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Associations between self-reported post-diagnosis physical activity changes, body weight changes and psychosocial well-being in breast cancer survivors

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Abstract

Purpose—Decreased physical activity and weight gain post- breast cancer diagnosis are associated with negative psychosocial, health and disease outcomes, but little is known about how these factors interact. The purpose of the present study was to conduct a preliminary examination of the association between post-diagnosis physical activity changes, weight changes and psychosocial well-being in breast cancer survivors.

Methods—We examined the association between retrospectively collected, self-reported post-diagnosis changes in physical activity and body weight and post-diagnosis fatigue, anxiety, depression, stress, self-esteem, and health-related quality of life (HRQOL) in breast cancer survivors (N=1348) using univariate analyses of covariance with Bonferroni's adjustment.

Results—After adjusting for covariates, maintaining and/or increasing physical activity post-diagnosis was significantly ($p < .05$ for all), independently associated with lower fatigue, anxiety, depression and stress and higher physical self-worth, physical, social, emotional, functional and breast cancer specific well-being and overall HRQOL (effect sizes = .23 to .60). Maintaining and/or losing weight was significantly ($p < .05$), independently associated with lower fatigue and higher physical self-worth, physical and breast cancer-specific well-being and overall HRQOL (effect sizes = .28 to .87). There were no significant interaction effects between physical activity and body weight changes.

Conclusions—This study provides preliminary data to suggest that maintaining or increasing physical activity and controlling weight post-diagnosis may be independently, positively associated with psychosocial well-being and HRQOL in breast cancer survivors. In addition, weight management effects may be larger and more outcome-specific while physical activity effects may be more general. Future research is warranted to replicate and confirm these findings.

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Conflict of Interest Statement

The authors have no conflicts of interest. The authors have full control of all primary data and agree to allow the journal to review these data upon request.

Keywords

physical activity; body weight; breast cancer survivors; quality of life; fatigue; depression; self-esteem; stress

Introduction

There are approximately 2.6 million breast cancer survivors in the United States, and this number is expected to increase due to relatively high incidence and survival rates and the aging U.S. population [1]. Thus, identifying modifiable lifestyle factors that have the potential to both improve breast cancer survivors' health and be integrated into care is an important public health concern [2,3]. Physical activity and weight management are two behaviors recommended to enhance survivorship [2] and have demonstrated considerable promise in mitigating disease-specific outcomes including mortality, recurrence and progression [4,5] and reducing risk of post-diagnosis comorbidities [2]. Additionally, physical activity has been consistently associated with reductions in treatment-related side effects and enhanced health-related quality of life (HRQOL) post-diagnosis [6,7]. While existing physical activity and weight management research is promising, it is limited by its focus on the time period immediately post-diagnosis and examination of body weight and physical activity separately. Thus, little is known about how changes in physical activity and body weight from pre-cancer diagnosis to varying times post-treatment may influence health outcomes and whether these factors interact.

Engaging in sufficient physical activity post-diagnosis has been consistently associated with reduced treatment-related side effects, recurrence [5] and all-cause and cancer-specific mortality [5,8] and enhanced HRQOL in breast cancer survivors [6,7]. However, fewer studies have examined changes in physical activity pre- and post-diagnosis and health outcomes. In general, studies have found increasing, or maintaining, physical activity post-diagnosis is associated with reduced treatment-related side effects, enhanced HRQOL, and better disease prognosis [5, 9,10]. In contrast, being overweight or obese at diagnosis [4,11,12] and post-diagnosis [11] has been associated with poorer prognosis in breast cancer survivors [12-16]. Evidence regarding changes in weight post-diagnosis is more equivocal [3,11,12,17] with some studies finding associations between weight gain and poorer prognosis and survival [6,18, 19] and others showing no effect [20-22]. Few studies have examined the effects of body weight or weight changes on treatment-related side effects. However, post-diagnosis weight gain has been associated with higher hot flashes prevalence [23] and higher post-diagnosis BMI has been associated with poorer physical functioning and pain and lower vitality [24].

Whereas physical activity and weight management may both be beneficial for breast cancer survivors, they are not mutually exclusive. Physical activity has been associated with changes in body weight and composition outcomes [25,26] with decreases in physical activity, and consequently daily energy expenditure contributing to weight gain post-diagnosis [27,28]. Additionally, women who are overweight or obese demonstrate greater reductions in physical activity during active treatment [29] and indicators of body

composition have been shown to mediate the relationship between physical activity and psychosocial well-being in healthy women [30]. However, many studies of body weight and physical activity effects on health or disease outcomes often fail to adjust for the other factor.

Understanding whether physical activity and weight management independently, or interactively, influence health outcomes in breast cancer survivors could assist in developing a better understanding of potential underlying mechanisms and improving recommendations for cancer survivors regarding dosage of health behaviors necessary to achieve specific post-treatment goals (e.g. reduced morbidity vs. enhanced HRQOL). Furthermore, it may help identify women at higher risk for long-term poorer health outcomes and direct them to appropriate lifestyle programs and interventions. Thus, the purpose of the present study was to conduct a secondary analyses of data from a previously published study [31] to examine self-reported changes in physical activity and body weight from pre-diagnosis to post-diagnosis and potential interactions of these factors in relation to psychosocial well-being including fatigue, depression, anxiety, stress, self-esteem and a composite measure of HRQOL in breast cancer survivors at varying times since diagnosis.

Methods

Participants

Women aged 18 years and older who had been diagnosed with breast cancer, were English-speaking and had access to a computer were eligible to participate in the present study.

Measures

Demographics—Self-reported age, race, income, and education were collected.

Health and cancer history—Participants' were asked to indicate (*yes or no*) whether they have been diagnosed with a list of 18 different comorbidities (i.e. diabetes, obesity, hypertension). Items with a positive response were summed to obtain total number of comorbidities. Women also self-reported breast cancer information (i.e. stage of disease, time since diagnosis in months, treatment regime, current hormone therapy use, estrogen receptor status), menopausal status at diagnosis and height and weight to calculate body mass index (BMI).

Physical activity—The Godin Leisure Time Exercise Questionnaire [32] was used to assess participants' current frequency of strenuous (e.g. running, jogging, cross country skiing, vigorous swimming, vigorous long distance bicycling), moderate (e.g. fast walking, tennis, easy bicycling, easy swimming, popular and folk dancing), and mild (e.g. yoga, bowling, golf, easy walking) exercise over the past seven days. Frequencies were multiplied by 9, 5, and 3 metabolic equivalents, respectively, and summed to form a measure of total physical activity. An additional version of the same questionnaire asked women to recall and report physical activity for the time period immediately prior to breast cancer diagnosis. Changes in physical activity were calculated by subtracting pre-diagnosis scores from current scores. Women were classified into 3 categories based on these values: decreased,

maintained, and increased. The GLTEQ is a simple, self-administered instrument that has been widely used in epidemiological, clinical, and behavioral change studies and has been shown to be both a valid and reliable measure of physical activity participation [32].

Body weight changes—Women were asked to indicate whether they currently weigh more, less or about the same compared to pre-breast cancer diagnosis and were then classified into 3 categories: decreased, maintained, and increased.

Depression and anxiety—The Hospital Anxiety and Depression Scale [33] assessed the frequency of depressive states (7 items) and anxiety (7 items) over the past week from 0 (not at all) to 3 (most of the time). Positively worded items were reverse scored. Individual items were summed to obtain total subscale scores from 0 to 21. Higher scores indicate greater symptomology and scores on this measure were highly reliable in the present study for both anxiety ($\alpha=0.82$) and depression ($\alpha=0.83$).

Physical self-worth—The 6-item physical self-worth scale of the Physical Self-Perception Profile [34] asked participants to indicate how characteristic each item was of them from 1 (not at all true) to 4 (completely true). Items were summed to obtain total scores ranging from 6 to 24. Higher scores signify higher physical self-worth, and scores demonstrated acceptable internal consistency ($\alpha=0.90$).

Self-esteem—The 10-item Rosenberg Self-esteem Scale [35] measured participants' agreement with each item from 0 (strongly disagree) to 3 (strongly agree). Items were summed to obtain total scores from 0 to 30. Higher scores reflect higher self-esteem. The internal consistency of scores in the present study were high ($\alpha=0.82$).

Stress—The 10-item Perceived Stress Scale [36] was used to measure participants' perception of stress during the last month from 0 (never) to 4 (very often). Positively stated items were reverse scored. All items were summed to obtain total stress scores from 0 to 40. Higher scores indicate higher perceived stress. Scores on this scale were highly reliable in the present study ($\alpha=0.90$).

Fatigue—The 14-item Fatigue Symptom Inventory [37] was used to assess fatigue severity, frequency, diurnal variation and perceived interference with quality of life. Internal consistency was acceptable for each of the subscales and ranged from 0.79 (duration) to 0.94 (interference).

HRQOL—The 39-item Functional Assessment of Cancer Therapy-Breast (FACT-B) [38,39] assessed physical, social/family, emotional and functional well-being and breast cancer specific concerns. Participants were asked to indicate how true each statement had been for them over the last 7 days from 0 (not at all true) to 4 (very much true). Subscale scores were calculated by multiplying the sum of each subscale's items by the number of items in the subscale and dividing by the number of items answered. Higher scores indicate better HRQOL and the internal consistency for the total FACT-B score was high ($\alpha=.90$) and values were acceptable for all of the subscales ranging from 0.58 (breast cancer specific concerns) to 0.85 (functional well-being).

Procedure

All study procedures and recruitment materials were approved by the university institutional review board. Participants were recruited via an Army of Women® “e-blast,” University e-mail, fliers, print media, and on-line community groups and postings. The Army of Women® is an on-line database of women who are interested in participating in breast cancer related research. The database consists of both healthy women and cancer survivors and approximately 325,000 women were members at the time of the present study. All women (N = 2,546) expressing an initial interest in study participation were e-mailed a full study description. Of those individuals, 1,631 (64%) responded to study investigators, qualified to participate and completed the informed consent. These women were sent an individualized secure link to study questionnaires and instructed to complete them within two weeks of receipt. Reminder e-mails were sent on a bi-weekly basis after the initial two week period until completion, or three reminders were sent, whichever came first. For the purposes of these secondary analyses, only women with complete data on change in physical activity and weight were included (n = 1,348).

Data Analysis

Initial descriptive and bivariate correlation analyses were performed to examine physical activity and weight change categories and psychosocial well-being. General linear models with Bonferroni’s multiple comparisons test were used to determine main effects and interaction effects of categories of change in physical activity and change in weight on each health outcome. Initial models (Model 1) controlled for age and time since diagnosis. Next, analysis of covariance (ANCOVA) models were conducted to calculate means for each psychosocial outcome for each physical activity and weight change level adjusted for BMI, current age, education, income, total comorbidities, time since diagnosis, stage of disease, treatment, and menopausal status at diagnosis (Model 2). Additionally, each of the physical activity and weight change models were adjusted for the other predictor variable (Model 3). Finally, we assessed the interaction between physical activity and weight change by entering a dummy variable to combine the two categorical variables adjusting for all covariates described in Model 3. All analyses were conducted using IBM SPSS Statistics version 19.0 [40]. A priori, effect sizes (i.e. standardized mean difference between groups) were calculated using Cohen’s *d* [41] for those between group differences that were significant in Tables 2 and 3 to determine the magnitude of the observed effects. Effects are defined as “small” ($d = .2$ to $.4$), “moderate” ($d = .5$ to $.7$) or “large” ($d = .8$) [40].

Results

Participant characteristics

Participant characteristics by physical activity change category are displayed in Table 1. Compared to women who decreased or maintained physical activity post-diagnosis, those who increased activity were further from treatment (79.3 v. 98.0, $p < 0.001$ and 74.3 v. 90.0, $p < 0.001$, respectively). In addition, breast cancer survivors who maintained activity were significantly older than those who were less active post-diagnosis (57.7 v. 55.0, $p < 0.01$), and women who were more active reported a lower BMI than those who decreased activity (25.9 v. 27.1, $p < 0.01$). A significantly ($p < 0.05$) higher proportion of women who reported

maintaining (25.3%) or increasing (23.3%) physical activity reported stage 0 disease compared to women who decreased activity (15.9%), and a higher proportion of women ($p < 0.05$) who reported reducing activity (13.3%) reported stage 3 disease compared to those who maintained activity (6.4%). Finally, a smaller proportion of breast cancer survivors who maintained physical activity reported being post-menopausal at diagnosis compared to those who decreased or increased physical activity (45.6% v. 56.9% and 45.6% v. 58.6%, respectively). Women in each physical activity group did not differ on any other demographic or disease characteristics.

Changes in physical activity and weight post-diagnosis

The majority of women reported physical activity changes post-diagnosis with 41.7% decreasing (range: -1 to -118 points) and 40.2% increasing (range of change: 1 to 102 points) physical activity. Additionally, most breast cancer survivors reported gaining (43.2%) or maintaining (36.8%) weight compared to pre-diagnosis. The largest proportion of women (22.0%) reported decreasing physical activity and gaining weight post-diagnosis; the smallest proportion (3.0%) reported maintaining physical activity and losing weight post-diagnosis. A statistically significantly ($p < 0.05$) higher proportion of women who increased physical activity lost weight (56.3%) compared to those who maintained (15.2%) or decreased activity (28.5%), and a higher proportion of women who maintained activity also reported weight maintenance (22.4%) than those who increased (39.5%) or decreased (38.1%). Finally, women who decreased physical activity were statistically significantly ($p < 0.05$) more likely to report gaining weight (50.9%) than those who increased (15.8%) or maintained (33.3%) activity.

Main effects of physical activity changes on psychosocial well-being

Table 2 displays mean scores for psychosocial well-being by physical activity change category. Change in physical activity was significantly ($p = 0.01$) related to all health outcome measures controlling for age and time since diagnosis. After adjustment for covariates and change in body weight, relationships remained significant ($p = 0.01$) for all psychosocial well-being except self-esteem. Specifically, compared to women who reported decreased physical activity post-diagnosis, those who maintained or increased physical activity reported significantly lower fatigue severity (3.9 vs. 3.3, $p = 0.01$, $d = .31$ and 3.9 vs. 2.8, $p < 0.001$, $d = 0.58$, respectively), interference (2.4 vs. 1.7, $p = 0.01$, $d = .35$ and 2.4 vs. 1.4, $p < 0.001$, $d = .55$ respectively) and duration (3.3 vs. 2.6, $p < 0.01$, $d = .35$ and 3.3 vs. 2.4, $p < 0.001$, $d = .45$ respectively); depression (5.2 vs. 3.9, $p < 0.001$, $d = .34$ and 5.2 vs. 3.6, $p < 0.001$, $d = .43$, respectively) and perceived stress (14.4 vs. 12.3, $p = 0.02$, $d = .29$ and 14.4 vs. 12.0, $p < 0.001$, $d = .35$). Additionally, women who maintained or increased physical activity reported significantly higher physical (24.3 vs. 22.5, $p < 0.001$, $d = .41$ and 25.0 vs. 22.5, $p < 0.001$, $d = .60$, respectively) and functional well-being (22.3 vs. 20.8, $p < 0.01$, $d = .28$ and 22.9 vs. 20.8, $p < 0.001$, $d = .41$, respectively); breast cancer specific functioning (26.4 vs. 24.0, $p < 0.01$, $d = .40$ and 26.7 vs. 24.0, $p < 0.001$, $d = .47$, respectively) and overall HRQOL (115.2 vs. 107.2, $p < 0.001$, $d = .45$ and 116.9 vs. 107.2, $p < 0.001$, $d = .48$, respectively) compared to those who decreased physical activity. Increased physical activity post-diagnosis was also associated with significantly higher physical self-

worth (18.1 vs. 16.2, $p < 0.001$, $d=.44$), emotional functioning (20.3 vs. 19.1, $p = < 0.01$, $d=.33$) and lower anxiety (4.9 vs. 5.7; $p = 0.01$, $d=.23$) compared to decreased physical activity.

Main effects of body weight changes on psychosocial well-being

Table 3 displays mean scores for psychosocial well-being by weight change category. When controlling for age and time since diagnosis, change in body weight was significantly ($p < 0.01$) related to all health outcomes except anxiety. After adjusting for covariates, the effect of weight change was no longer significant for stress, self-esteem and social and emotional well-being. After further adjustment for physical activity, depression and functional well-being were no longer significantly associated with weight change but all other relationships remained significant ($p < 0.05$). Specifically, compared to breast cancer survivors who maintained or lost weight, those who gained weight reported lower physical self-worth (18.2 vs. 15.9, $p = < 0.001$, $d=.43$ and 18.1 vs. 15.9, $p = < 0.01$, $d=.50$, respectively), overall HRQOL (116.0 vs. 107.7, $p = < 0.001$, $d=.44$ and 116.7 vs. 107.7, $p = < 0.001$, $d=.51$, respectively) and breast cancer specific well-being (27.2 vs. 23.1, $p = < 0.001$, $d=.73$ and 27.7 vs. 24.6, $p = < 0.001$, $d=.87$ respectively). Additionally, women who gained weight post-diagnosis reported significantly higher levels of fatigue severity (3.1 vs. 3.8, $p = 0.01$, $d=.36$), interference (2.2 vs. 1.6, $p = 0.02$, $d=.32$) and duration (3.1 vs. 2.5, $p = 0.01$, $d=.35$) and lower levels of physical well-being (24.3 vs. 23.1, $p = 0.03$, $d=.28$) compared to women who maintained their weight.

Interaction effects between physical activity and body weight changes on psychosocial well-being

There was a significant ($p < 0.05$) interaction effect for physical activity change and body weight change for fatigue interference and perceived stress. However, after controlling for covariates, effects were no longer significant.

Discussion

This study indicates that similar proportions of breast cancer survivors report decreasing or increasing physical activity post-diagnosis and more women report weight gain post-diagnosis than weight maintenance or loss. In general, maintaining or increasing physical activity post-diagnosis was associated with fewer symptoms and better psychosocial well-being post-diagnosis than decreasing physical activity. The majority of relationships held when accounting for covariates and weight change. Additionally, gaining weight post-diagnosis was associated with poorer post-diagnosis psychosocial well-being than maintaining or losing weight. Weight change effects were less consistent when controlling for covariates and physical activity change but remained significant for fatigue, physical self-worth, overall HRQOL and some HRQOL subdomains. There were no statistically significant interaction effects for the associations between physical activity and weight change and any psychosocial or HRQOL outcomes when controlling for covariates.

Findings regarding pre- and post-diagnosis physical activity changes and psychosocial well-being are consistent with existing research in breast cancer survivors that indicates physical activity post-diagnosis is beneficial for reducing negative treatment-related side effects and

enhancing HRQOL [6,7,42]. Effect sizes in the present study ranged from small ($d = .23$ for anxiety) to moderate ($d = .60$ for physical well-being). These effect sizes are consistent with meta-analyses of post-diagnosis physical activity only [6,7] and consistent with values deemed to be clinically important for similar measures in advanced cancer patients [43]. Increasing physical activity was associated with lower levels of fatigue severity and interference, depression, anxiety, and perceived stress and higher levels of physical self-worth, well-being and overall HRQOL than decreasing physical activity and the majority of these differences were clinically significant [44,45,46]. Additionally, maintaining physical activity post-diagnosis was associated with lower levels of fatigue duration, depression, and perceived stress and higher physical, emotional and functional well-being, breast cancer specific well-being, and overall HRQOL than decreasing physical activity when controlling for covariates and weight change indicating increasing or maintaining physical activity post-diagnosis may have beneficial effects on psychosocial well-being in this population although not all of these differences were clinically significant.

Our results regarding weight management also indicate that maintaining or decreasing body weight post-diagnosis may be beneficial for breast cancer survivors. Effect sizes ranged from moderate ($d = .28$ for physical well-being) to large ($d = .87$ for breast cancer specific concerns) and are consistent with values deemed clinically significant for other, similar measures in advanced cancer patients [43]. However, these findings were not quite as robust as the findings regarding changes in physical activity. Weight gain post-diagnosis was associated with lower physical self-worth, breast-cancer specific well-being and overall HRQOL compared to weight loss. Additionally, gaining weight post-diagnosis was associated with greater fatigue severity, interference, and duration and lower physical self-worth, physical well-being, breast cancer specific well-being and overall HRQOL compared to maintaining weight post-diagnosis. However, only the differences observed between groups on the breast cancer specific well-being and overall HRQL scales were clinically significant [44]. Finally, in general, this study suggests that the associations between physical activity and body weight changes and psychosocial well-being are independent of one another.

Results of this study provide additional support for the importance of, not only monitoring physical activity and body weight post breast cancer diagnosis, but encouraging women to, at a minimum, maintain physical activity and weight. In addition, findings indicate that changes in physical activity or body weight may be good indicators of psychosocial well-being in breast cancer survivors and that these relationships may be independent of one another. Finally, weight management effects may be larger and more outcome-specific while physical activity effects may be more general or systemic. Thus, it is possible that the mechanisms underlying these relationships might differ. It may be enough, in regard to symptom management, to focus on physical activity behavior, itself, without weight loss or weight loss without increasing physical activity. However, focusing on maintaining or increasing physical activity, regardless of body weight changes, could potentially have more robust effects than focusing solely on weight management. As maximizing HRQOL and reducing poor psychosocial well-being may be important to breast cancer survivors, these findings, in addition to potential survival benefits [5, 18], could be used as more proximal

outcomes to motivate and empower women to maintain/increase physical activity and/or maintain/lose weight post-diagnosis.

Our study has several limitations. First, both physical activity and weight change were collected via relatively crude, self-report questionnaires with pre-diagnosis data collected retrospectively, potentially many years post-diagnosis. Although studies have indicated recall of physical activity [47] and body weight from up to 10 and 28 years prior, respectively, can be reliable [48], these data may be subject to recall bias. We are also unable to infer anything about the potential magnitude of changes or dosage necessary to achieve optimal benefit because of the crudeness of the measures. Moreover, we cannot deduce the directionality of relationships because of the lack of HRQOL measures prior to physical activity assessments and diagnosis. Hence, we cannot rule out the possibility that HRQOL influences both current and pre-diagnosis body weight and physical activity participation and reporting. Future studies should examine whether the results of the present study can be replicated prospectively using cohort studies with pre- and post-diagnosis data. In addition, these relationships should be tested as the result of an intervention using objectively measured body weight and physical activity measures and incorporating pre-treatment assessments, if possible. Furthermore, to the extent possible, studies should incorporate additional measures such as body composition, fat distribution, fitness, and biomarkers to determine whether these factors may differentially mediate relationships between changes in body weight and activity and psychosocial well-being. Additional concerns relative to this study include the sample's relative demographic homogeneity, time since diagnosis heterogeneity. Future studies should attempt to examine these relationships in more demographically diverse samples and determine whether there is a critical time period post-diagnosis where changes in activity or body weight have the greatest influence on psychosocial well-being. Finally, women in this study were, on average, only moderately overweight (BMI $M=26.5$, $SD=5.73$), had relatively low symptom burden, and 56% engaged in physical activity at a level to produce health benefits both pre- and post-diagnosis, respectively. This is likely reflective of the use of Army of Women for recruitment, as women who join a database focused on breast cancer research may be more health conscious than the general breast cancer survivor population. Future studies should examine these relationships in less active, obese women with highly compromised psychosocial well-being to examine whether relationships and magnitude of effects are similar.

To the best of our knowledge, this is one of the first studies to examine changes in physical activity and body weight post-diagnosis and psychosocial well-being simultaneously in breast cancer survivors. Thus, despite its limitations, this study is an important first step in trying to understand and delineate the relationships between these factors and psychosocial well-being. These data provide preliminary evidence to suggest maintaining or increasing physical activity and maintaining or decreasing body weight post-diagnosis are associated with better psychosocial well-being in breast cancer survivors and that, these effects may be independent of one another when controlling for disease and demographic characteristics. In addition, these data indicate that although effects may be larger for weight management, maintaining or increasing physical activity may have more systemic effects that influence

multiple psychosocial outcomes. Findings from this study suggest physical activity and weight management may play an integral role in maximizing psychosocial well-being in breast cancer survivors and enhancing disease-free survivorship. Future research should further elucidate the roles of physical activity and body weight changes in enhancing psychosocial well-being in breast cancer survivors.

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Table 1

Sample demographic and disease characteristics

	Category of Change in Physical Activity			<i>p</i>
	Decrease n= 562 (a)	Maintain n= 244 (b)	Increase n = 542 (c)	
Age (<i>M</i>, <i>SD</i>)	55.1 (9.5)^b	57.7 (9.13)^a	56.2 (9.13)	<0.01
Time Since Treatment (months) (<i>M</i>, <i>SD</i>)	79.3 (66.3)^c	74.3 (55.8)^a	98.0 (79.1)^{a,b}	0.02
Estrogen Receptor Positive (%)	74.1%	68.9%	69.3%	0.10
Body Mass Index (<i>M</i>, <i>SD</i>)	27.1 (6.2)^c	26.5 (5.6)	25.9 (5.2)^a	<0.01
Race (%)				
Non-white	4.8	5.7	4.2	0.66
White	95.2	94.3	95.8	
Education (%)				
< College	33.8	32.8	29.7	0.33
College	66.2	67.2	70.3	
Income (%)				
< \$40,000	23.7	26.2	21.4	0.32
\$40,000	76.3	73.8	78.6	
Total Comorbidities (%)				
None	27.0	29.1	30.8	0.25
1 to 2	45.7	41.8	46.3	
3	27.2	29.1	22.9	
Disease Stage (%)				
0	15.9^{b,c}	25.3^a	23.2^a	<0.01
1	35.0	30.9	32.9	
2	32.9	35.6	33.1	
3	13.3^b	6.4^a	9.7	
4	3.0	1.0	1.2	
Primary Treatment (%)				
Surgery, Radiation & Chemotherapy	39.9	34.4	39.5	0.27
Surgery & Chemotherapy	18.7	15.6	17.3	
Surgery & Radiation	24.2	30.3	28.4	
Surgery Only	15.1	18.0	13.8	
Other	2.1	1.6	0.9	
Currently on Hormone Therapy (%)	53.0	58.2	54.7	0.22
Post-Menopausal at Diagnosis (%)	56.9^b	45.6^{a,c}	58.6^b	<0.01
Post-diagnosis Weight Change (%)				
Decrease	13.7^c	16.8^c	28.0^{a,b}	<0.001
Maintain	33.6^b	45.5^{a,c}	36.2^b	

Category of Change in Physical Activity				
	Decrease n= 562 (a)	Maintain n= 244 (b)	Increase n = 542 (c)	<i>p</i>
Increase	52.7 ^{<i>b,c</i>}	37.7 ^{<i>a</i>}	35.8 ^{<i>a</i>}	

Note:

^{*a*} Comparison between physical activity change categories where a= decrease, b=maintain and c= increase and indicate significance between groups at $p < 0.05$; values in bold indicate significant group differences.

^{*b*} Comparison between physical activity change categories where a= decrease, b=maintain and c= increase and indicate significance between groups at $p < 0.05$; values in bold indicate significant group differences.

^{*c*} Comparison between physical activity change categories where a= decrease, b=maintain and c= increase and indicate significance between groups at $p < 0.05$; values in bold indicate significant group differences.

Table 2

Change in physical activity post-diagnosis and psychosocial well-being in breast cancer survivors

	Category of Change in Physical Activity						
	Minimally Important Differences [42-45]	Decrease n= 562 (a, x)	Maintain n= 244 (b, y)	Increase n = 542 (c, z)	Model 1 <i>p</i>	Model 2 <i>p</i>	Model 3 <i>p</i>
Fatigue							
Severity	- 0.6	3.9 (1.9) <i>b,c,y,z</i>	3.3 (2.0) <i>a,x</i>	2.8 (1.9) <i>a,x</i>	<0.001	<0.001	<0.001
Interference	—	2.4 (2.1) <i>b,c,y,z</i>	1.7 (1.9) <i>a,x</i>	1.4 (1.6) <i>a,x</i>	<0.001	<0.001	<0.001
Duration	—	3.3 (2.1) <i>b,c,y,z</i>	2.6 (1.9) <i>a,x</i>	2.4 (1.9) <i>a,x</i>	<0.001	<0.001	<0.001
Anxiety	1.32	5.7 (3.7) <i>b,c,z</i>	4.9 (3.4) <i>a</i>	4.9 (3.1) <i>a,x</i>	<0.001	0.01	0.01
Depression	1.4	5.2 (4.1) <i>b,c,y,z</i>	3.9 (3.5) <i>a,x</i>	3.6 (3.3) <i>a,x</i>	<0.001	<0.001	<0.001
Stress		14.4 (7.3) <i>b,c,y,z</i>	12.3 (7.1) <i>a,x</i>	12.0 (6.3) <i>a,x</i>	<0.001	<0.001	<0.001
Physical Self-Worth	—	16.2 (4.6) <i>b,c,z</i>	17.3 (4.6) <i>a,c</i>	18.1 (4.1) <i>a,b,x</i>	<0.001	<0.001	<0.001
Self-Esteem	—	39.7 (6.0) <i>c</i>	41.5 (4.4)	40.8 (5.5) <i>a</i>	0.01	0.11	0.11
HRQOL(FACT-B)							
Physical Well-being	2-3	22.5 (4.9) <i>b,c,y,z</i>	24.3 (3.8) <i>a,c,x</i>	25.0 (3.2) <i>a,b,x</i>	<0.001	<0.001	<0.001
Social Well-being	—	20.8 (5.8) <i>b,c</i>	21.9 (6.0) <i>a</i>	22.0(5.2) <i>a</i>	0.001	0.01	0.03
Emotional Well-being	2	19.1 (4.2) <i>b,c,z</i>	20.2 (3.6) <i>a</i>	20.3 (3.1) <i>a,x</i>	<0.001	0.001	<0.01
Functional Well-being	2-3	20.8 (5.6) <i>b,c,y,z</i>	22.3 (5.1) <i>a,x</i>	22.9 (4.7) <i>a,x</i>	<0.001	<0.001	<0.001
Breast Cancer Concerns	2-3	24.0 (6.2) <i>b,c,y,z</i>	26.4(5.7) <i>a,x</i>	26.7 (5.2) <i>a,x</i>	<0.001	<0.001	<0.001
Total Score	7-8	107.2 (20.1) <i>b,c,y,z</i>	115.2 (18.4) <i>a,x</i>	116.9 (20.1) <i>a,x</i>	<0.001	<0.001	<0.001

Note: Model 1 is adjusted for age and time since diagnosis. Model 2 is adjusted for all covariates in Model 1 and BMI, education, income, total comorbidities, stage of disease, type of treatment received and menopausal status at diagnosis. Model 3 is adjusted for all covariates in Model 2 and weight change category. All models were adjusted using Bonferroni's correction;

* All values represent Mean (Standard Deviation)

^a Indicate significant between group differences at $p < 0.05$ for physical activity change categories for Model 1 where a= decrease, b=maintain and c= increase.

^b Indicate significant between group differences at $p < 0.05$ for physical activity change categories for Model 1 where a= decrease, b=maintain and c= increase.

^c Indicate significant between group differences at $p < 0.05$ for physical activity change categories for Model 1 where a= decrease, b=maintain and c= increase.

^x Indicate significant between group differences at $p < 0.05$ for physical activity change categories for *fully adjusted values* (Model 3) where x= decrease, y= maintain and z= increase and. Values in bold indicate significant between group differences after controlling for covariates.

^y Indicate significant between group differences at $p < 0.05$ for physical activity change categories for *fully adjusted values* (Model 3) where x= decrease, y= maintain and z= increase and. Values in bold indicate significant between group differences after controlling for covariates.

^zIndicate significant between group differences at $p < 0.05$ for physical activity change categories for *fully adjusted values* (Model 3) where x= decrease, y= maintain and z= increase and. Values in bold indicate significant between group differences after controlling for covariates.

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Table 3

Change in body weight post-diagnosis and psychosocial well-being in breast cancer survivors

	Category of Change in Body Weight						
	Minimally Important Differences [42-45]	Decrease (a,x)	Maintain (b,y)	Increase (c,z)	Model 1 <i>p</i>	Model 2 <i>p</i>	Model 3 <i>p</i>
Fatigue							
Severity	-0.6	3.0 (2.0) ^c	3.1 (2.0)^{c,z}	3.8 (1.9)^{a,b,y}	<0.001	<0.001	<0.01
Interference	—	1.6 (1.8) ^c	1.6 (1.8)^{c,z}	2.2 (2.0)^{a,b,y}	<0.001	<0.01	0.02
Duration	—	2.5 (2.0) ^c	2.5 (1.9)^{c,z}	3.1 (2.1)^{a,b,y}	<0.001	<0.01	0.01
Anxiety	1.32	5.1 (3.3)	5.0 (3.4)	5.4 (3.6)	0.30	0.01	0.92
Depression	1.4	4.0 (3.5) ^c	3.7 (3.5) ^c	4.9 (3.9) ^{a,b}	<0.001	<0.01	0.05
Stress		12.4 (6.9) ^c	12.5 (6.8) ^c	13.8 (7.2) ^{a,b}	<0.01	0.38	0.81
Physical Self-Worth	—	18.1 (4.4)^{c,z}	18.2 (4.3)^{c,z}	15.9 (4.4)^{a,b,xy}	<0.001	<0.001	<0.001
Self-Esteem	—	40.3 (5.8)	41.0 (5.2) ^c	39.6 (6.0) ^b	0.001	0.25	0.25
HRQOL (FACT-B)							
Physical Well-being	2-3	24.6 (3.8) ^{c,y}	24.3 (4.2)^{c,z}	23.1(4.4)^{a,b,y}	<0.001	<0.01	0.02
Social Well-being	—	21.7 (5.4)	22.0 (5.5) ^c	21.0 (5.8) ^b	<0.01	0.07	0.17
Emotional Well-being	2	20.2 (3.2) ^c	20.0 (3.7) ^c	19.4 (3.9) ^{a,b}	0.001	0.05	0.18
Functional Well-being	2-3	22.4 (4.8) ^c	22.6 (4.9) ^c	21.1 (5.6) ^{a,b}	<0.001	0.01	0.05
Breast Cancer Concerns	2-3	27.7 (4.9)^{c,z}	27.2 (5.5)^{c,z}	23.1 (5.7)^{a,b,xy}	<0.001	<0.001	<0.001
Total Score	7-8	116.7 (16.3)^{c,z}	116.0 (18.4)^{c,z}	107.7 (19.1)^{a,b,xy}	<0.001	<0.001	<0.001

Note: Model 1 is adjusted for age and time since diagnosis. Model 2 is adjusted for all covariates in Model 1 and BMI, education, income, total comorbidities, stage of disease, type of treatment received and menopausal status at diagnosis. Model 3 is adjusted for all covariates in Model 2 and physical activity change category. All models adjusted using Bonferroni's correction.

* All values represent Mean (Standard Deviation)

^a Indicate significant between group differences at $p < 0.05$ for weight change categories for Model 1 where a= decrease, b=maintain and c= increase.

^b Indicate significant between group differences at $p < 0.05$ for weight change categories for Model 1 where a= decrease, b=maintain and c= increase.

^c Indicate significant between group differences at $p < 0.05$ for weight change categories for Model 1 where a= decrease, b=maintain and c= increase.

^x Indicate significant between group differences at $p < 0.05$ for weight change categories for *fully adjusted values* (Model 3) where x= decrease, y= maintain and z= increase. Values in bold indicate significant between group differences after controlling for covariates.

^y Indicate significant between group differences at $p < 0.05$ for weight change categories for *fully adjusted values* (Model 3) where x= decrease, y= maintain and z= increase. Values in bold indicate significant between group differences after controlling for covariates.

^z Indicate significant between group differences at $p < 0.05$ for weight change categories for *fully adjusted values* (Model 3) where x= decrease, y= maintain and z= increase. Values in bold indicate significant between group differences after controlling for covariates.