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Mediators of a Randomized Controlled Physical Activity Intervention for Breast Cancer Survivors

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Physical activity (PA) interventions diminish some of the physical and psychosocial sequelae of breast cancer diagnosis and treatment. To increase intervention efficacy and portability, it is necessary to determine the factors mediating intervention effects on physical and psychosocial outcomes. This study presents mediator analyses from a randomized controlled trial of a home-based PA intervention (focused primarily on brisk walking) for breast cancer survivors. Eighty-six survivors were randomized to PA or contact control groups (mean age = 53.42 years, SD = 9.08 and 52.86 years, SD = 10.38 respectively; mean time since diagnosis < 2 years). The PA intervention was based on the transtheoretical model (TTM). Kraemer's approach was used to test hypothesized mediators. TTM variables did not mediate intervention effects on PA. Data indicate that increases in moderate-intensity PA and improved fitness may mediate intervention effects on vigor (β = .21; p = .01) and fatigue (β = .24; p = .05) and suggest the value of future research on these potential mediators.

Key words: exercise, cancer survivors, vigor, fatigue

The breast cancer experience—including diagnosis, treatment, and the post-treatment phase—puts survivors at risk for a number of physical and psychosocial sequelae. Physical sequelae may include an increased risk of cardiovascular disease (Cardinale et al., 2002; Loescher, Welch-McCaffrey, Leigh, Hoffman, & Meyskens, 1989) or second cancers (Levi, Randimbison, & Vecchia, 2003; Loescher et al., 1989; Zablotska & Neugut, 2003). Psychosocial sequelae may include ongoing fatigue (Beisecker et al., 1997; de Jong, Courtens, Abu-Saad, & Schouten, 2002), poor body image (Schain, d'Angelo, Dunn, Lichter, & Pierce, 1994; Schover et al., 1995), and depression and/or anxiety (Amir & Ramati, 2002;

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Hjerl, Andersen, Keiding, Mortense, & Jorgensen, 2002). There is a growing body of research, however, indicating that physical activity may reduce these risks; for example, breast cancer survivors who are physically active demonstrate improved quality of life, better physical functioning, less distress, less fatigue, and lower risk of mortality from breast cancer (Courneya, 2003; Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005; Mock et al., 1997; Pinto, Trunzo, Reiss, & Shiu, 2002). Unfortunately, most breast cancer survivors do not reap these benefits because they do not meet recommendations made by the American College of Sports Medicine (ACSM) for vigorous-intensity activity (≥20 min on 3 days/week) or the ACSM's and Centers for Disease Control's goals for moderate-intensity activity (≥30 min on 5 days/week; Irwin et al., 2004; Pinto et al., 2002; USDHHS, 1996). A recent study found that only 32% of breast cancer survivors participated in at least 150 min/week of moderate- to vigorous-intensity activity (Irwin et al., 2004).

To enhance the health and quality of life of breast cancer survivors, investigators have begun to develop physical activity (PA) interventions for this population. Outcome data indicate that breast cancer survivors are able to adhere to a PA intervention (either during or after treatment) and increase their PA relative to that of controls (Courneya, Mackey, Bell, Jones, Field, & Fairey, 2003; Jones, Courneya, Fairey, & Mackey, 2004; Mock et al., 1997). Further, breast cancer survivors receiving a PA intervention demonstrate both physical and psychosocial improvements (again, relative to controls). These improvements include enhanced physical functioning, physical well-being, cardiac fitness, muscle mass, body image, self-esteem, mood, and quality of life (Courneya, 2003; Courneya et al., 2003; Galvao & Newton, 2005; Kuhn, Boesen, Ross, & Johansen, 2005; MacVicar, Winningham, & Nickel, 1989; Mock et al., 1997; Pinto, Clark, Maruyama, & Feder, 2003; Schmitz, Ahmed, Hannan, & Yee, 2005). In addition, breast cancer survivors receiving a PA intervention report less fatigue and distress than controls postintervention (Mock et al., 1997; Courneya, 2003; Segar et al., 1989).

Mediator analyses have been recommended to help investigators determine the mechanisms by which interventions achieve their effects (Kraemer, Wilson, Fairburn, & Agras, 2002). For example, researchers have identified decisional balance, self-efficacy, and processes of change as mediators of the effects of PA interventions (Brassington, Atienza, Perczek, DiLorenzo, & King, 2002; Pinto, Lynn, Marcus, DePue, & Goldstein, 2001; Sallis, Calfas, Alcaraz, Gehrman, & Johnson, 1999). (See Lewis, Marcus, Pate, & Dunn, 2002, for a review.). In addition, a recent PA intervention for breast cancer survivors grounded in the theory of planned behavior found that perceived behavioral control—which is similar to self-efficacy though there are conceptual distinctions (Motl et al., 2005)—mediated intervention effects on PA (Jones, Courneya, Fairey, & Mackey, 2005). Identifying mediators allows investigators to enhance the efficacy of an intervention by removing unnecessary components and highlighting those that are most potent. The revised intervention may also be easier to disseminate because streamlined interventions can be more easily delivered. (We did not investigate moderators, as we were primarily interested in the aspects of the intervention that contributed to its potency, rather than in identifying subgroups for whom the intervention was most efficacious.)

This study investigated the mediators of both physical activity and psychosocial outcomes from Moving Forward, a randomized, controlled PA intervention trial

with breast cancer survivors. The Moving Forward trial investigated whether a brief intervention delivered over the telephone could help sedentary, early-stage breast cancer survivors adopt a moderate-intensity PA program. The main outcomes from this trial have been reported elsewhere (Pinto, Frierson, Rabin, Trunzo, & Marcus, 2005). Of primary interest to the mediator analyses presented here, we found that, when compared to the contact control group at postintervention, women receiving the 12-week intervention reported a greater number of minutes of moderate-intensity activity per week, higher levels of vigor, enhanced perception of their physical condition, and lower levels of fatigue; this study sought to identify the variables mediating the intervention's effect on these outcomes. Also of interest to the study reported here, outcome analyses from Moving Forward demonstrated that women receiving the intervention outperformed controls on a standard test of fitness (a possible mediator of some of the outcomes listed above).

Because the Moving Forward intervention was based in the transtheoretical model (TTM; Prochaska & DiClemente, 1983), we hypothesized that certain TTM constructs would mediate the effect of the intervention on PA (i.e., lead to increases in PA in the intervention group). The TTM proposes that individuals adopting a new behavior, such as PA, progress along a continuum of five stages of change. These stages include (1) precontemplation (not considering exercise adoption), (2) contemplation (considering exercise, but not yet exercising), (3) preparation (exercising, but not regularly—such as not meeting ACSM or CDC guidelines for moderate-intensity [USDHHS, 1996] or vigorous-intensity [ACSM, 1990]) activity, (4) action (exercising regularly for <6 months), and (5) maintenance (exercising regularly for ≥6 months). According to this theory, certain cognitive and behavioral factors increase the likelihood of progressing through these stages. A positive "decisional balance" (endorsing more pros than cons to PA), greater use of experiential processes of change (e.g., setting realistic goals) and behavioral processes of change (e.g., rewarding oneself for PA), and greater self-efficacy have been associated with greater progress through the stages of PA adoption and maintenance (Bock, Marcus, Pinto & Forsyth, 2001; Brassington et al., 2002; Marcus, Rakowski & Rossi, 1992; Marcus, Rossi, Selby, Niaura & Abrams, 1992; Sallis et al., 1999). Likewise, there is some evidence that decisional balance, processes of change, and self-efficacy mediate the effects of a TTM-based PA intervention on PA outcomes (Brassington et al., 2002; Pinto et al., 2001; Sallis et al., 1999). Thus, the baseline to postintervention changes in these variables—decisional balance, behavioral processes of change, experiential processes of change, and self-efficacy—were hypothesized to mediate the effect of the intervention on postintervention (i.e., 12-week) reports of minutes of moderate-intensity activity.

Our second hypothesis was that change in moderate-intensity PA and improved fitness would mediate the effect of the intervention on psychosocial outcomes. Previous PA interventions with cancer survivors have indicated that those receiving the intervention report less fatigue (Courneya, 2003; Dimeo, Rumberger, & Keul, 1998; Mock et al., 1997). It has not yet been documented whether the increase in PA that occurs over the course of the intervention mediates the reduction in fatigue. Similarly, increased PA has been linked to higher levels of vigor among breast cancer survivors (Pinto et al., 2002), although PA has not yet been established as a mediator of intervention effects. Finally, investigators have reported that increased PA among early-stage breast cancer survivors enhances aspects of body esteem,

such as the perception of physical condition (Pinto et al., 2003). We, therefore, hypothesized that the change in minutes of moderate-intensity PA reported from baseline to postintervention would mediate the effect of the intervention on vigor, fatigue, and perceived physical condition at postintervention (12 weeks). Likewise, we hypothesized that baseline to postintervention change in fitness would mediate intervention effects on vigor, fatigue, and perceived physical condition.

Method

Design

We conducted a randomized controlled trial comparing a 12-week, home-based moderate-intensity PA program, and a contact control condition. Eighty-six sedentary women who had completed treatment for stage 0–2 breast cancer were randomized to either the PA or control group. Assessments were conducted at baseline, postintervention (12 weeks), and 6 and 9 months postbaseline. Institutional review boards at Miriam Hospital and Women and Infants' Hospital of Rhode Island approved the study.

Recruitment

Participants were recruited by various methods including informational letters sent by oncologists to their patients, in-person recruitment at two hospital-based oncology clinics and a private practice, and mailings to work sites. Eligibility criteria included age ≥18 years, currently sedentary (exercised less than once per week for 20 min at vigorous intensity and less than twice per week for 30 min at moderate intensity for the past 6 months), diagnosed with stage 0–2 breast cancer over the past 5 years, completed surgery, chemotherapy and/or radiation, ambulatory, and willing to be randomized. Participants were excluded if they had a history of any cancer (with the exception of nonmelanoma skin cancer) or had a medical or current psychiatric illness that could make compliance with the study protocol difficult or dangerous (e.g., cardiovascular disease, diabetes, orthopedic problem that limits exercise). We completed 424 initial telephone screens to determine study eligibility. Of the 424 screened, 86 (20.3%) were eligible, interested, and eventually randomized; 37 were initially eligible (8.7%), but were not randomized (e.g., were not interested); and 301 (71%) were not eligible. (The reasons for ineligibility have been detailed previously [Pinto et al., 2004] with the highest percentage ineligible for multiple reasons, e.g., high blood pressure and inability to complete the walk test.)

Procedure

Participants obtained medical clearance from their primary physicians. They were stratified by age (<50 years vs. ≥50 years), cancer stage (stage 0 or 1 vs. 2), and medical treatment (received vs. did not receive chemotherapy)—because these factors may have affected participants' ability to adopt a PA program and/or outcomes—and then were randomized by a data specialist. The data specialist sealed the results of the randomization in an envelope and gave the envelope to the

researcher performing the baseline assessment; participants were notified of their group assignment after completing all baseline measures. Neither participants nor research staff members were blinded to their group assignment after that point. Both intervention conditions are described briefly below; for additional details, see Pinto et al. (2005).

Home-Based PA Intervention

Following randomization, each PA participant received in-person instructions on how to exercise at moderate intensity, monitor heart rate, warm up before exercise, and cool down after exercise. They were given home logs to monitor PA and a pedometer (Digiwalker, Yamax Corp.) to wear during walks for exercise. During the first week of the intervention, participants were encouraged to exercise for at least 10 min on at least two days per week; the goals were gradually increased over the 12 weeks to 30 min of accumulated PA per day on at least five days per week by the final two weeks of the intervention (USDHHS, 1996; Pate et al., 1995). The program promoted moderate-intensity PA at 55–65% maximum heart rate (e.g., brisk walking, biking, swimming).

Each participant received a weekly telephone call over 12 weeks from research staff to monitor PA participation, identify relevant health problems, problem-solve barriers to PA, and reinforce participants' efforts. Activity counseling was tailored to each participant's motivational readiness (Marcus & Simkin, 1993). Those who were ready to become active (contemplation stage) were guided to set small, achievable goals; identify potential barriers; and problem-solve to achieve PA goals. Those who were engaging in some level of PA (preparation stage) were encouraged to increase the frequency and duration over 12 weeks to achieve recommendations for moderate-intensity PA (USDHHS, 1996; Pate et al., 1995). Physical activity counseling also focused on enhancing participants' self-efficacy (by setting small, easily attainable goals to boost confidence), decisional balance (by highlighting the personally relevant benefits of PA), and use of experiential and behavioral processes of change (by suggesting practical strategies known to facilitate PA); these constructs are believed to increase motivational readiness for PA. At the weekly calls, participants reported on the PA recorded on home logs and received feedback. Physical activity participants also received two weekly tip sheets in the mail—one on a topic relevant to beginning a PA program (e.g., fitting exercise into a busy schedule) and one on a cancer survivorship topic (e.g., coping with body changes).

Contact Control Group

These participants were asked not to change their current level of activity during the 12 weeks. They received a weekly phone call from research staff for 12 weeks, during which the Symptom Questionnaire (Winningham, 1993) was administered to monitor problems, such as headaches, that can affect normal activity of daily life. The goal of the calls was to match the frequency of contact with the PA group; no attempt was made to match the duration of telephone contact between groups. These women received the same cancer survivorship tip sheets as did the PA group. After completing the final follow-up assessment, they received the PA tip sheets.

Measures

Demographic, disease, and treatment information was obtained at baseline. Participants provided consent for medical record review to extract disease and treatment data. At baseline and postintervention, participants completed measures of vigor, fatigue, perceived physical condition, self-efficacy, decisional balance, and behavioral and cognitive processes of change (described below), and their PA and fitness were assessed using the following measures.

1. *Seven-Day Physical Activity Recall (7-day PAR; Blair et al., 1985).* This validated, interviewer-administered measure was developed for the Stanford Five City Project and was administered per protocol (Blair et al., 1985; Sallis et al., 1985; Sarkin et al., 1997). When testing Hypothesis 1, the quantity of minutes of moderate-intensity PA (at postintervention) was used as the outcome. Change in minutes of moderate-intensity PA from baseline to postintervention was used as a mediator for some analyses testing Hypothesis 2.
2. *Rockport One-Mile Walk Test.* Participants were asked to complete a validated field test of fitness, the Rockport One-Mile Walk Test, on an indoor track at all assessments (ACSM, 1992; Kline et al., 1987; Pober, Freedson, Kline, McInnis & Rippe, 2002). Per protocol, they were asked to walk as fast as possible. This field test yields the time taken to complete the walk.
3. *Profile of Mood States* (McNair, Lorr, & Droppelman, 1971)—a reliable (McNair, Lorr, & Droppelman, 1992) 65-item questionnaire—taps a variety of mood states including anger, tension/anxiety, depression, vigor, fatigue, confusion, and total mood disturbance. Participants were asked to describe "how you have been feeling during the past week including today" and respond on a scale from 0 (not at all) to 4 (extremely).
4. *Fatigue* was assessed using a 10-cm linear analog scale (Boyd, Selby, Sutherland, & Hoggs, 1988), with the left anchor indicating the least fatigue and the right anchor the most fatigue.
5. *Perceived Physical Condition Subscale of the Body Esteem Scale (BES; Franzoi & Shields, 1984).* The BES is an internally consistent, 35-item scale assessing a participant's evaluation of sexual attractiveness, weight concerns, and physical condition. Only the perceived physical condition subscale (e.g., evaluation of one's physical stamina, energy level) was used as an outcome in this paper.
6. *Decisional Balance* for exercise was assessed using a validated (Marcus, Rakowski, et al., 1992) 16-item questionnaire comprised of items that reflect positive (Pro) and negative (Con) aspects of exercise adoption. A decisional balance index is created by subtracting the *t* score of the Cons subscale from the *t* score of the Pros subscale.
7. *Exercise Self-Efficacy* was assessed using a validated (Marcus, Selby, Niaura, & Rossi, 1992) five-item measure that determines confidence in one's ability to engage in regular exercise in specific situations (e.g., "When I am tired.").
8. *Processes of Behavior Change* were assessed using a 40-item version of the Exercise Processes of Change questionnaire (Marcus, Rossi, et al., 1992). The instrument assesses 10 processes of change that people use in changing sedentary behavior: five are behavioral (e.g., reinforcement management)

and five are cognitive/experiential (e.g., consciousness raising). Participants were instructed to think back over the past month and to rate the frequency of occurrence of each item on a 5-point Likert scale from 1 (never) to 5 (repeatedly). Behavioral process of change items were used to calculate a behavioral processes of change variable and likewise for experiential processes of change.

Data Analyses

Before conducting analyses, PA and control groups were compared for differences on demographic, medical, or treatment variables. Significant differences were found on two variables: more control group participants were on hormone treatment (74.4% vs. 48.8%; $\chi^2(1, 86) = 5.950$, $p = .015$) and PA group participants were more often married or partnered ($\chi^2(1, 86) = 4.807$, $p = .028$). Both variables were controlled in subsequent analyses. Four women, all from the PA group, dropped out during the 12-week program and did not provide postintervention data. The retained sample ($n = 82$) and the four dropouts did not differ significantly on demographic, medical, or treatment variables. Hypothesis testing was conducted on all participants who completed baseline and postintervention (12-week) assessments, while excluding outlier data (i.e., three participants for minutes of moderate-intensity activity on the PAR, and two participants for fatigue scale scores).

We used the approach to mediator analyses advocated by Kraemer and colleagues (2002), an approach also used by other investigators (Brassington et al., 2002). According to this approach, a mediator variable "would have to measure an event or change occurring during treatment, and then it must correlate with treatment choice . . . and have either a main or interactive effect on the outcome." The mediators proposed for this investigation satisfy the first two criteria because the intervention had a significant or marginally significant effect on each (when previous intent-to-treat analyses were conducted and baseline values replaced postintervention values for dropouts and missing data): for decisional balance, $F(1, 79) = 2.43$, $p = .094$; for self-efficacy, $F(1, 80) = 21.38$, $p = .001$; for experiential processes, $F(1, 81) = 7.57$, $p = .007$; for behavioral processes, $F(1, 81) = 31.02$, $p = .001$; for Rockport walk-test time (i.e., fitness), $F(1,68) = 21.12$, $p < .001$ (Pinto et al., 2005); and for minutes of moderate-intensity PA, $F(1,74) = 11.06$, $p < .001$ (Pinto et al., 2005). To assess mediator relationships we regressed each outcome onto the group assignment variable (i.e., PA vs. control), proposed mediator, and interaction between the group assignment and mediator (see Figure 1). As previously noted, we controlled for hormone treatment status and marital status. We also controlled for baseline values of the outcome variable. Note that, although other variables measured in this trial (e.g., cancer-related beliefs) may have affected some of the outcomes of interest, they do not satisfy mediator criteria; these variables are present at baseline, uncorrelated with treatment group, and are not affected by the intervention.

Although the most stringent test of mediator relationships would involve assessing mediators prior to outcomes, that was not possible in this investigation. This intervention study was designed to minimize participant burden and thus did not include a mid-intervention assessment. In order to address this methodological limitation, we calculated baseline-to-postintervention change scores for each

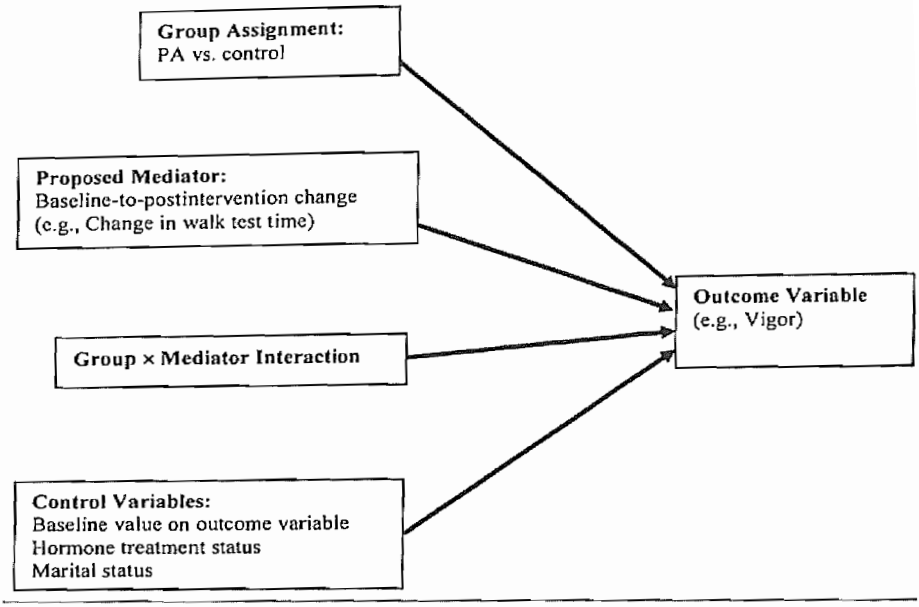

Figure 1 — Variables included in mediator analyses (PA = physical activity group).

mediator variable (as other investigators [Pinto et al., 2001] assessing mediators of a PA intervention have done). Change scores were calculated by simply subtracting the value of the variable at baseline from the value at postintervention (12 weeks).

Results

The sample characteristics and main outcomes have been described previously (Pinto et al., 2005). Briefly, 86 women were randomized to either the PA intervention ($n = 43$) or control group ($n = 43$). Average age for the PA group was 53.42 years (range 32–75, $SD = 9.08$), and for the control group it was 52.86 years (range 31–76, $SD = 10.38$). Average time since diagnosis was less than 2 years in both groups (PA group = 1.74 years, $SD = 1.49$; control group = 1.93 years, $SD = 1.37$). Both groups had a majority of White participants of high socioeconomic status (i.e., most were highly educated, employed, and with household income exceeding $50,000). Descriptives of variables used in mediator analyses are provided in Table 1.

Hypothesis 1: a change in decisional balance, behavioral processes of change, experiential processes of change, and self-efficacy (from baseline to postintervention) will mediate the effect of the intervention on minutes of moderate-intensity activity (at postintervention). The findings from regression analyses testing the first hypothesis are summarized in Table 2. The proposed mediators failed to show a significant relationship with the outcome (minutes of moderate-intensity activity). Thus, neither decisional balance, self-efficacy, behavioral processes of change, nor

Table 1 Descriptives of Variables Used in Mediator Analyses

		PA Group					Control Group				
	Scale	Baseline		Postintervention		Δ score[a]	Baseline		Postintervention		Δ score[a]
	Range	*M*	*SD*	*M*	*SD*	*M*	*M*	*SD*	*M*	*SD*	*M*
Self-Efficacy	1–5	2.88	.90	3.20	.80	.32	2.76	.76	2.41	.72	–.35
Decisional Balance[b]	—	1.90	10.7	5.33	13.09	3.43	–.20	13.7	–3.36	14.3	–3.16
Experiential Processes of Change	1–5	2.82	.45	2.94	.69	.11	2.95	.57	2.68	.61	–.27
Behavioral Processes of Change	1–5	2.60	.52	3.33	.73	.73	2.44	.63	2.34	.70	–.10
Minutes of Moderate-Intensity PA	—	76.24	88.98	187.24	157.75	111.0	58.75	79.08	70.72	85.40	11.97
Walk Test Time (min)	—	17.33	1.95	16.14	1.96	–1.19	17.57	1.96	17.82	2.19	.26
Vigor	0 –32	18.08	5.79	21.08	5.71	3.00	15.02	5.53	15.52	5.10	.50
Fatigue	0–100	41.03	23.51	28.69	19.46	–12.34	40.36	23.82	41.42	25.88	1.06
Perceived Physical Condition	9–45	28.23	7.37	30.87	7.77	2.64	27.05	6.37	27.05	6.76	0

[a]Δ score: the baseline to postintervention change score has been provided; note that this represents the mediator variable for hypothesized mediators (i.e., self-efficacy, decisional balance, experiential processes of change, behavioral processes of change, minutes of moderate-intensity PA, walk test time).

Table 2 Analyses Examining Proposed Mediators of Physical Activity

Proposed Mediator (Change scores)	Minutes of Moderate-Intensity Activity at Postintervention				
	β	*p*	B	95% CI[a]	
Decisional Balance	.12	.30	1.27	−1.14	3.67
Decisional Balance × Group Interaction	.05	.63	1.16	−3.66	5.99
Self-Efficacy	.18	.14	31.65	−10.49	73.79
Self-Efficacy × Group Interaction	.03	.77	13.13	−75.41	101.68
Experiential Processes	−.02	.86	−5.08	−63.32	53.15
Experiential Processes × Group Interaction	.12	.26	66.71	−51.34	184.76
Behavioral Processes	.14	.32	26.14	−25.60	77.87
Behavioral Processes × Group Interaction	.13	.32	52.47	−51.13	156.08

[a]CI = confidence interval.

experiential processes of change can be considered to mediate the effect of the intervention on moderate-intensity PA.

Hypothesis 2: A change in minutes of moderate-intensity physical activity and Rockport walk test time (from baseline to postintervention) will mediate the effect of the intervention on vigor, fatigue, and perceived physical condition (at postintervention). The findings from regression analyses that investigated the second hypothesis are summarized in Table 3. The number of minutes of moderate-intensity activity was significantly associated with vigor ($\beta = .21$, $p < .05$). Likewise, there was a borderline association between Rockport walk test time and fatigue ($\beta = .24$, $p = .05$). Although other data seemed to indicate a trend in the expected direction (i.e., the association between minutes of moderate-intensity activity and fatigue: $\beta = -.17$, $p = .11$), the data did not approach statistical significance. Data did not support moderate-intensity PA or Rockport walk test time as mediators of intervention effects on perceived physical condition.

Discussion

This study examined hypothesized mediators of the effects of a PA intervention for early-stage breast cancer survivors on various physical and psychological outcomes. Mediator analyses can identify the constructs that make PA interventions for cancer survivors efficacious (Jones et al., 2005) and allow researchers to further develop these interventions. Moving Forward produced changes in the proposed

Table 3 Analyses Examining Proposed Mediators of Psychosocial Outcomes

Proposed Mediator (change scores)	Psychosocial Outcome at Postintervention				
	β	*p*	B	95% CI[a]	
Vigor					
Minutes of Moderate-Intensity Activity	**.21**	**.01**	.01	.00	.02
Moderate Minutes × Group Interaction	−.05	.58	−.00	−.02	.01
Walk Test Time	−.14	.17	−.58	−1.42	.26
Walk Test × Group Interaction	.15	.12	1.33	−.34	3.00
Fatigue					
Minutes of Moderate-Intensity Activity	−.17	.11	−.03	−.06	.01
Moderate Minutes × Group Interaction	.09	.41	.03	−.04	.10
Walk Test Time	**.24**	**.05**	3.69	−.02	7.40
Walk Test × Group Interaction	−.10	.38	−3.24	−10.62	4.14
BES—Physical Condition					
Minutes of Moderate-Intensity Activity	.0	.42	.00	−.01	.01
Moderate Minutes × Group Interaction	−.01	.89	−.00	−.02	.02
Walk Test Time	.04	.69	.20	−.80	1.19
Walk Test × Group Interaction	−.03	.75	−.32	−2.31	1.66

[a]CI = confidence interval.

mediators (from baseline to postintervention) in favor of the PA group (Pinto et al., 2005). Despite this, there was mixed support for hypotheses that these variables mediated the causal path between the PA intervention and various physical and psychosocial outcomes.

The TTM constructs of decisional balance, experiential process of change, behavioral processes of change and self-efficacy were not significant mediators of intervention effects on minutes of moderate-intensity PA. There are several possible explanations. First, given our research design, mediator scores were created by calculating baseline-to-postintervention (i.e., 12-week) change scores; thus, we were assessing the hypothesized mediators simultaneously with the (12-week) psychological and physical outcomes. Ideally, mediators would be assessed before the assessment of outcomes, not simultaneously (Lewis et al., 2002). Even though this simultaneous approach is common in the PA literature (Lewis et al., 2002), we may have been more able to demonstrate mediation if our hypothesized mediators had been assessed at some midpoint during the 12-week trial. Second, consistent with our findings, cognitive processes of change, self-efficacy, and decisional balance have not always been shown to be mediators in the PA literature (Lewis et al., 2002; Motl et al., 2005; Pinto et al., 2001). Finally, the TTM variables may not have mediated the PA outcome in this study owing to a lack of statistical power; this indicates the need for conducting intervention studies with larger samples.

Hypothesis 2 proposed that minutes of moderate-intensity PA and fitness mediate the causal path between the PA intervention and psychosocial outcomes (i.e., vigor, fatigue, and perceived physical condition). Minutes of moderate-intensity PA was a significant mediator of intervention effects on vigor. Similarly, fitness marginally mediated intervention effects on fatigue. It is possible that the effect on fatigue would have been more pronounced if a multidimensional measure of fatigue had been used; for example, fitness may exert differential effects on physical and mental fatigue. Our findings suggest that in order for a moderate-intensity PA intervention to improve variables related to mental health, participants must increase the time spent in moderate-intensity PA (e.g., brisk walking) and show improvements in fitness. Neither of these proposed mediators were significant for the BES subscale of perceived physical condition; further research is needed to determine which aspects of the intervention (if not improved PA or fitness) lead to improvements in perceived physical condition.

Some of the key limitations of this study—including the relatively small sample size and simultaneous assessment of mediators and outcomes—have been noted above. Given these two key limitations (and the number of mediators assessed), these findings should be seen as preliminary; they suggest the utility of additional research, designed to assess mediators, with a larger sample. Given the relative homogeneity of this sample (Pinto et al., 2005), additional research will also be needed determine whether these findings generalize to other cancer populations. Additional research could also be used to determine whether aspects of the intervention design (e.g., that PA group participants were asked to attempt the final goal of walking for 30 min on 5 days/week only during the last two weeks of the intervention) precluded finding more-robust mediator effects.

It is also possible that other variables, not evaluated in this study, are mediating intervention effects on the psychosocial and behavioral outcomes used in testing our hypotheses. For example, weight loss could potentially mediate PA intervention

effects on psychosocial variables, such as perceived physical condition. As this intervention was not directed at weight loss and did not have a significant effect on weight, weight loss was not a mediator in this sample. Other psychosocial variables that were not assessed in this sample, such as an increased sense of hopefulness, might also have mediated intervention effects on psychosocial outcomes.

It should be acknowledged that there are variations in the analytic strategies to demonstrate mediation. Whereas some researchers use Kraemer and colleagues' (2002) analytic strategy, others use strategies advocated by Baron and Kenny (1986) or by others (Jones et al., 2005). To further complicate matters, a recent article by MacKinnon and colleagues (2002) reviewed fourteen analytic strategies that could be used to examine mediators, including Baron and Kenny's (1986), but Kraemer and colleagues' (2002) was not one of these approaches. The gold standard for testing mediation remains nebulous, and it is difficult to compare results obtained using different approaches.

This study used Kraemer and colleagues' (2002) mediator analytic strategy because it clarifies the operational framework and analytic models for identifying mediators and moderators. When we analyzed some of our hypothesized mediators through Baron and Kenny's (1986) approach, our findings were largely consistent with findings from Kraemer's (2002) approach (Pinto, Rabin, & Frierson, 2004). Furthermore, the analytic strategy used in this study emphasizes using effect sizes rather than *p*-values, which are dependent on sample sizes.

This paper examines the potential mechanisms of a PA intervention that was successful in increasing PA, and improving fitness and specific psychosocial outcomes among breast cancer survivors. The results indicate mediational links between fitness and fatigue, and minutes of moderate-intensity activity and vigor. This study should be replicated using a larger sample and assessing mediators at time points that are distinct from the predictors and outcomes. Identifying mediators aids in developing and tailoring future PA interventions for breast cancer survivors.

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