistics, Fielding School of Public Health, University of California, Los Angeles, Los Angeles, CA, USA

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 (BHE) 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 BHE and BPA 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 and 2007. Eligibility criteria were: stage 1, 2, or 3 breast cancer diagnosed at age $\leq$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

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 kg/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-

Table 1 Descriptive characteristics of participants by responses to the barriers to healthy eating (HE) and barriers to physical activity (PA) scales

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[2]
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 %)	–	–	
Marital status						
Married/living as married versus single/ divorced	122 (75.3 %)	76 (76.8 %)	22 (75.9 %)	9 (60.0 %)	15 (78.9 %)	0.54
Lives alone (percent yes)	24 (14.8 %)	12 (12.1 %)	5 (17.2 %)	4 (26.7 %)	3 (15.8 %)	0.50
Has children (percent yes)	109 (67.3 %)	66 (66.7 %)	20 (69.0 %)	8 (53.3 %)	15 (78.9 %)	0.47
Educational attainment ($n = 162$)						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 %)	
Current employment status						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 %)	
Total family income ($n = 157$)						0.24
Under $60,000	27 (17.2 %)	17 (17.7 %)	4 (13.8 %)	2 (14.3 %)	4 (22.2 %)	
$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[2]
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[a] (30.5)	161.7 (47.7)	149.1 (30.1)	176.3[a] (50.9)	**0.002**
Current BMI	25.1 (5.5)	24.0[b,c] (4.3)	27.0[b] (6.6)	24.5 (4.6)	28.6[c] (7.8)	**0.001**

Table 1 continued

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[2]
BMI at diagnosis ($n = 158$)	24.5 (5.5)	23.4[d,e] (4.4)	26.4[d] (7.2)	24.5 (4.7)	28.1[e] (6.9)	**0.002**
Menopausal status						**0.03**[1]
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 (0–13, $n = 161$)	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**
CES-D	14.1 (10.1)	12.2[a] (8.7)	15.0 (12.4)	18.3 (11.9)	19.5[a] (9.4)	**0.008**
PSS ($n = 161$)	16.7 (6.7)	15.2[b] (6.1)	17.9 (6.9)	19.5 (7.0)	20.7[b] (7.2)	**0.002**
MOS emotional social support ($n = 162$)	75.1 (22.5)	79.6[c] (19.5)	68.3 (26.1)	71.3 (22.6)	64.8[c] (26.1)	**0.01**
MOS instrumental social support ($n = 161$)	73.8 (27.0)	79.7[d] (23.0)	65.3 (31.8)	65.8 (27.3)	62.5[d] (31.7)	**0.006**
FSI Level of fatigue on the day felt most fatigued during the last week	6.3 (2.6)	5.8[e] (2.7)	6.8 (2.5)	7.0 (2.4)	7.6[e] (1.7)	**0.01**
SF-12 physical component ($n = 159$)	47.9 (9.6)	49.5[f,g] (8.7)	43.6[f,h] (10.1)	51.7[h,i] (8.0)	43.0[g,i] (10.9)	**0.001**
SF-12 mental component ($n = 159$)	47.1 (10.8)	49.1[j] (9.4)	46.2 (13.5)	41.2[j] (9.6)	42.8 (11.6)	**0.01**
BCPT symptom scales						
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[k] (0.7)	0.7 (0.8)	0.7 (1.1)	1.0[k] (1.0)	**0.003**

Table 1 continued

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
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[l] (1.1)	1.4 (0.9)	2.3[l] (1.3)	1.7 (1.1)	**0.049**
Weight problems	1.7 (1.2)	1.4[m] (1.2)	1.7 (1.2)	1.9 (1.3)	2.6[m] (1.1)	**0.002**
Arm Problems	0.6 (0.8)	0.4[n] (0.7)	1.2[n] (1.1)	0.7 (0.9)	0.7 (0.8)	**<0.001**

Superscripts a–n indicate pairs which differ significantly. 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." 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 to 4 with higher indicating greater severity of symptoms

$p < 0.05$ was deemed statistically significant and is shown in bold

[1] For menopausal status, the low PA/high HE group differs significantly from all three other groups

[2] Analysis of variance (ANOVA) used to compare participants by barrier quadrants for continuous variables and Chi square tests for categorical variables

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 BHE were assessed by a scale developed for this study to parallel the Rogers scale. A list of 19 BHE 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.

Table 2 Frequency of responses to barriers to healthy eating and barriers to physical activity scales

Barrier	Percent response					Mean score	SD
Healthy eating	Never	Rarely	Sometimes	Often	Very often		
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
Physical activity							
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
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

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

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 versus high categorizations of the two 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), cormorbid 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 bivariately, 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) versus 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 Fig. 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. 61 % 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 Fig. 2. There was a strong correlation between BPA and BHE ($r = 0.44$, $p < 0.0001$).

Since 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

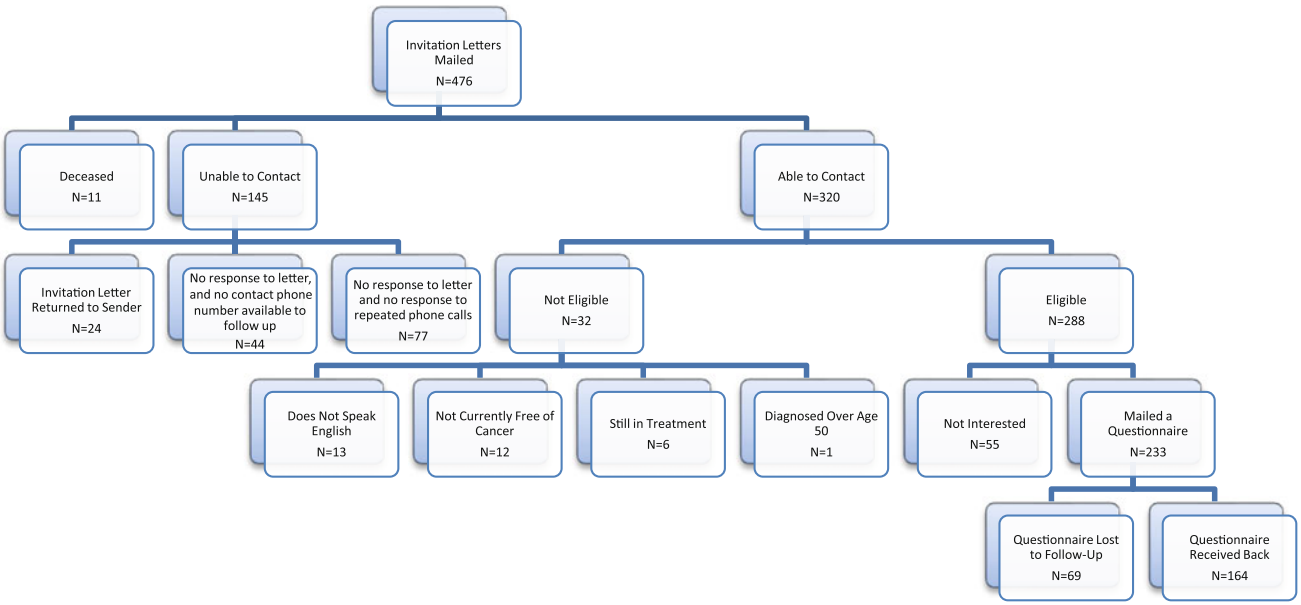

Fig. 1 ABC study recruitment flow chart

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 pre-menopausal than the other three 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 both the low/low group and the low PA/high BHE group.

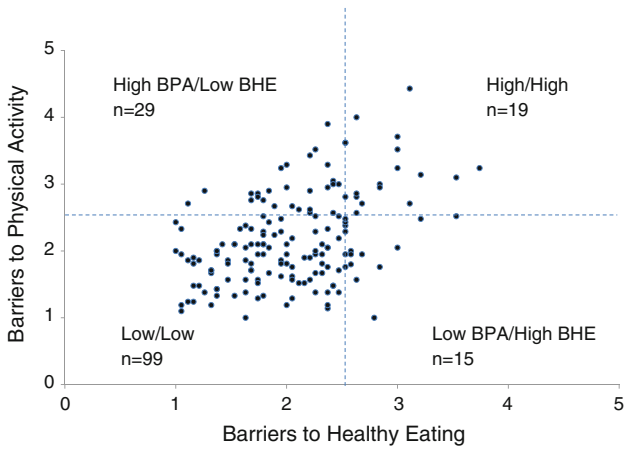

Fig. 2 Subgroups of young breast cancer survivors categorized by level of barriers to healthy eating and barriers to physical activity. Participants ($n = 162$) are graphed according to their mean response on the barriers to physical activity scale (BPA) and the barriers to healthy eating scale (BHE). 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"

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

Table 3 Multivariate regression of barriers to healthy eating and barriers to physical activity on demographics, quality of life, symptoms, and cancer treatment

Variables	Model 1: BHE		Model 2: BPA	
	$R^2 = 0.21$		$R^2 = 0.34$	
	Coef (SE)	p value	Coef (SE)	p value
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	**0.02**	−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	**0.03**	0.01	0.15
Level of fatigue on the day most fatigued of past week	0.02	0.34	0.02	0.30
BCPT bladder control	–	–	0.17	**0.01**
BCPT weight problems	0.13	**0.002**	0.07	0.15
Physical component well-being	0.004	0.44	−0.02	**0.003**

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

$p \leq 0.05$ was deemed statistically significant and is shown in bold

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 $p < 0.05$, $R^2 = 0.24$).

Table 4 Multivariate regression of BMI on BHE and BPA

Variables	BMI on BHE and BPA	
	$R^2 = 0.24$	
	Coef (SE)	p value
Current age	0.19	**0.01**
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	**0.03**
Comorbid conditions (yes vs. no)	2.13	**0.02**
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	**0.03**
Barriers to physical activity (BPA)	1.40	**0.046**

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

$p \leq 0.05$ was deemed statistically significant and is shown in bold

* p value for test of joint significance = 0.001

Discussion

In this study sample, the most frequently reported barrier to PA was "Lack of time" and the most frequently reported BHE 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) versus responding "often" to the set of barriers. Similarly, our results suggest that each one-unit increase in response to 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 BHE, and the intersection of the two sets of barriers. We identified six studies [22, 25–29] that investigated barriers to PA in BCS, as well as three studies that evaluated barriers to PA in breast cancer patients [21, 30, 31]. No studies were found that explored BHE in BCS or patients. An additional six studies [32–37] were reported on barriers to PA in other cancer patient or survivor populations, three of which [32, 36, 37] were also reported on BHE, but did not systematically explore correlates of perceived barriers or associations between perceived barriers and BMI.

Of the six 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 aged 33–63, 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" of "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 PA 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.

Acknowledgments This project was supported by funding from the Jonsson Cancer Center Foundation to Dr. Patricia Ganz. Additional funding from NIH R25 CA 87949 to Drs. Ventura, Stanton, and Ganz and NIH CA16024 to Dr. Crespi. We thank the participants in this study for contributing to this research and increasing our knowledge about the experiences of younger women with breast cancer. We also want to acknowledge the support of the research team members, including Barbara Kahn-Mills, Sasha Sobolevsky, and Patricia Voege.

Conflicts of interest The authors have no conflicts of interest to declare.

References

1. American Cancer Society (2012) Cancer treatment & suvivorship: facts and figures 2012–2013. Atlanta, ACS
2. American Cancer Society (2012) Breast cancer facts and figures 2011–2012. American Cancer Society Inc, Atlanta
3. Howard-Anderson J, Ganz PA, Bower JE, Stanton AL (2012) Quality of life, fertility concerns, and behavioral health outcomes in younger breast cancer survivors: a systematic review. J Natl Cancer Inst 104(5):386–405

4. Ewertz M, Jensen MB, Gunnarsdóttir K et al (2011) Effect of obesity on prognosis after early-stage breast cancer. J Clin Oncol 29(1):25–31
5. Goodwin PJ, Ennis M, Pritchard KI et al (1999) Adjuvant treatment and onset of menopause predict weight gain after breast cancer diagnosis. J Clin Oncol 17(1):120–129
6. Kroenke CH, Chen WY, Rosner B, Holmes MD (2005) Weight, weight gain, and survival after breast cancer diagnosis. J Clin Oncol 23(7):1370–1378
7. Ballard-Barbash R, Friedenreich CM, Courneya KS, Siddiqi SM, McTiernan A, Alfano CM (2012) Physical activity, biomarkers, and disease outcomes in cancer survivors: a systematic review. J Natl Cancer Inst 104(11):815–840
8. Herman DR, Ganz PA, Petersen L, Greendale GA (2005) Obesity and cardiovascular risk factors in younger breast cancer survivors: the Cancer and Menopause Study (CAMS). Breast Cancer Res Treat 93(1):13–23
9. Davies NJ, Batehup L, Thomas R (2011) The role of diet and physical activity in breast, colorectal, and prostate cancer survivorship: a review of the literature. Br J Cancer 105(Suppl 1):S52–S73
10. Rock CL, Doyle C, Demark-Wahnefried W et al (2012) Nutrition and physical activity guidelines for cancer survivors. CA Cancer J Clin 62(4):243–274
11. Ganz PA, Greendale GA, Petersen L, Kahn B, Bower JE (2003) Breast cancer in younger women: reproductive and late health effects of treatment. J Clin Oncol 21(22):4184–4193
12. Ganz PA, Kwan L, Stanton AL, Bower JE, Belin TR (2011) Physical and psychosocial recovery in the year after primary treatment of breast cancer. J Clin Oncol 29(9):1101–1109
13. Radloff LS (1977) The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1:385–401
14. Cohen S, Kamarck T, Mermelstein R (1983) A global measure of perceived stress. J Health Soc Behav 24(4):385–396
15. Ganz PA, Guadagnoli E, Landrum MB, Lash TL, Rakowski W, Silliman RA (2003) Breast cancer in older women: quality of life and psychosocial adjustment in the 15 months after diagnosis. J Clin Oncol 21(21):4027–4033
16. Hann DM, Jacobsen PB, Azzarello LM et al (1998) Measurement of fatigue in cancer patients: development and validation of the Fatigue Symptom Inventory. Qual Life Res 7(4):301–310
17. Hann DM, Denniston MM, Baker F (2000) Measurement of fatigue in cancer patients: further validation of the Fatigue Symptom Inventory. Qual Life Res 9(7):847–854
18. Stein KD, Martin SC, Hann DM, Jacobsen PB (1998) A multidimensional measure of fatigue for use with cancer patients. Cancer Pract 6(3):143–152
19. Ware J Jr, Kosinski M, Keller SD (1996) A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. Med Care 34(3):220–233
20. Stanton AL, Bernaards CA, Ganz PA (2005) The BCPT symptom scales: a measure of physical symptoms for women diagnosed with or at risk for breast cancer. J Natl Cancer Inst 97(6):448–456
21. Rogers LQ, Shah P, Dunnington G et al (2005) Social cognitive theory and physical activity during breast cancer treatment. Oncol Nurs Forum 32(4):807–815
22. Rogers LQ, McAuley E, Courneya KS, Verhulst SJ (2008) Correlates of physical activity self-efficacy among breast cancer survivors. Am J Health Behav 32(6):594–603
23. Calfas KJ, Patrick K, Hagler A, Norman GJ, Zabinski MF, Sallis JF (2006) Twelve-month dietary and physical activity outcomes in 'PACEi-Women in Balance': a primary-care and web-based intervention. Ann Behav Med 31(suppl):S184
24. Ganz PA, Rowland JH, Desmond K, Meyerowitz BE, Wyatt GE (1998) Life after breast cancer: understanding women's health-related quality of life and sexual functioning. J Clin Oncol 16(2):501–514
25. Leddy SK (1997) Incentives and barriers to exercise in women with a history of breast cancer. Oncol Nurs Forum 24(5):885–890
26. Loh SY, Chew SL, Lee SY (2011) Barriers to exercise: perspectives from multiethnic cancer survivors in Malaysia. Asian Pac J Cancer Prev 12(6):1483–1488
27. Ottenbacher AJ, Day RS, Taylor WC et al (2011) Exercise among breast and prostate cancer survivors—what are their barriers? J Cancer Surviv 5(4):413–419
28. Rogers LQ, Vicari S, Courneya KS (2010) Lessons learned in the trenches: facilitating exercise adherence among breast cancer survivors in a group setting. Cancer Nurs 33(6):E10–E17
29. Sander AP, Wilson J, Izzo N, Mountford SA, Hayes KW (2012) Factors that affect decisions about physical activity and exercise in survivors of breast cancer: a qualitative study. Phys Ther 92(4):525–536
30. Rogers LQ, Courneya KS, Verhulst S, Markwell S, Lanzotti V, Shah P (2006) Exercise barrier and task self-efficacy in breast cancer patients during treatment. Support Care Cancer 14(1):84–90
31. Gho SA, Steele JR, Munro BJ (2010) Is bra discomfort a barrier to exercise for breast cancer patients? Support Care Cancer 18(6):735–741
32. Anderson AS, Caswell S, Wells M, Steele RJ, Macaskill S (2010) "It makes you feel so full of life" LiveWell, a feasibility study of a personalised lifestyle programme for colorectal cancer survivors. Support Care Cancer 18(4):409–415
33. Clark MM, Vickers KS, Hathaway JC et al (2007) Physical activity in patients with advanced-stage cancer actively receiving chemotherapy. J Support Oncol 5(10):487–493
34. Courneya KS, Friedenreich CM, Quinney HA et al (2005) A longitudinal study of exercise barriers in colorectal cancer survivors participating in a randomized controlled trial. Ann Behav Med 29(2):147–153
35. Rogers LQ, Courneya KS, Robbins KT et al (2008) Physical activity correlates and barriers in head and neck cancer patients. Support Care Cancer 16(1):19–27
36. Satia JA, Campbell MK, Galanko JA, James A, Carr C, Sandler RS (2004) Longitudinal changes in lifestyle behaviors and health status in colon cancer survivors. Cancer Epidemiol Biomarkers Prev 13(6):1022–1031
37. Satia JA, Walsh JF, Pruthi RS (2009) Health behavior changes in white and African American prostate cancer survivors. Cancer Nurs 32(2):107–117
38. Paxton RJ, Phillips KL, Jones LA et al (2012) Associations among physical activity, body mass index, and health-related quality of life by race/ethnicity in a diverse sample of breast cancer survivors. Cancer 118(16):4024–4031
39. Bertram LA, Stefanick ML, Saquib N et al (2011) Physical activity, additional breast cancer events, and mortality among early-stage breast cancer survivors: findings from the WHEL Study. Cancer Causes Control 22(3):427–435