Timing and Sustainability of an Exercise Intervention in Women With Breast Cancer During and After Cancer Treatment

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Purpose/Objectives: To compare changes in frequency, duration, and intensity of exercise behaviors over time in women with breast cancer between those who started their exercise intervention at the beginning of chemotherapy (EE) and those who started at the completion of chemotherapy (CE).

Design: A secondary data analysis of a randomized, controlled trial for exercise intervention.

Setting: Five cancer centers in the San Francisco Bay Area in California.

Sample: 66 outpatient women with breast cancer who were receiving chemotherapy.

Methods: Piecewise linear mixed models analysis was used to study changes in exercise behaviors over time in the EE group during and after treatment. In addition, linear mixed models analysis was used to examine changes between the EE and CE groups after treatment. Participants were in the trial for various length of time (EE group: 19–86 weeks; CE group: 6–43 weeks).

Main Research Variables: Exercise frequency, intensity, and duration.

Findings: In the EE group, weekly exercise duration increased significantly during treatment ($p = 0.02$). In addition, weekly exercise intensity increased significantly during treatment ($p = 0.02$) and decreased significantly after treatment ($p = 0.003$). After treatment, initial weekly exercise duration was significantly lower in the CE group than in the EE group ($p = 0.01$). No significant differences existed in frequency and intensity over time between the EE and CE groups.

Conclusions: Women with breast cancer can sustain exercise behaviors when they start an exercise intervention in the beginning of chemotherapy treatment.

Implications for Nursing: Strategies to support patients in maintaining their exercise habit may be needed during the post-treatment period.

Exercise intervention programs in women with breast cancer have been associated with several positive health outcomes (McNeely et al., 2006), such as functional capacity (Griffith et al., 2009), cardiorespiratory fitness (Griffith et al., 2009; Hsieh et al., 2008; Schneider, Hsieh, Sprod, Carter, & Hayward, 2007), insulin level (Ligibel et al., 2008), body composition and weight (Irwin et al., 2009; Morey et al., 2009; Rogers et al., 2009), bone mass (Irwin et al., 2009; Winters-Stone, Schwartz, & Nail, 2010), muscle strength and balance (Twiss et al., 2009), fatigue (Hsieh et al., 2008; Mock, 1994; Schneider et al., 2007), nausea (Lee, Dodd, Dibble, & Abrams, 2008), sleep (Payne, Held, Thorpe, & Shaw, 2008), and social well-being (Rogers et al., 2009). Exercise interventions employed in studies of women with breast cancer include a home-based walking program, aerobic and resistance programs, yoga, or a supervised individual program for either women with breast cancer receiving active treatment or breast cancer survivors. In addition, Sprod, Hsieh, Hayward, and Schneider (2010) reported that breast cancer survivors in a longer duration (six-month) exercise intervention had greater improvements in pulmonary function and muscular endurance than those in a shorter duration (three-month) intervention.

For patients with cancer receiving active treatment such as chemotherapy, the goal of exercise is to maintain endurance, strength, and level of function (Schwartz, 2003). However, what effect the timing of initiating an exercise-training program may have in relation to how participants sustain the exercise regimen during chemotherapy and beyond is not known. The purpose of this study was to compare changes in frequency, duration, and intensity of exercise behaviors over time between women with breast cancer who were prescribed an exercise intervention (a) at the beginning of cancer treatment or (b) at the completion of cancer treatment.

Methods

The data used in this analysis were part of a single-blind, randomized clinical trial (Dodd et al., 2010) to test the effectiveness of an exercise intervention, the

Pro-Self: Fatigue Control Program, in a longitudinal repeated-measures, two-staged design. The original trial was initiated at the beginning of cancer treatment (baseline [T1]) and continued until treatment was completed (T2) and beyond the cessation of treatment for an equivalent period of time until the end of the study (T3). In the parent study, participants were randomized into three groups at T1. Group 1 (exercise/exercise [EE]) received the intervention at T1 and continued through T2 and T3; group 2 (control/exercise [CE]) received standard care and instructions to continue usual activities through T2, then received the intervention through T3; and the control group received standard care and instructions to continue usual activities through the study period. Weekly exercise data were collected with exercise logs. The parent study found no difference in fatigue level among the three groups (Dodd et al., 2010). For the purposes of this article, the period from T1 to T2 is referred to as phase 1, whereas the period from T2 to T3 is called phase 2. The control group was not included in this analysis. The study aims of this secondary data analysis were to compare (a) the frequency, duration, and intensity of exercise of the EE group during phase 1 and 2, and (b) the frequency, duration, and intensity of exercise between the EE and CE groups in phase 2 only (see Figure 1).

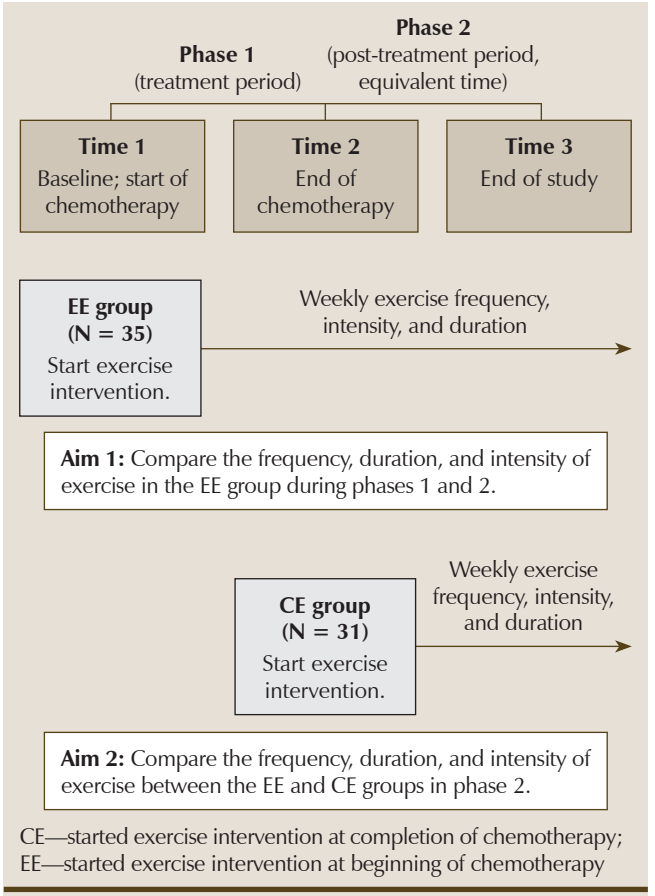


Figure 1. Schematic Diagram of Study Aims

Sample and Setting

Participants were recruited from five cancer centers in the San Francisco Bay Area in California. Eligible participants were aged 18 years or older, had breast cancer, were initiating their first course of cancer chemotherapy, were expected to survive at least 12 months, had Karnofsky Performance Status (KPS) scores of 60 or higher (indicates patient requires occasional assistance and is able to care for most needs), and were able to read, write, and understand English. The final analyses include 66 women with breast cancer (EE group: N = 35; CE group: N = 31).

Exercise Intervention

The Pro-Self: Fatigue Control Program was designed for adult learners with at least an eighth-grade education level. Participants followed the program at home and were monitored by the exercise trainers when patients visited the oncologist's office. The intervention included teaching guides to increase knowledge about fatigue and exercise in general. The exercise teaching guide included the specific skills of the exercise-intervention protocol and an individualized exercise prescription, developed based on a baseline exercise treadmill test. The exercise trainers also provided monitoring and encouragement in weekly follow-up telephone calls.

The exercise prescription included exercise mode, frequency, duration, and intensity of exercise. The prescription was adjusted over time based on tolerance to the program. The participants were instructed to increase their exercise sessions weekly by two to five minutes according to individual tolerance. The exercise types were aerobic activity of the participant's choice (e.g., walking, stationary bicycling) to be performed independently at home. Other activities such as low-impact aerobics were approved as supplemental or occasional activities.

In the current study, frequency of exercise was defined as the number of days of exercise per week, with the ultimate goal being five days a week (one exercise session per day). The duration of exercise was the time spent in each session of exercise, with a goal of 45–60 minutes per session (including warm-up and cool-down components). The intensity of exercise was based on the rating of perceived exertion level (RPE) reported by the patient on the Borg scale from 6 (no exertion at all) to 20 (maximal exertion) (Borg, 1998). The length of time each participant stayed in the intervention varied based on the length of their chemotherapy treatment and subsequent length of post-treatment period. The weekly exercise log data on those variables were collected in the parent study.

Instruments

Participants completed the 30-item **demographic profile** at baseline. Data were collected on age, income, ethnicity, gender, menopausal status, perceived KPS score,

Table 1. Sample Characteristics

Characteristic	Total (N = 66)			EE Group (N = 35)			CE Group (N = 31)		
	$\bar{X}$	SD	Range	$\bar{X}$	SD	Range	$\bar{X}$	SD	Range
Age (years)	49.12	8.93	30–69	48.81	8.54	30–69	49.47	9.5	33–68
Years in education	16.2	2.64	12–24	16.26	2.93	12–24	16.14	2.28	12–20
KPS at baseline	87.7	8.79	70–100	88.09	8.53	70–100	87.24	9.22	70–100
Characteristic		**n**			**n**			**n**	
Caucasian		48			24			24	
Lives alone		9			4			5	
Married		48			27			21	
Annual income of $70,000 or higher		39			19			20	
Employed full-time		23			10			13	
Premenopausal		25			13			12	

CE—started exercise intervention at completion of chemotherapy; EE—started exercise intervention at beginning of chemotherapy; KPS—Karnofsky Performance Status

Note. Two-tailed T test was used for continuous variable comparisons between the EE and CE groups (no significant differences), and two-tailed chi-squared test was used for categorical variable comparisons between the EE and CE groups (no significant differences).

and current symptomatology. The **KPS** (Karnofsky & Burchenal, 1949) uses a rating of the physical abilities of the patient based on the definitions provided on a scale from 0 (equivalent to being dead) to 100 (no decrease in performance). The demographic profile required about 10 minutes for participants to complete.

A **medical record form** comprising a 10-item instrument and flow sheet was used to obtain data on patients' tumor characteristics, chemotherapy protocol, treatment goals, and response to chemotherapy. Laboratory data and clinical parameters were recorded on the flow sheet. The form was completed by the research personnel using medical record review and clinician (physician or nurse) interviews.

A **weekly exercise log** was completed by each participant to record the type of exercise, time of day exercise was being performed, duration, heart rate, and perceived exertion. The logs were returned every two weeks in a self-addressed, stamped envelope; if the logs were not received within three working days of the expected receipt, patients received a reminder telephone call from the exercise trainer. Patients were instructed to bring their logs completed since their last mailing to their scheduled oncologist clinic visit, and the exercise trainer reviewed those logs with the patients.

Statistical Analysis

SPSS®, version 15.0, statistical software was used. The data in the main study were cleaned through descriptive and frequency analysis repeatedly to ensure the accuracy of the data.

Linear mixed model analyses were used to compare the weekly change in frequency, duration, and intensity of exercise over time. An advantage of this approach over a more traditional repeated-measures analysis of variance is that linear mixed models more closely satisfy the tenants of an intent-to-treat strategy. Linear mixed models allow all participants to be included in the analysis, even if data are missing; patients contribute information to the analysis for as many assessments as they provide data (Singer & Willett, 2003). For the first study aim, piecewise linear mixed models (Singer & Willett, 2003) were used to analyze the change over time in exercise in the EE group from phase 1 to phase 2. That technique allowed for modeling the data trajectory from phase 1 to phase 2 while time was divided into phases in the current study. Therefore, the authors could compare shifts in intercept elevation (initial exercise

Table 2. Piecewise Linear Mixed Model of Exercise Frequency, Duration, and Intensity in the EE Group by Phase

Parameter	Est	SE	p	95% CI
Frequency (times per week)				
Intercept in phase 1[a]	3.74	0.39	< 0.001	[2.96, 4.53]
Intercept change in phase 2[b]	–0.13	0.51	0.8	[–1.13, 0.88]
Slope in phase 1[c]	–0.02	0.02	0.24	[–0.05, 0.01]
Slope change in phase 2[d]	0.02	0.02	0.27	[–0.01, 0.05]
Duration (minutes per session)				
Intercept in phase 1[a]	37.3	2.3	< 0.001	[32.64, 41.95]
Intercept change in phase 2[b]	3.24	2.14	0.13	[–0.96, 7.44]
Slope in phase 1[c]	0.22	0.1	0.02	[0.03, 0.42]
Slope change in phase 2[d]	–0.09	0.63	0.17	[–0.21, 0.04]
Intensity (average RPE score)				
Intercept in phase 1[a]	11.9	0.38	< 0.001	[11.14, 12.66]
Intercept change in phase 2[b]	1.13	0.42	< 0.01	[0.31, 1.95]
Slope in phase 1[c]	0.03	0.01	0.02	[0.01, 0.06]
Slope change in phase 2[d]	–0.04	0.01	< 0.01	[–0.07, –0.01]

[a] Baseline exercise data

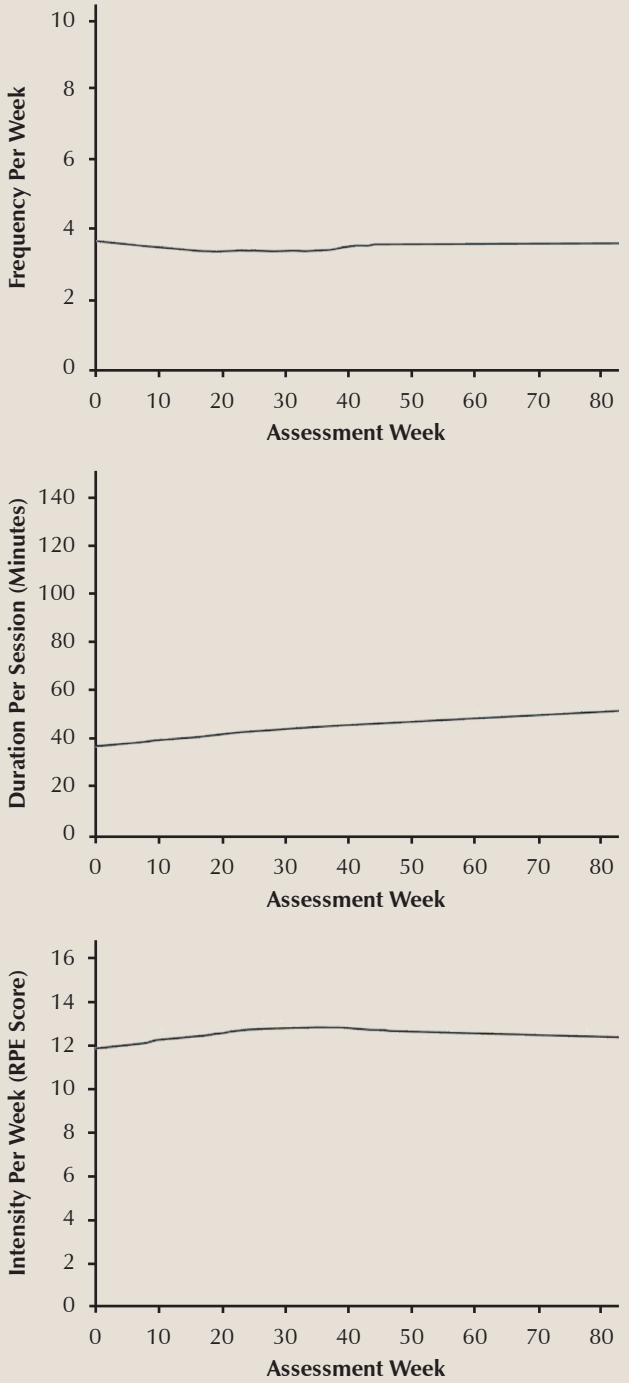
[b] Difference of initial exercise data in phase 2 compared to phase 1

[c] Weekly change in phase 1

[d] Difference of weekly change in phase 2 compared to phase 1

CI—confidence interval; EE—started exercise intervention at beginning of chemotherapy; Est—estimate; RPE—rating of perceived exertion level; SE—standard error

behavior) and slopes (weekly change) from phase 1 to phase 2. For the second study aim, linear mixed models were used to compare the change of exercise behavior over time between the EE and CE groups in phase 2. The data were modeled into two trajectories (one for each group) to determine the intercept and slope differences between the two groups. In addition, descriptive statistics were determined for demographic characteristics. Statistical significance was preset at an alpha of 0.05.



EE—started exercise intervention at beginning of chemotherapy; RPE—rating of perceived exertion level

Figure 2. EE Group Change From Phase 1 to Phase 2

Results

Sample Characteristics

Table 1 shows demographic characteristics. The mean age of the sample was 49.12 years (SD = 8.93), and most were Caucasian. The mean KPS score was 87.7 (SD = 8.79). Fifty-seven women received doxorubicin plus cyclophosphamide; four received cyclophosphamide, methotrexate, and fluorouracil; two received doxorubicin, cyclophosphamide, and paclitaxel; two received cyclophosphamide, fluorouracil, and epirubicin; and one received doxorubicin, cyclophosphamide, and fluorouracil. No statistically significant differences were found among demographic and clinical characteristics between the EE and CE groups.

Exercise Frequency, Duration, and Intensity

In the EE group, the average weekly frequency of exercise was 3.6 times (SD = 4.28), the average duration of each exercise session was 42.84 minutes (SD = 18.89), and the mean intensity of exercise was 12.55 on the Borg RPE scale (SD = 3.31) during the intervention (phases 1 and 2). The length of time that the EE group participants were enrolled in the randomized, clinical trial ranged from 19–86 weeks.

In the CE group, the average weekly frequency of exercise was 3.22 times (SD = 1.55), the average duration of each exercise session was 37.84 minutes (SD = 18.79), and the mean intensity of exercise was 12.39 on the Borg RPE scale (SD = 2.95) during the intervention (phase 2). The length of time that the CE group participants were enrolled in the randomized, clinical trial ranged from 6–43 weeks.

Comparison Over Time

EE group change from phase 1 to phase 2: In the EE group, the initial frequency of exercise in phase 1 was estimated as 3.74 times per week (intercept) and decreased slightly every week (π = –0.02), but the change was not statistically significant (p = 0.24). In phase 2, the estimated intercept of exercise frequency decreased slightly by 0.13 from phase 1, but the difference was not significant (p = 0.8). The exercise frequency in phase 2 showed an increased slope of weekly change (π = 0.02); however, the change was not statistically significant (p = 0.27) (see Table 2 and Figure 2). The initial duration in each exercise session in phase 1 was estimated as 37.3 minutes (intercept) and increased significantly and slightly every week in phase 1. The slope (π) was 0.22 (p = 0.025). In phase 2, the estimated intercept of duration increased by 3.24 minutes from phase 1, but the change was not significant (p = 0.13). The slope of weekly change in phase 2 decreased slightly from phase 1 (π_{change} = –0.09); however, the difference was not significant (p = 0.17). The initial intensity level of exercise in phase 1 was estimated as 11.9 (intercept) and increased significantly every week

(π = 0.03, p = 0.02). In phase 2, the estimated intercept of intensity increased by 1.13–13.03 (p = 0.007), but the slope of the weekly change decreased significantly over time in phase 2 (π_{change} = –0.04, p = 0.003).

Comparison of CE and EE groups in phase 2: The initial frequency of exercise of the CE group in phase 2 was estimated as 3.27 times every week and was not significantly different from the EE group (3.87). The CE group change over time was almost flat (< –0.001) and did not differ from the EE group's slightly decreased slope (–0.02) (see Table 3 and Figure 3). The initial duration of each exercise session for the CE group in phase 2 was estimated as 34.71 minutes (intercept) and was significantly lower than the EE group's duration of 43.66 minutes (p = 0.01). The slope of duration in the CE group increased over time (0.218) and was greater than that of the EE group (0.12); however, the difference was not statistically significant. The initial intensity level of exercise in the CE group during phase 2 was estimated as 12.34 (intercept) and was not significantly different from the intercept of 12.91 for the EE group. No significant difference was found in the slope of change over time in exercise intensity between the two groups.

In summary, the results suggested that exercise frequency had a decreasing trend during and after treatment in the EE group, but the change was not statistically significant. The weekly exercise duration increased significantly during treatment, but the increase was not significant after treatment. The exercise intensity increased significantly during treatment and decreased significantly after treatment. The comparison of EE and CE groups during the post-treatment period showed that the initial exercise duration of the CE group was significantly lower than that of the EE group. The CE group had a greater increase in weekly exercise duration compared to the EE group, but this difference was not significant. No significant differences were found in change over time in exercise frequency and intensity between the CE and EE groups.

Table 3. Linear Mixed Model of Exercise Duration, Frequency, and Intensity in the CE and EE Groups During Phase 2

Parameter	Est	SE	p	95% CI
Frequency (times per week)				
Intercept in CE group[a]	3.27	0.24	< 0.001	[2.8, 3.75]
Intercept change in EE Group[b]	0.59	0.33	0.07	[–0.06, 1.24]
Slope in CE group[c]	–0.001	0.01	0.99	[–0.03, 0.03]
Slope change in EE group[d]	–0.02	0.02	0.27	[–0.06, 0.02]
Duration (minutes per session)				
Intercept in CE group[a]	34.71	2.32	< 0.001	[30.07, 39.34]
Intercept change in EE group[b]	8.95	3.18	< 0.01	[2.59, 15.31]
Slope in CE group[c]	0.22	0.17	0.19	[–0.11, 0.55]
Slope change in EE group[d]	–0.1	0.23	0.66	[–0.56, 0.36]
Intensity (average RPE score)				
Intercept in CE group[a]	12.34	0.34	< 0.001	[11.67, 13.01]
Intercept change in EE group[b]	0.58	0.46	0.21	[–0.34, 1.49]
Slope in CE group[c]	0.01	0.02	0.71	[–0.03, 0.04]
Slope change in EE group[d]	–0.01	0.02	0.62	[–0.06, 0.04]

[a] Baseline exercise data of CE group in phase 2

[b] Difference of phase 2 initial exercise data in EE group compared to CE group

[c] Weekly change of CE group in phase 2

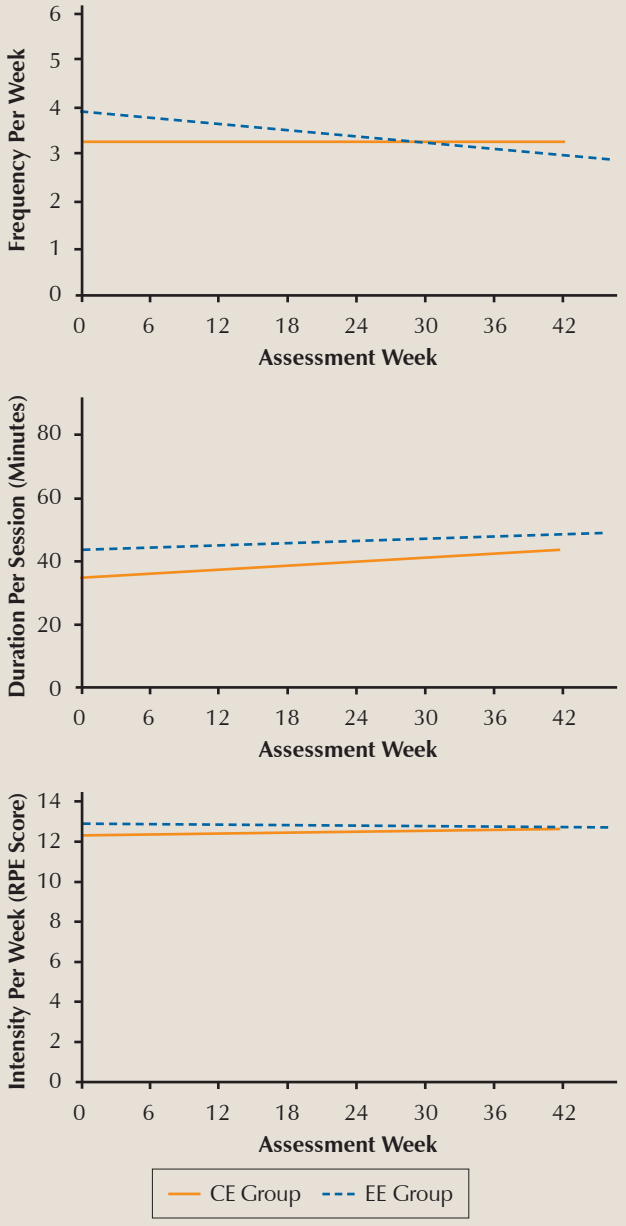
[d] Difference of weekly change in EE group compared to CE group in phase 2

CE—started exercise intervention at completion of chemotherapy; CI—confidence interval; EE—started exercise intervention at beginning of chemotherapy; Est—estimate; RPE—rating of perceived exertion level; SE—standard error

Discussion

The current study is among the first to examine and compare longitudinal exercise behaviors when an exercise intervention is initiated at the start of or after chemotherapy among women with breast cancer. The results provided important information on exercise habits that can be accomplished by patients with breast cancer during a stressful time. A limitation of the study was the reliance on self-report exercise logs and unmonitored home exercise, which was implemented in the original intervention. The overall results suggested that women with breast cancer who started an exercise intervention at the beginning of chemotherapy could maintain the same level of exercise frequency per week throughout the chemotherapy treatment period and continue the habit for an equivalent time after they finished their treatment. The sustainability can last more than one year. Concurrently, women could increase their weekly exercise duration and intensity throughout their chemotherapy treatment. However, after treatment they could not maintain the exercise intensity at the same or increasing level as they could in the treatment period.

The results from the post-treatment period comparison between the two groups suggested that women with breast cancer who started the exercise intervention during the postchemotherapy period (i.e., the CE group) had shorter initial exercise duration per session than those who started the exercise intervention at the beginning of chemotherapy (i.e., the EE group). The change over time in exercise frequency, intensity, and duration of women in the CE group was not different from that of women who started the exercise intervention at the beginning of chemotherapy in the EE group. The overall results suggested that even at the post-treatment period, patients who started the exercise intervention at the beginning of chemotherapy had better initial exercise frequency, duration, and intensity compared to those who started exercise at the post-treatment stage. The insignificant difference between the two groups in change over time post-treatment could indicate that having



CE—started exercise intervention at completion of chemotherapy; EE—started exercise intervention at beginning of chemotherapy; RPE—rating of perceived exertion level

Figure 3. Comparison of CE and EE Groups During Phase 2 Only

patients initiate exercise after they finish chemotherapy treatment does not significantly strengthen their exercise behaviors. Therefore, staring exercise at the beginning of chemotherapy appears to result in better sustainability of exercise behaviors, continuing to the post-treatment stage.

Strategies to help patients sustain their initial higher levels of exercise habits may be needed during the post-treatment period. As the results indicated in this analysis, exercise intensity decreased significantly for women with breast cancer during the post-treatment period when they started the exercise intervention at the beginning of treatment and needed to maintain a longer length of time in the intervention. An explanation may be that patients are in better physical condition to start an exercise regimen at the start of chemotherapy. Other factors may contribute to the change in exercise behavior. As reported by Wu, Dodd, and Cho (2008), women with breast cancer reported that the worst levels of fatigue peaked immediately after chemotherapy. The change in symptom experience may have an effect on exercise behaviors. However, barriers to adherence to an exercise regimen also should be noted. In an earlier analysis of the parent study by Dodd et al. (2010), the results suggested the barriers to adherence in the post-treatment period were predominately life-related (e.g., work, vacation, illness, family obligations) for both the EE and CE groups. The finding suggests that commitment and time availability for exercise behaviors in women with breast cancer could be compromised because of the demand to return to normalcy for work and life obligations after cancer treatment. Sprod et al. (2010) suggested that the longer patients can maintain exercise behaviors, the greater the overall benefit; therefore, future research should explore innovative and patient-friendly approaches to help patients integrate exercise in daily life and sustain a targeted exercise goal. Additional study of the facilitators and barriers to maintaining long-term exercise habits among patients with cancer also are recommended.

Conclusions and Implications for Nursing Practice

The benefit of exercise is evident for patients with breast cancer. As recommended by the Oncology Nursing Society's (n.d.) Clinical Resources Web page, exercise as an intervention can help manage symptoms such as fatigue, anxiety, and depression. Clinicians should encourage patients with breast cancer to start exercise at the beginning of chemotherapy treatment and continue for as long as possible. The benefits of exercise and the American College of Sport Medicine guidelines (Schmitz et al., 2010) should be communicated routinely to patients. The monitoring and assessment of exercise frequency, duration, and intensity can become part of the standardized assessment when patients have regular visits with their healthcare providers and treatments. In addition, regular assessment can help reinforce and remind patients about their exercise habits.

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Digital Object Identifier: 10.1188/12.ONF.91-97

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