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Theory-Based Predictors of Follow-Up Exercise Behavior After A Supervised Exercise Intervention in Older Breast Cancer Survivors

Paul D. Loprinzi, PhD[1], **Bradley J. Cardinal, PhD**[2], **Qi Si, PhD**[3], **Jill A. Bennett, PhD, RN**[4], and **Kerri Winters-Stone, PhD**[2,4]

[1]Bellarmine University, Department of Exercise Science, Louisville, KY

[2]Oregon State University, Department of Nutrition and Exercise Sciences, Corvallis, OR

[3]Zhejiang University, Department of Physical Education, Zhejiang, China

[4]Oregon Health & Science University, School of Nursing, Portland, OR

Abstract

Purpose—Supervised exercise interventions can elicit numerous positive health outcomes in older breast cancer survivors. However, to maintain these benefits, regular exercise needs to be maintained long after the supervised program. This may be difficult, as in this transitional period (i.e., time period immediately following a supervised exercise program), breast cancer survivors are in the absence of on-site direct supervision from a trained exercise specialist. The purpose of the present study was to identify key determinants of regular exercise participation during a 6-month follow-up period after a 12-month supervised exercise program among women aged 65+ years who had completed adjuvant treatment for breast cancer.

Methods—At the conclusion of a supervised exercise program, and 6-months later, 69 breast cancer survivors completed surveys examining their exercise behavior and key constructs from the Transtheoretical Model.

Results—After adjusting for weight status and physical activity at the transition point, breast cancer survivors with higher self-efficacy at the point of transition were more likely to be active 6-months after leaving the supervised exercise program (*OR [95% CI]: 1.10 [1.01–1.18]*). Similarly, breast cancer survivors with higher behavioral processes of change use at the point of transition were more likely to be active (*OR [95% CI]: 1.13 [1.02–1.26]*).

Conclusion—These findings suggest that self-efficacy and the behavioral processes of change, in particular, play an important role in exercise participation during the transition from a supervised to a home-based program among older breast cancer survivors.

Address Correspondence to: Paul Loprinzi, PhD, Bellarmine University, Department of Exercise Science, Louisville, KY 40205, 205-272-8008, ploprinzi@bellarmine.edu.

Conflict of Interest

The authors declare no conflicts of interest and have full control of all primary data, and agree to allow the journal to review the data if requested.

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Keywords

behavior; cancer; determinants; oncology; physical activity

Introduction

In addition to the benefits of exercise in reducing the risk of primary breast cancer [1], recent observational studies suggest that regular exercise participation may reduce the risk of breast cancer recurrence and breast cancer-related mortality [2]. However, a significant percentage of breast cancer survivors do not engage in regular exercise. For example, data from a prospective study of leisure-time exercise in 231 women with early-stage breast cancer showed that prior to breast cancer diagnosis, 70% of women met current physical activity guidelines [3]. However, after the first course of adjuvant therapy, the percent meeting guidelines dropped to 39%. After the second course of cancer treatment, the percent dropped to 15%. Two- and 6-months after completing treatment, respectively, 41% and 37% of individuals continued to be insufficiently active (i.e., not meeting physical activity guidelines).

To increase participation in exercise and to examine the influence of exercise on health outcomes in breast cancer survivors, researchers have begun to develop structured exercise programs specific to people with cancer. In a systematic review, Knols et al. [4] summarized the current evidence of the effect of exercise interventions on exercise behavior in breast cancer survivors. Among the five randomized controlled trials identified, results showed that, on average, exercise-based interventions coupled with counseling can increase daily step counts by over 500 steps per day (i.e., approximately ¼ of a mile). Additionally, prior studies have shown that adherence to a supervised exercise program can reduce common side effects associated with breast cancer treatment, such as fatigue [5], depression [6], bone loss [7], decreased levels of muscular strength [8], decreased aerobic capacity [9], increased weight gain [10], and impaired quality of life [11].

At some point, breast cancer survivors make the transition from a supervised exercise program to exercising on their own either because the supervised program ends or access to the program becomes an issue. During this transitional period, maintaining regular participation in exercise and continuing to achieve positive health outcomes may be more difficult, as women no longer have direct supervision from a trained exercise specialist. Consequently, factors that influence regular participation in exercise during the transitional period are important to identify, as these factors can then be targeted for change during the supervised exercise programs to increase the likelihood of a successful transition. To date, few studies have examined determinants of exercise behavior during the transitional period among breast cancer survivors [12], and we know even less about the determinants of exercise behavior among older breast cancer survivors.

The purpose of the present study is to identify key determinants of regular participation in exercise during a 6-month follow-up period after a 12-month supervised exercise program among women aged 65+ years who have been previously diagnosed with breast cancer. The Transtheoretical Model (TTM) of behavior change developed by Prochaska et al. [13–15] served as the conceptual framework for this study. Briefly, the TTM is an integrative model of behavior change that involves progressing through five stages of change, including precontemplation, contemplation, preparation, action, and maintenance. Key predictors or facilitators that produce progress through these stages of change include processes of change (i.e., cognitive and behavioral processes of change), self-efficacy, and decisional balance (i.e., pros and cons for exercise). These key TTM constructs have been shown to predict exercise behavior in younger populations [16, 17], adults [18–21], older adults [22], individuals with chronic diseases [23, 24], and even among cancer patients participating in a supervised exercise [25] or home-based program [26–28]. The present study extends and complements previous investigations by examining determinants of exercise behavior during the transitional period from a supervised to a home-based exercise program among older breast cancer survivors. These data will be useful in identifying theoretical predictors of exercise behavior during the transition period that can be targeted for change prior to the transition.

The aim of the present study was to examine the influence of key TTM constructs (i.e., self-efficacy, processes of change, and pros and cons of exercise) on changes in exercise behavior after a supervised exercise program among older breast cancer survivors. We hypothesized that older breast cancer survivors who had higher perceptions of exercise-related efficacy, more utilization of behavioral and cognitive processes of change, and report more pros and fewer cons regarding exercise would be associated with higher levels of physical activity 6 months after completion of the supervised exercise program.

Methods

Setting and Participants

Participants for the present study were part of a randomized controlled trial of supervised exercise. We examined the influence of TTM variables on changes in exercise behavior after the 12-month trial. For the original trial, recruitment strategies included mailings to potentially eligible women by the Oregon State Cancer Registry and through direct community approaches. All testing procedures were conducted at Oregon Health & Science University (OHSU) in Portland, OR. Ethical approval was obtained by the institutional review board at OHSU and written informed consent was obtained from each participant prior to participation. Eligibility criteria included breast cancer survivors aged 65+ years who had completed breast cancer chemotherapy or radiation treatment more than two years prior to enrollment and who were currently inactive (i.e., less than 30 minutes of planned moderate-intensity exercise three days a week). Participants were excluded if they had 1) cognitive difficulties that precluded them from answering survey questions, participating in the performance tests, or giving informed consent, 2) a medical condition, movement or neurological disorder, or medication that contraindicated participation in moderate-intensity aerobic or resistance exercise, and 3) plans to move out of the immediate study area within 18-months.

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Design and Procedures

Participants were part of a prospective, three-armed, randomized controlled trial. The supervised intervention period was 12-months, with outcomes measured at baseline, 3, 6, and 12 months. Following the supervised program, additional assessments were made at 18-months (6-month follow-up). At baseline, participants were randomized into one of three training groups: aerobic exercise, resistance exercise, and a control group that consisted of stretching and relaxation exercises. Briefly, participants in each group attended supervised classes 3 days a week for 12-months with each class lasting approximately 60 minutes. Both the aerobic and resistance training groups were matched as closely as possible in progression from the low to high end of the range for moderate-intensity over the first 9-months, with the intensity maintained for the final 3-months. After the 12-month supervised exercise program, participants were instructed to continue their intervention exercises as a part of a home-based program for an additional 6-months. At the end of the supervised program, participants were provided with their own equipment, an instructional DVD, and a 6-month training program to follow. Women were neither encouraged nor discouraged from performing additional physical activity outside of their assigned intervention group and this additional activity was tracked by self report. Participants from all three groups were included in the present study.

Assessment of Predictors

Stage of Change—To be consistent with stages of change in the TTM, regular participation in exercise was defined as “equal to five or more days per week of at least 30-minutes at a moderate-intensity.” As used in previous studies [24, 29], participants chose one of five statements describing their readiness to change their exercise behavior. The five different stages of change include: precontemplation, contemplation, preparation, action, and maintenance. For example, participants who reported “No, I don’t plan to start in the next six months” were classified in the pre-contemplation stage. The stage of change algorithm has demonstrated evidence of reliability and validity in adults of the general population and those with chronic diseases [24, 29]. Using the participants stage of change score at the completion of the supervised exercise program (12-months) and at the 18-month assessment period, five transitional shift groups were created: 1) stable sedentary (pre-contemplation and/or contemplation at both assessment periods); 2) activity relapsers (action or maintenance at 12-months moving to contemplation or pre-contemplation at 18-months); 3) perpetual preparers (preparation at both assessments; preparation at 12-months moving to pre-contemplation or contemplation at 18 months; action or maintenance at 12-months moving to preparation at 18 months); 4) activity adopters (pre-contemplation, contemplation, or preparation at 12-months moving to action or maintenance at 18 months); and 5) stable active (action and/or maintenance at both assessment periods). *Activity status* at the 12-month assessment period was assessed, with participants in the activity adopters and stable active transitional shift groups classified as “sufficiently active” and those in the remaining transitional shift groups classified as “insufficiently active.” These transitional shift groups have been validated in the general population and among adults with chronic diseases [19, 24, 30].

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Processes of Change—To examine the strategies individuals use to change their exercise behaviors, a 30-item measure was used to assess both behavioral and cognitive processes of change. Fifteen items assessed behavioral processes of change (i.e., contingency management, counterconditioning, helping relationships, self-liberation, and stimulus control), whereas the other 15-items assessed cognitive processes of change (i.e., consciousness raising, dramatic relief, environmental reevaluation, self-reevaluation, and social liberation). Participants responded to each question using a Likert scale, with endpoints ranging from 1 (never) to 5 (repeatedly). A sample behavioral process of change item is “Instead of relaxing by watching TV or eating, I take a walk or do physical activity.” A sample cognitive process of change item is “I believe that regular physical activity will make me a healthier, happier person.” Reliability and validity of both the behavioral and cognitive processes of change have been previously established [31]. In this sample, internal consistency, as measured by Cronbach’s alpha, was 0.80 and 0.82 for cognitive processes of change at the 12- and 18-month assessment periods, respectively. For behavioral processes of change, internal consistency was 0.79 and 0.86 at the 12- and 18-month assessment periods, respectively. Behavioral and cognitive processes of change were calculated by summing the items for each process of change separately and then together for an assessment of overall process of change (i.e., behavioral plus cognitive). Higher scores indicate higher use of behavioral processes or cognitive processes of change.

Self-Efficacy—To assess self-efficacy, or an individual’s confidence in her ability to overcome exercise-related barriers, a 18-item measure, which has demonstrated evidence of reliability and validity, was used [32, 33]. For each question, participants responded using a Likert scale, with endpoints ranging from 1 (not at all confident) to 5 (very confident). A sample item is “I feel confident that I can participate in physical activity when I don’t feel like it.” In this sample, internal consistency, as measured by Cronbach’s alpha, was 0.93 and 0.95 for self-efficacy at the 12- and 18-month assessment periods, respectively. Items were summed, with higher scores indicating higher self-efficacy.

Decisional Balance—An individual’s reflection of the pros and cons in engaging in regular physical activity, referred to as decisional balance, was evaluated using a 10-item measure. Five items assessed pros of regular exercise, whereas the other five items evaluated the cons of engaging in regular exercise. Using a Likert scale anchored by 1 (not at all) and 5 (very much), participants rated their degree of agreement with each perceived positive and negative consequence of exercise involvement. A sample item of pros for exercise is “physical activity would help me reduce tension or manage stress.” A sample item of cons for exercise is “physical activity would take too much of my time.” This measure has previously demonstrated evidence of reliability and validity [34]. In this sample, internal consistency, as measured by Cronbach’s alpha, was 0.77 and 0.84 for the pros of exercise at the 12- and 18-month assessment periods, respectively. For the cons of exercise, internal consistency, as measured by Cronbach’s alpha, was 0.77 and 0.86 at the 12- and 18-month assessment periods, respectively. Pros and Cons were scored separately by summing the respective items, with a higher pros score indicating more perceived pros of exercise and a lower cons score indicating fewer perceived cons of exercise. Overall decisional balance was calculated by subtracting the cons score from the pros score.

Self-Reported Physical Activity—To validate the transitional shift groups and to control for physical activity at the 12-month assessment period, participants self-reported their physical activity levels using the Community Healthy Activities Model Program for Seniors (CHAMPS) questionnaire. CHAMPS is a 41-item questionnaire estimating frequency and caloric expenditure per week in moderate-to-vigorous intensity exercise-related activities and all exercise-related activities. For the present study, estimation of caloric expenditure per week in moderate-to-vigorous physical activity was used. First, a weighted duration variable was calculated by multiplying the duration of time spent in each moderate-to-vigorous intensity activity and then multiplying by its corresponding MET value. Then, to estimate caloric expenditure per week in moderate-to-vigorous physical activity, the weighted duration variable was multiplied by 3.5 and by 60 (to convert METs/minute to METs/hours) and by (weight in kg/200). The caloric expenditure per week variable was summed across all moderate-to-vigorous physical activities to create caloric expenditure per week. Higher caloric expenditure indicates greater time spent in moderate-to-vigorous physical activity. The CHAMPS questionnaire has demonstrated evidence of reliability and validity [35–37].

Other Variables—Prior to the supervised exercise program, demographic data were collected by self-report and consisted of age, race-ethnicity, education, marital status, and employment. Updated information on the health status of participants was obtained immediately prior to the transition (i.e., 12-month assessment period) and assessed whether the participants were diagnosed or experienced any of the following within the last 6-months: bone fracture, fall, hypertension, diabetes, high cholesterol, osteoporosis, arthritis, vision changes, heart disease, myocardial infarction, transient ischemic attack, stroke, seizure, fainting, and pulmonary embolism. Other self-reported medical variables that were obtained from surveys administered at enrollment included stage of breast cancer, months since cancer diagnosis, and currently adjuvant hormone therapy. Body mass index (BMI) was calculated from measured weight and height (weight in kilograms divided by the square of height in meters). Overweight was defined as a BMI between 25.0 and 29.9 and obese was defined as a BMI greater than or equal 30.0.

Statistical Analyses

All analyses were performed in STATA. To describe the sample, means were calculated for continuous variables and proportions were calculated for categorical variables. Statistical differences between continuous variables were tested using a student's *t*-test and statistical differences between categorical variables were tested with Pearson chi-square (χ^2) tests (Table 1). Due to positively skewed data, the distributions of self-reported CHAMPS physical activity data were normalized through a square-root transformation. For composite score variables (e.g., self-efficacy), there were 54 missing values. Of the possible 4,002 values for the TTM variables, this resulted in a 99% completion of all TTM items. For these 54 missing values, row mean substitution was used. There were 6 missing values for the stage of change variable at either the 12- or 18-month assessment period. Values were not imputed or substituted for the stage of change variable.

Pairwise correlation coefficients were calculated to examine the inter-relationships between caloric expenditure in moderate-to-vigorous intensity exercise-related activities, as measured by CHAMPS, and the TTM variables (i.e., processes of change, self-efficacy, and decisional balance) (Table 3). The significance of the pairwise correlation coefficients was tested using the pairwise significance option. A one-way analysis of variance was used to examine the association between the TTM variables at the 12-month assessment period and stage of change, as well as activity status, at the 18-month assessment period. To validate activity status at the 18-month period, a student *t*-test was used to determine whether there was a statistically significant difference in caloric expenditure in moderate-to-vigorous intensity exercise-related activities at the 18-month period between those classified as "sufficiently active" (i.e., activity adopters and stable active) and "insufficiently active" (i.e., all those in the remaining three transitional shift groups). TTM variables at the 12-month assessment period that were significantly associated ($p < 0.05$) with either caloric expenditure in moderate-to-vigorous intensity exercise-related activities, stage of change, or activity status (i.e., "sufficiently active" and "insufficiently active") at the 18-month period were examined in a logistic regression analysis (Table 4). For the logistic regression analysis, activity status served as the dependent variable, with "insufficiently active" coded as 0, and "sufficiently active" coded as 1. To obtain odds ratios for the association of the TTM variables at the 12-month period and activity status at the 18-month period, an adjusted logistic regression analysis was used that controlled for weight status and physical activity levels at the 12-month assessment period. Weight status was controlled for in this model because this variable was significantly associated with activity status (Table 1). Physical activity levels at the 12-month assessment period, as assessed by the CHAMPS data, were included in the logistic regression because activity behavior at 12-months was associated with activity behavior at 18-months (Table 3). Statistical significance was established as $p < 0.05$.

Results

Of the 115 participants enrolled and randomized to one of the three intervention groups (n = 39 strength training; n = 37 aerobic training; and n = 39 control group) at the start of the randomized controlled trial, 84 participants were still enrolled in the study at the point of transition (i.e., 12-month assessment period, baseline for the present study). Of those, 69 participants completed the health history, TTM, and CHAMPS surveys at both the 12- and 18-month assessment periods. Therefore, the sample for the present study was 60% of the original sample (i.e., 69/115) and 82.1% of the available sample from point of transition at 12-months (i.e., 69/84). With the exception of age (63.0 ± 3.3 vs. 70.6 ± 1.2 yrs, $p = 0.01$; mean ± S.E.; values for 115 participants are listed first) and months since breast cancer diagnosis (164.4 ±45.3 vs. 80.6 ± 5.4, $p = 0.02$; mean ± S.E., values for 115 participants are listed first), there were no differences between the 115 participants enrolled and randomized to the supervised program and the 69 participants who completed questionnaires at the 12- and 18-month assessment periods with respect to race, education, employment, and stage of breast cancer. Descriptive characteristics stratified by activity status among these 69 participants are displayed in Table 1. Among all the demographic variables, only weight status differed by activity status ($p = 0.02$). Descriptive statistics for the TTM variables assessed at the 12-month period are shown in Table 2.

Table 3 displays the correlation matrix between caloric expenditure in moderate-to-vigorous intensity exercise-related activities, as measured by CHAMPS, and the TTM variables (i.e., processes of change, self-efficacy, and decisional balance) at both the 12- and 18-month assessment periods. For the TTM variables, self-efficacy at 12-months was significantly associated with physical activity at 18-months ($r = 0.35$, $p = 0.003$). Similarly, cons for exercise ($r = -0.35$, $p = 0.003$) and behavioral processes of change ($r = 0.30$, $p = 0.01$) at 12-months were significantly associated with physical activity at 18-months. Pros for exercise ($r = 0.09$, $p = 0.44$) and cognitive processes of change ($r = 0.07$, $p = 0.56$) at 12-months, however, were not significantly associated with physical activity at 18-months. Overall decisional balance (i.e., pros minus cons for exercise) at 12-months was significantly associated with physical activity at 18-months ($r = 0.30$, $p = 0.01$). Overall processes of change (cognitive plus behavioral processes of change) at 12-months was not associated with physical activity at 18-months ($r = 0.21$, $p = 0.08$). As expected, physical activity at 12-months was significantly associated with physical activity at 18-months ($r = 0.68$, $p < 0.0001$). Similarly, with the exception of the cognitive processes of change, all of the TTM variables were significantly associated with each other at both assessment periods.

Using the transformed physical activity data to validate activity status, those classified as sufficiently active had significantly higher caloric expenditure than those classified as insufficiently active ($M = 43.7$ kcals/wk [95% CI: 37.7–49.7] vs. $M = 21.1$ kcals/wk [95% CI: 14.4–27.8], $p < 0.001$).

Results from the one-way analysis of variance showed that for the TTM variables at the 12-month period, breast cancer survivors with higher perceptions of self-efficacy ($p = 0.01$) and greater use of the behavioral processes of change ($p < 0.01$) were more likely to be in a higher stage of change at the 18-month assessment period. Similarly, breast cancer survivors with higher perceptions of self-efficacy ($p < 0.001$) and greater use of the behavioral processes of change ($p < 0.001$) were more likely to be classified as sufficiently active at the 18-month assessment period.

Results from the logistic regression analysis are shown in Table 4. The adjusted logistic regression model including self-efficacy, cons for exercise, behavioral processes of change, physical activity at the 12-month assessment period and weight status significantly predicted activity status, $p < 0.001$. Thirty-one percent of the total variability of activity status was accounted for in this model. Breast cancer patients who had higher self-efficacy at the point of transition had greater odds of being sufficiently active at the 18-month assessment period (OR [95% CI]: 1.10 [1.01–1.18]). Similarly, breast cancer survivors utilizing more of the behavioral processes of change at the point of transition had greater odds of being sufficiently active at the 18-month assessment period (OR [95% CI]: 1.13 [1.02–1.26]). Women with higher physical activity levels at the point of transition had greater odds of being sufficiently active at the 18-month assessment period (OR [95% CI]: 1.05 [1.00–1.10]).

Discussion

To date, few studies have examined theory-based factors that influence changes in exercise behavior among breast cancer survivors. Moreover, our knowledge in this area is even more limited for older breast cancer survivors (i.e., 65+ years), as the few studies that have examined determinants of exercise behavior have been conducted in younger survivors [12]. Therefore, the aim of the present study was to utilize the TTM to identify theoretical determinants of regular participation in exercise during a 6-month follow-up period after a 12-month supervised exercise program among breast cancer survivors aged 65+ years. Six months after completion of a supervised exercise program, 57% of breast cancer survivors were considered to be sufficiently active. These exercise participation rates are similar to those reported by Courneya et al. [12], who reported that 58% of breast cancer survivors were meeting exercise guidelines 6 months after a supervised exercise program. Given the empirical evidence that regular participation in exercise among breast cancer survivors may reduce the risk of breast cancer recurrence and breast cancer-related mortality [2], these exercise participation rates 6 months following a supervised exercise program are less than optimal. To increase the likelihood of breast cancer survivors maintaining their exercise program following a supervised exercise program, it is important to understand factors that influence follow-up exercise participation rates. In partial support of our hypothesis, the major finding of the present study was that older breast cancer survivors who had higher self-efficacy and utilized more behavioral processes of change at the end of a 12-month supervised exercise program had greater odds of being sufficiently active at the 18-month assessment period.

Limitations of the present study include the relatively small sample size and the use of self-reported physical activity data. Additionally, the 69 participants in the present study, compared to the 115 participants randomized to the original supervised exercise program, differed by age and months since breast cancer diagnosis, suggesting that this select group may not entirely reflect the broader group of breast cancer survivors interested in exercise. Future studies using objective measures of physical activity may be useful in confirming our findings. However, our results are important because this study is the first to assess predictors of follow-up behavior after a supervised exercise program in older breast cancer survivors.

Given the benefits of regular participation in exercise among breast cancer survivors, it is surprising that our knowledge of correlates of increased exercise participation among breast cancer survivors is limited. Although a few studies have examined cross-sectional correlates of exercise behavior in breast cancer survivors [38–40], or examined correlates of exercise adherence during a supervised exercise program[41] or an unsupervised home-based program [42], we were only able to identify one study examining predictors of follow-up exercise behavior after an exercise-based intervention in breast cancer survivors [12]. Courneya and colleagues [12] examined predictors of follow-up exercise behavior 6-months after a randomized trial of exercise training among 201 women with breast cancer. In addition to examining the influence of demographic, behavioral, medical, and physical fitness variables, these authors investigated the influence of psychosocial variables on changes in exercise behavior, specifically examining key constructs from the Theory of

Planned Behavior (TPB). The TPB asserts that the most important determinant of behavior is behavioral intention, with key antecedents to intention including an individual's attitude (i.e., overall evaluation of the behavior) toward the behavior, their subjective norm (i.e., belief about whether most people approve or disapprove of the behavior) associated with the behavior, and their perceptions of control over the behavior (e.g., whether they feel the behavior is under their control or not under their control) [43]. Their results showed that breast cancer survivors with more favorable attitudes toward exercise, stronger perceptions of control over exercise, and a stronger subjective norm for exercise were more likely to meet exercise guidelines 6 months after the supervised exercise program. Although the present study did not examine the utility of the TPB in explaining changes in exercise behavior, our findings are similar to those of Courneya et al. [12] in that psychological constructs play an important role in exercise participation. In fact, constructs from the TPB and TTM share many conceptual similarities in terms of explaining changes in exercise behavior. For example, attitude from the TPB includes all of the individual beliefs of decisional balance (pros and cons for exercise); perceived behavioral control from the TPB has similar qualities as self-efficacy from TTM; and the stage of change construct from TTM reflects both intention and behavior in the TPB [44].

Additional comparisons can be drawn to a descriptive study from Pinto and colleagues [39] that examined the inter-relationships between TTM variables, physical activity, dietary behavior, and weight status among 86 women diagnosed with breast cancer within the last 10-years who were not currently undergoing any cancer-related treatments. Importantly, as with the majority of other studies [45], this study assessed some (i.e., stage of change, decisional balance, and self-efficacy), but not all (i.e., processes of change) of the constructs from the TTM. Results showed that those in the higher stages of motivational readiness (e.g., maintenance) engaged in more moderate-to-vigorous physical activity than those in lower stages (e.g., precontemplation and contemplation). Compared to women who were considered unhealthy (dietary fat ≥ 30% fat and not in the action/maintenance stage of change for exercise), women who were considered healthy (low-fat diet and exercising at recommended levels) reported significantly higher self-efficacy for exercise ($M = 3.27$ vs. $M = 2.26$, $F = 20.82$, $p \leq 0.001$). Collectively, these findings, together with the present study, suggest that the TTM is a useful theoretical framework for explaining exercise behavior among breast cancer survivors.

In addition to self-efficacy and the behavioral processes of change, and as expected, women with higher exercise levels at the point of transition had greater odds of being sufficiently active at the 18-month assessment period. This finding is consistent with that of Courneya and colleagues [12] who demonstrated that past exercise behavior was a significant predictor of 6-month follow-up exercise behavior among breast cancer survivors. We ran another logistic regression model (data not shown) and controlled for potential confounding variables such as age, weight status, education, marital status, stage of breast cancer, months since breast cancer diagnosis, exercise attendance during the 12-month supervised program, and the group assignment during the supervised program. This model produced similar results as the logistic regression model displayed in Table 4 that controlled for only weight status and physical activity levels at the 12-month assessment period. It is important to note, though, that all of the covariates in the overly adjusted model did not predict activity status at the 6-month follow-up. With respect to null findings for the demographic variables, this is similar to the longitudinal findings of Courneya and colleagues [12], but in contrast to other cross-sectional studies showing that age [46] and education [40] were significant predictors of exercise behavior in breast cancer survivors. These findings, along with, for example, the non-significant association of group assignment (i.e., strength training, aerobic training, and control group) on follow-up activity status (data not shown), suggest that all breast cancer survivors in a supervised exercise program can benefit from being taught behavioral skills and strategies to enhances perceptions of exercise-related efficacy.

On the basis of our findings, we recommend that, prior to transitioning into a home-based exercise program, supervised exercise interventions teach behavioral skills and strategies to increase self-efficacy among breast cancer survivors. Some behavioral strategies for changing behaviors that have been successful in persons without cancer include, enlisting social support, substituting a sedentary behavior with an exercise behavior, and rewarding oneself for engaging or maintaining exercise behavior [47, 48].

It is important to note that processes of change, as well as self-efficacy, theoretically increase in a linear sequence across the stages of change (i.e., from precontemplation to maintenance) [18, 49]. More specifically, behavioral processes of change demonstrate a greater strength of association with the later stages of change (i.e., action and maintenance stages), whereas the cognitive processes of change may be more influential in progressing through the earlier stages of change (i.e., precontemplation to preparation stages). In the present study, 62% of the breast cancer survivors were in either the action or maintenance stage at the 12-month assessment period (data not shown); thus, possibly explaining why the cognitive processes of change at 12-months did not predict activity status at the 18-month assessment period. This suggests that, with more variability in the stages of change, cognitive processes of change may have played an important role in shaping exercise behavior. If future research confirms this speculation, then teaching cognitive skills during the early part of a supervised intervention may be a sensible strategy too.

In addition to behavioral processes of change, older breast cancer survivors with higher perceptions of self-efficacy at the conclusion of the supervised program had greater odds of being sufficiently active at the 18-month assessment period. This finding is consistent with other cross-sectional studies among women with breast cancer [39, 42], as well as other non-cancer populations [18, 19, 23]. In accordance with the tenets of TTM [13–15], self-efficacy perceptions can be influenced from past performances, vicarious experiences (modeling), verbal encouragement, and physiological state. Therefore, to increase exercise-specific self-efficacy among breast cancer survivors, supervised exercise programs could: 1) provide enjoyable and appropriate positive exercise experiences (e.g., moderate intensity activities such as brisk walking); 2) create opportunities to observe other influential individuals (e.g., other breast cancer survivors) perform exercise; 3) provide reinforcement to participate in exercise; and 4) reduce any potential stress or anxiety associated with exercise (e.g., encourage exercising in a safe and enjoyable location).

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In summary, our findings suggest that the behavioral processes of change and exercise-specific self-efficacy play an important role in follow-up exercise behavior after a supervised exercise program for older breast cancer survivors. Therefore, strategies to encourage self-efficacy and use of behavioral processes may be useful in supervised exercise programs in order to promote long-term adherence to physical activity by older breast cancer survivors.

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Table 1

Descriptive characteristics (mean or proportion [standard error]) of the analyzed sample at baseline (12-months).

Variable	Sufficiently Active[b]	Insufficiently Active[c]	P-Value
N	36	27	
Age	71 (1)	72 (1)	$p = 0.75$
Race/Ethnicity			$p = 0.39$
% Non Hispanic White	97 (0.3)	100	
% Non Hispanic Black	3 (2)	0	
Education			$p = 0.38$
% High School	22 (7)	19 (8)	
% Associate/Technical Degree	14 (5)	23 (8)	
% Bachelor’s Degree	33 (7)	19 (7)	
% Advanced Degree	19 (6)	34 (9)	
% Other	11 (5)	3 (3)	
Marital Status			$p = 0.44$
% Married	69 (7)	57 (9)	
% Divorced	19 (6)	19 (7)	
% Widowed	11 (5)	23 (8)	
Employment			$p = 0.46$
% Retired	80 (6)	77 (8)	
% Full-time	0	3 (3)	
% Part-Time	11 (5)	11 (6)	
% Homemaker	3 (2)	7 (5)	
% Unemployed	5 (3)	0	
BMI	28 (1)	28 (0)	$p = 0.57$
Weight Status[a]			$p = 0.02$
% Underweight	0	3 (3)	
% Normal Weight	36 (8)	7 (5)	
% Overweight	30 (7)	59 (9)	
% Obese	33 (7)	29 (8)	
% Taking Hormones for Breast Cancer	23 (7)	18 (7)	$p = 0.68$
Stage of Breast Cancer			$p = 0.72$
0	11 (5)	19 (7)	
I	50 (8)	57 (9)	
IIa	25 (7)	15 (7)	
IIb	8 (4)	3 (3)	
IIIa	5 (3)	3 (3)	
Months Since Breast Cancer Diagnosis	84 (7)	71 (8)	$p = 0.27$

Variable	Sufficiently Active[b]	Insufficiently Active[c]	P-Value
% Who had a Health Problem that Prevented Exercise[b]	33 (8)	29 (8)	$p = 0.75$

[a]Underweight defined as a BMI < 18.5; normal weight defined as a BMI between 18.5 and 24.9; overweight defined as a BMI between 25.0 and 29.9; and obese defined as a BMI greater than or equal 30.0.

[b]Participants in the activity adopters or stable active transitional shift groups

[c]Participants in the stable sedentary, perpetual preparers, and activity relapsers transitional shift groups.

Table 2

Descriptive statistics of the TTM variables assessed at the 12-month period.

Variable	Mean (SD)	Range
Self-Efficacy	67.7 (11.4)	37–90
Pros	19.2 (3.3)	11–25
Cons	8.9 (3.6)	5–20
Decisional Balance (Pros – Cons)	10.3 (5.2)	−4 – 20
Cognitive Processes of Change	51.9 (7.1)	34–69
Behavioral Processes of Change	48.8 (7.5)	34–69
Processes of Change (All)	100.7 (12.9)	74–129

Higher self-efficacy scores indicate greater confidence in overcoming exercise-related barriers.

Higher pros scores indicate more perceived pros of exercise.

Lower cons score indicates fewer perceived cons of exercise.

Higher cognitive and behavioral processes of change scores indicate greater use of these processes.

Table 3

Correlation matrix between moderate-intensity physical activity and each of the Transtheoretical Model variables at the 12- and 18-month assessment periods.

	Physical Activity at 12-months	Physical Activity at 18-months	Self-efficacy at 12-months	Self-efficacy at 18-months	Pros at 12-months	Pros at 18-months	Cons at 12-months	Cons at 18-months	Decisional Balance at 12-months	Decisional Balance at 18-months	Cognitive Processes of change at 12-months	Cognitive Processes of change at 18-months	Behavioral Processes of Change at 12-months	Behavioral Processes of Change at 18-months	Overall processes of change at 12-months	Overall processes of change at 18-months
Physical Activity at 12-months	1															
Physical Activity at 18-months	0.68	1														
Self-efficacy at 12-months	0.21	0.35	1													
Self-efficacy at 18-months	0.13	0.35	0.60	1												
Pros at 12-months	0.13	0.09	0.32	0.32	1											
Pros at 18-months	0.13	0.27	0.42	0.56	0.62	1										
Cons at 12-months	−0.26	−0.35	−0.35	−0.43	−0.14	−0.21	1									
Cons at 18-months	−0.34	−0.28	−0.25	−0.31	−0.03	−0.04	0.50	1								
Decisional Balance at 12-months	0.27	0.30	0.44	0.50	0.73	0.53	−0.78	−0.37	1							
Decisional Balance at 18-months	0.33	0.39	0.46	0.59	0.43	0.70	−0.50	−0.74	0.62	1						
Cognitive Processes of change at 12-months	0.01	0.07	0.13	0.06	0.44	0.41	−0.02	−0.03	0.29	0.30	1					
Cognitive Processes of change at 18-months	0.11	0.16	0.28	0.29	0.45	0.60	−0.15	−0.13	0.39	0.49	0.74	1				
Behavioral Processes of Change at 12-months	0.25	0.30	0.42	0.45	0.38	0.55	−0.31	−0.12	0.45	0.46	0.55	0.54	1			
Behavioral Processes of Change at 18-months	0.26	0.37	0.31	0.49	0.40	0.57	−0.36	−0.18	0.50	0.51	0.41	0.63	0.72	1		
Overall processes of change at 12-months	0.15	0.21	0.31	0.29	0.46	0.55	−0.19	−0.09	0.42	0.43	0.87	0.72	0.89	0.65	1	
Overall processes of change at 18-months	0.22	0.30	0.32	0.44	0.47	0.65	−0.30	−0.17	0.50	0.55	0.61	0.87	0.71	0.93	0.75	1

The size of the correlation coefficient corresponding to a p-value of 0.05 is 0.24.

Table 4

Results of the logistic regression analysis.

Transtheoretical Model Variable[a]	Adjusted Odds Ratio (95% CI) of Being Sufficiently Active at 6-Month Follow-Up[b,c]	P-Value
Self-efficacy	1.10 (1.01–1.18)	0.01
Cons for exercise	1.14 (0.92–1.40)	0.20
Behavioral processes of change	1.13 (1.02–1.26)	0.02
	Pseudo-R^2 = 0.31	

[a]Variable assessed prior to the transition from supervised to home-based exercise (i.e., 12-month assessment period).

[b]Participants in the activity adopters and stable active transitional shift groups.

[c]Model adjusted for moderate-to-vigorous physical activity at the 12-month assessment period (continuous) and weight status (underweight, normal weight, overweight, and obese) at the 12-month assessment period.

Participants in the stable sedentary, perpetual preparers, and activity relapsers transitional shift groups served as the reference group.