Physical Activity in Women Receiving Chemotherapy for Breast Cancer: Adherence to a Walking Intervention

Karen K. Swenson, PhD, RN, AOCN®, Mary Jo Nissen, PhD, MPH, and Susan J. Henly, PhD, RN

Purpose/Objectives: To describe and predict adherence to a physical activity protocol for patients with breast cancer receiving chemotherapy.

Design: Longitudinal, observational study.

Setting: Cancer center in the upper Midwestern region of the United States.

Sample: 36 patients with breast cancer aged 40–55 years who were receiving adjuvant treatment.

Methods: A longitudinal study was conducted within a randomized clinical trial comparing the effects of physical activity versus bisphosphonates on bone mineral density. Participants randomized to physical activity were advised to walk 10,000 steps per day and received initial physical therapy consultation and ongoing motivational interviewing. Multilevel modeling was used to identify variables that predict adherence.

Main Research Variables: Adherence to the 10,000-step protocol was estimated with total steps and mean steps per day.

Findings: Thirty-six women were enrolled in the physical activity group; 29 provided step data. The mean total steps per participant for the first six weeks was 280,571 (SD = 111,992), which is 67% of the prescribed steps. Excluding days when no steps were recorded, the mean steps per day for the initial six-week period was 7,363 (SD = 2,421), a 74% adherence rate. A significant linear increase occurred in steps per day after chemotherapy in a treatment cycle ($p < 0.0001$). Baseline inactivity predicted adherence.

Conclusions: Adherence to the walking program was compromised during chemotherapy but improved after chemotherapy completion.

Implications for Nursing: Knowing that chemotherapy predicts adherence to a walking protocol is useful for selecting the type, timing, and intensity of physical activity interventions.

Breast cancer is the most common cancer diagnosed among women in the United States, with an incidence of more than 192,000 cases of invasive breast cancer in 2009 (Jemal et al., 2009). Although age-adjusted breast cancer incidence rates have leveled off, death rates from breast cancer have declined steadily since 1990, resulting in an increase in breast cancer survivors. Currently, more than 2.5 million breast cancer survivors live in the United States (Horner et al., 2009). Therefore, long-term health-related issues are very relevant for patients who may live for many years after breast cancer diagnosis.

Treatment for breast cancer generally includes initial surgery with either a mastectomy or lumpectomy and removal of axillary lymph nodes on the ipsilateral side. After surgical healing, chemotherapy is administered to most patients with invasive breast cancer ("Adjuvant Therapy for Breast Cancer," 2000). Chemotherapy for breast cancer often is associated with alopecia, fatigue, neuropathy, nausea, and muscle and joint pain (Yarbro, Frogge, & Goodman, 2005). Aromatase inhibitors or tamoxifen treatments are recommended for hormone receptor–positive breast cancer, which occurs in approximately 75% of cases ("Adjuvant Therapy for Breast Cancer," 2000). Hormone treatment may cause hot flashes, sleep disturbances, loss of bone mineral density (BMD), and muscle and joint pain (Yarbro et al., 2005). In addition to physical symptoms related to treatments, psychological symptoms such as depression and anxiety associated with the diagnosis of a serious illness may be present. Treatment-related side effects and the demands of undergoing multiple cancer treatments while maintaining normal activities of daily living (e.g., employment, child care) can lead to physical deconditioning during cancer treatments (Irwin et al., 2003).

Long-term sequelae resulting from breast cancer treatments also are troublesome for cancer survivors. Prolonged fatigue may persist long after cancer treatments are completed. Chemotherapy often leads to early onset of menopause in younger women (Bines, Oleske, & Cobleigh, 1996), which, in turn, may be associated with other long-term consequences such as BMD loss and weight gain.

Evidence is increasing that physical activity interventions have beneficial effects on the physical and psychological side effects of breast cancer (Courneya, 2003; Pinto & Maruyama, 1999). Psychological benefits include enhancements in mood and vigor and decreases in depression and anxiety (Courneya & Friedenreich, 1997). Physical benefits include improvements in cancer-related symptoms such as fatigue and nausea, as well as other health improvements in cardiovascular fitness, bone density, sleep quality, and weight management (Courneya, 2003; Ingram, Courneya, & Kingston, 2006; Mock et al., 1997; Schwartz, 2000a, 2000b; Schwartz, Winters-Stone, & Gallucci, 2007). Studies have found that greater levels of physical activity are associated with improved overall survival from cancer (Abrahamson et al., 2006; Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005; Pierce et al., 2007).

Despite the widespread evidence of the benefits of being physically active, only 31% of U.S. adults engage in regular physical activity (National Center for Health Statistics, 2008). In patients receiving breast cancer treatment, adherence to a regular physical activity program is even more challenging because of the demands of undergoing multiple cancer treatments (Irwin et al., 2003). To confidently infer that a physical activity intervention affects BMD or symptoms and quality-of-life outcomes, participants must adhere to expected levels of program participation (Friedman, Furberg, & DeMets, 1998; Santacroce, Maccarelli, & Grey, 2004).

Exercise adherence is defined as the extent to which individuals in the exercise group perform the exercise prescription (Courneya, Segal, et al., 2004). Previous studies have reported the proportion of exercise sessions attended or the number of hours per week of exercise. The studies reported adherence rates ranging from 65%–84% (Courneya, Blanchard, & Laing, 2001; Courneya, Friedenreich, et al., 2004; Courneya, Friedenreich, Sela, Quinney, & Rodes, 2002; Courneya, Segal, et al., 2004; Mock et al., 2001; Pickett et al., 2002; Schwartz, 2000a; Segal et al., 2001). Measuring adherence to home-based physical activity intervention requires methodology that captures activities of daily living such as housework and gardening in addition to intentional aerobic exercises such as walking and jogging and leisure activities such as bowling and golfing. In a home-based physical activity program, activities of daily living, aerobic exercises, and leisure activities all are important components of physical activity and can be captured by a pedometer.

The purpose of this study was to evaluate the integrity and feasibility of a 12-month home-based physical activity intervention in pre- and perimenopausal women receiving chemotherapy for breast cancer. Data were obtained as part of a randomized, controlled trial designed to compare the impact of bisphosphonates (usual care activity) versus a prescribed physical activity intervention on BMD during breast cancer treatment. Participants who were randomized to the physical activity intervention were prescribed 10,000 steps per day. Specific aims were to (a) estimate adherence to the physical activity walking prescription with pedometer information; (b) compare indices of adherence with pedometer readings and self-report physical activity questionnaires, (c) describe daily patterns of physical activity during the first two chemotherapy cycles (days 1–14), and (d) evaluate potential predictors of adherence.

Theoretical Framework

The Theory of Planned Behavior (Ajzen, 1991; Blanchard et al., 2003) and Social Cognitive Theory (Bandura, 1997; McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003) have been used widely to explicate adherence to exercise. However, neither of the theories considers the profound physiologic effects of breast cancer treatments on exercise adherence. A more comprehensive model, the Physical Activity Adherence Model (PAAM), was developed for this study to measure, predict, and intervene in the promotion of physical activity over time during breast cancer treatments (see Figure 1). The PAAM includes physical variables, psychological variables, social variables, history of previous physical activity, activities of daily living, and critical health events overlaid on the treatment trajectory. The PAAM can be used to test predictive models of adherence, develop interventions, and recognize changes in symptoms depending on individual treatment trajectories. The PAAM is a dynamic model focused on description and explanation of the experiences of individual women over time (Henly, 2007) that served as the foundation for theory about change, design of the study, and analysis of data (Collins, 2006).

Methods

Study Design

This was a longitudinal, observational study to evaluate the integrity of a physical activity intervention in a randomized, controlled trial evaluating the effects of physical activity versus bisphosphonates on BMD in women undergoing treatment for breast cancer. In this analysis, only participants in the physical activity group were included. This study provides the opportunity to evaluate patterns and predictors of adherence to a prescribed walking program over time in a group of patients with breast cancer undergoing active treatment.

Setting and Sample

This study was conducted at Park Nicollet Clinic, an outpatient cancer center in the upper Midwestern region of the United States that diagnoses and treats about 400 new breast cancer cases annually. The Park Nicollet and University of Minnesota institutional review boards reviewed and approved the study. Consecutive women diagnosed with breast cancer from August 2003–April

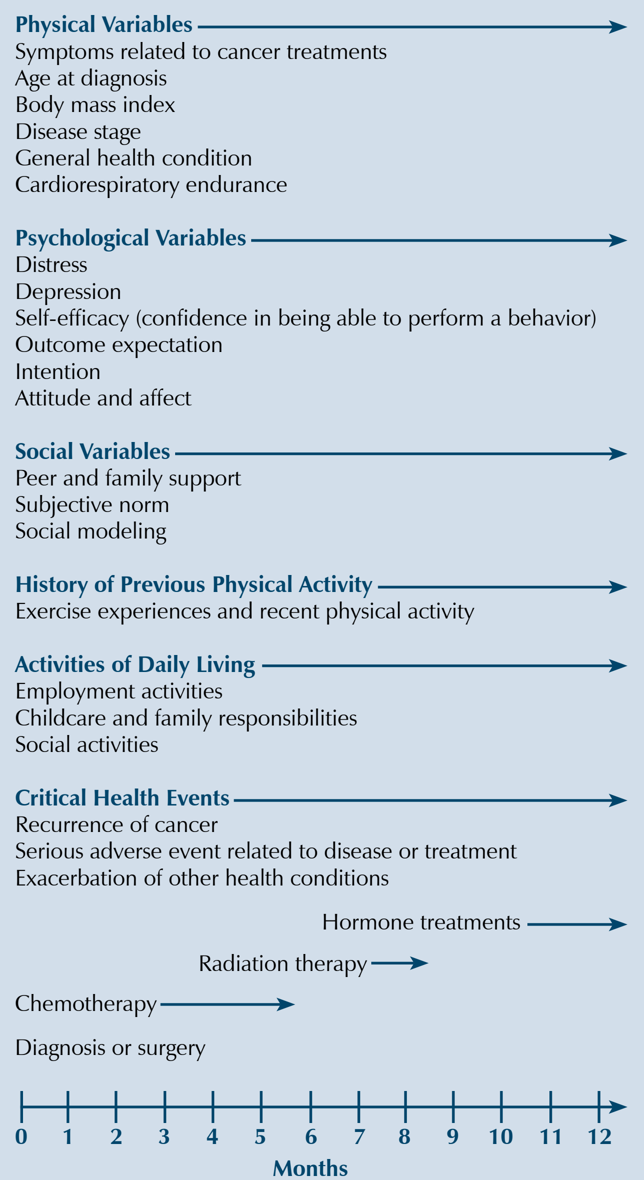


Figure 1. Physical Activity Adherence Model During Breast Cancer Treatment

2006 were invited to participate in the study if they were diagnosed with stage I–III invasive breast cancer, were aged 40–55 and within 24 months of having their last menstrual period, were within one month of beginning adjuvant or neoadjuvant chemotherapy, had a baseline lumbar spine and total hip BMD t score ≥ –2 standard deviations, were able to read and write English, and signed the consent form. Patients were excluded if they had health conditions that contraindicate exercise participation, previous treatment with bisphosphonates, laboratory evidence of renal or hepatic disease, previous treatment for another cancer, transrectus abdominus muscle flap reconstruction, a positive pregnancy test, or mental illness that prevented them from giving informed consent.

Study Procedures

After informed consent was obtained, baseline measurements were performed before patients began the intervention. BMD of the lumbar spine, total hip, and whole body, as well as body composition, were measured with dual-energy X-ray absorptiometry (DEXA) scans. Physical activity was measured with the Paffenbarger Physical Activity Questionnaire (PPAQ), a self-administered survey that quantifies the amount and intensity of physical activity participation and has been validated in previous studies (Cauley, LaPorte, Sandler, Schramm, & Kriska, 1987; Paffenbarger, Blair, Lee, & Hyde, 1993). After being assigned to the walking intervention, patients were given a Walk 4 Life LS2500 pedometer (Walk 4 Life Inc.) and asked to record daily step counts. Crouter, Schneider, Karabulut, and Bassett (2003) evaluated the validity of electronic pedometers and found them to be accurate within 1% of actual steps. Participants were instructed to wear the pedometer every day for the first six weeks of the study and then for seven consecutive days at 3, 6, 9, and 12 months after enrollment. Self-report of pedometer readings has been shown to be a valid and reliable measure of total physical activity except swimming and bicycling (Croteau, 2004; Croteau, Richeson, Farmer, & Jones, 2007; Stel et al., 2004). Adherence to walking 10,000 steps per day correlates with physiologic measures such as decreased blood pressure and sympathetic nerve activity (Iwane et al., 2000).

Other cancer-related symptoms such as fatigue, pain, nausea, sleep disturbance, distress, and depression were measured with the M.D. Anderson Symptom Inventory (MDASI), the Schwartz Cancer Fatigue Scale (SCFS), and the Short Form-36 (SF-36). The instruments have been established with previous reliability and validity testing (Cleeland et al., 2000; Schwartz, 1998, 1999; Teixeira et al., 2002; Ware & Sherbourne, 1992). Demographic and treatment-related information, including age, race, employment status, childcare responsibilities, marital status, and treatment information, were collected on the Visit Assessment Form. The Visit Assessment Form, PPAQ, MDASI, SCFS, and SF-36 were collected at baseline and at 3, 6, 9, and 12 months.

Walking Protocol

Participants randomized to the physical activity arm of the parent study received a consultation with a trained physical therapist, a pedometer (to track the number of steps per day), an exercise video from the National Osteoporosis Foundation, and an exercise log to record the number of steps per day and the type of activity completed. Participants were taught to monitor their pulse rate and calculate their target heart range so that they stayed within a safe exercise zone, which resulted in a cardiovascular training effect. Participants were enrolled within one month of beginning chemotherapy and completed questionnaires before beginning the intervention. Participants were advised to reach a goal of a minimum of 10,000 steps per day, which is equivalent to approximately 5 miles of walking. This goal has been used in other programs to promote physical activity among sedentary adults (Bravata et al., 2007; Iwane et al., 2000).

At regular chemotherapy visits, participants were asked to bring in their exercise logs, and the research nurse made recommendations to maintain or increase the number of steps per day based on individual exercise logs. Research nurses conducted motivational interviewing with participants on an ongoing basis. Motivational interviewing is a counseling technique derived from a social cognitive theoretical framework and is designed to help move a person along the desired path of behavior change (Miller & Rollnick, 1991; Wankel, Yardley, & Graham, 1985). Motivational interviewing sessions were individualized to each participant based on life circumstances and symptoms related to treatment.

Adherence Outcomes

Adherence is the extent to which women in the walking group performed the exercise prescription. Adherence was operationalized in two ways: total number of steps and mean number of steps per day on days with any steps recorded. Pedometer-based measurements reflected activities of daily living such as housework, gardening, and yard work in addition to intentional aerobic exercises such as walking or jogging and leisure activities such as bicycling, golfing, and bowling. A secondary measure of adherence was obtained through the PPAQ, and the relation between PPAQ responses and pedometer measurements was examined.

Analysis Plan

Adherence was estimated in two ways with pedometer information. The total number of steps was calculated for participants during each of the first six weeks of the study and during the week of step data collection at 3, 6, 9, and 12 months. Means and standard deviations of the values were calculated. In addition, mean and standard deviation of the number of steps per day on days with any steps recorded were calculated for the same time periods. In calculating mean steps per day, the researchers excluded days on which no steps were recorded and counted them as missing. Nine participants provided complete step data during the first six weeks of the study, and 19 participants (66%) completed daily step logs on 90% or more during the first 42 days.

To compare indices of adherence based on pedometer information and PPAQ scores, Spearman correlation coefficients were computed between responses to specific questions on the PPAQ and mean steps per day. Data were obtained during week 1 and at 3, 6, 9, and 12 months.

A linear mixed-effects (hierarchical) model was estimated to describe individual trajectories of adherence over the course of two chemotherapy cycles and to identify predictors of adherence over time (Raudenbush & Bryk, 2002). Time was measured in days. Days were nested within the first two chemotherapy cycles while participants were on the study, such that the day on which chemotherapy was administered was designated day 1 for each cycle. Data from days 1–14 in each cycle were modeled. Within-person (level 1) linear models described individual walking trajectories and variability in patterns in steps per day over time. Chemotherapy cycle and other potential predictors of adherence included in the PAAM were used to predict initial status (intercept) and the true rate of change (slope) in walking trajectories for each participant in univariate analyses. Multivariate analysis included covariates that were significant on univariate analysis. PROC MIXED was used to estimate the model.

In the correlational analysis, a strict criterion of 0.01 was used to account for multiple tests. Lenient nominal p values of 0.1 were used to identify covariates to be included in the multivariate analysis. A conventional nominal p value of 0.05 was reserved for testing significance of parameter estimates in the mixed-effects model.

Results

Demographics

A total of 36 women were enrolled in the walking protocol; of that group, 29 remained in the study and provided pedometer data. The seven (19%) who dropped out said that demands of their treatments, follow-up appointments, and daily lives hindered their ability to participate. Baseline characteristics of the 29 participants are shown in Table 1. Mean age was 46.9 years (range = 40–54). Participants were predominantly Caucasian (90%), employed full-time (83%), and had one or more children at home (55%). Mean body mass index (BMI) was 26.7 kg/m^2, which is in the overweight category (BMI of 25–30 kg/m^2). Mean body composition measured on the whole-body DEXA scan was 34.1% fat. Most participants (69%) were premenopausal at the time of study enrollment.

All participants had breast surgery; 41% had a mastectomy and 59% had a lumpectomy. Most patients (83%) had a sentinel lymph node dissection with removal of one to four axillary lymph nodes, whereas only 17% had a more extensive axillary lymph node dissection. All patients received at least four cycles of chemotherapy

Table 1. Baseline Characteristics and Treatments Administered

Characteristic	n	%
Age at diagnosis (years)		
40–45	11	38
46–50	10	35
51–55	8	28
Race		
Caucasian	26	90
Asian	2	7
African American	1	3
Employment status		
Full-time	24	83
Part-time	–	–
Not employed	5	17
Children at home		
0	13	45
1–3	15	52
4 or more	1	3
Body composition		
Less than 25% fat	1	3
25%–35% fat	14	48
More than 35% fat	14	48
Body mass index		
Less than 25	12	41
25–30	10	35
More than 30	7	24
Menopausal status		
Premenopausal	20	69
Peri- or postmenopausal	9	31
Cancer stage		
I	13	45
II or II	16	55
Breast surgery		
Mastectomy	12	41
Lumpectomy	17	59
Node dissection		
Sentinel lymph node biopsy	24	83
Auxiliary lymph node dissection	5	17
Reconstructive surgery (breast implant)		
Yes	2	7
No	27	93
Chemotherapy		
Doxorubicin and cyclophosphamide (four treatments)	13	45
Doxorubicin and cyclophosphamide plus taxane (eight treatments)	14	48
Other	2	7
Radiation treatment		
Yes	19	66
No	10	35
Hormone treatment		
Tamoxifen	16	55
Aromatase inhibitor	5	17
None	8	28

N = 29

Note. Because of rounding, not all percentages total 100.

with doxorubicin and cyclophosphamide. This treatment was followed by four additional cycles of paclitaxel or docetaxel for 48% of patients. Nineteen participants (66%) also received external beam radiation therapy to the breast delivered Monday through Friday daily for approximately six weeks after completion of chemotherapy. Tamoxifen was prescribed for the majority of patients receiving hormone treatment (55% of participants), whereas an aromatase inhibitor was prescribed for 17% of participants for a period of five years following completion of chemotherapy.

Pedometer and Self-Reported Adherence

Indices of physical activity from pedometer readings versus responses on the PPAQ showed weak agreement. Spearman correlations, calculated from results at baseline and at 3, 6, 9, and 12 months, never exceeded 0.52 in absolute value, and with $p \leq 0.01$ as a criterion for multiple comparisons, only two were significant (see Table 2). At baseline, self-reported time spent sleeping or reclining was negatively correlated with mean steps per day; at 6 months, patients who reported that they "ought to exercise more" recorded fewer steps per day. However, some items on the PPAQ, such as number of flights of stairs walked up each day or level of exertion when exercising, would not necessarily be expected to correlate with steps per day, and of those that would be expected to agree, almost all were in the expected direction. For example, correlations between number of blocks walked per day reported on the PPAQ and steps per day from pedometer readings, although not significant, were positive at every time period, with r ranging from 0.19–0.38.

Patterns of Physical Activity and Walking

Total steps per week and mean steps per day on days with any steps recorded provided complementary measures of how physical activity changed during and after treatment (see Table 3). Both measures were lower in the first six weeks of the study during chemotherapy but increased at 3, 6, and 9 months before dropping somewhat at 12 months. Across the first six weeks, the mean number of total steps was 280,571 (SD = 111,992), for a 67% adherence rate, and the mean number of steps per day was 7,363 (SD = 2,421), for a 74% adherence rate. Linear regression analysis of the 14 days following each of the first two chemotherapy cycles showed a significant positive linear increase in steps per day with the number of days after treatment ($p < 0.0001$) (see Figure 2). This pattern was equally strong in the first and second chemotherapy cycles.

Predictors of Adherence

Table 4 shows results of univariate analyses of predictors of steps per day during the first 14 days following each of the first two chemotherapy treatments during the study. Significant predictors include chemotherapy day ($p < 0.0001$), hours spent sleeping or reclining at baseline ($p < 0.0001$), fatigue based on the SCFS total score at baseline ($p = 0.04$), and cancer stage ($p = 0.05$).

Table 2. Spearman Correlations Between Self-Report and Pedometer

Paffenbarger Physical Activity Questionnaire Item	Pedometer Steps Per Day: Week 1	Month 3	Month 6	Month 9	Month 12
Vigorous physical activity (hours per day)	0.17	0.28	0.21	0.09	–0.32
Moderate physical activity (hours per day)	0.01	0.09	0.36	0.18	–0.04
Light physical activity (hours per day)	0.13	0.17	0.18	–0.31	0.06
Sitting (hours per day)	0.03	0.02	0.32	–0.08	–0.22
Sleeping or reclining (hours per day)	–0.5*	–0.02	–0.05	–0.33	–0.21
Walking (blocks per day)	0.24	0.27	0.29	0.19	0.38
Walking pace (on a 4-point scale from casual to brisk)	0.13	0.06	0.29	0.22	–0.05
Stair climbing (flights per day)	0.02	–0.47	–0.23	–0.10	0.07
Do enough exercise (1) versus ought to exercise more (2)	0.32	–0.29	–0.52*	–0.48	–0.40
Engage in regular activity that is aerobic? Yes (1) versus no (2)	–0.14	–0.07	–0.02	–0.06	–0.16
Regular aerobic activity (times per weeks)	0.18	0.15	0.36	0.13	0.12
Level of exertion (on a scale of 0–10)	0.24	0.12	0.18	0.39	0.43

* $p \leq 0.01$

The effect of chemotherapy day, described in the preceding paragraph, reflected the linear increase in steps with days following treatment. Patients who at baseline reported more hours spent sleeping or reclining recorded significantly fewer steps per day. Similarly, patients who at baseline reported more fatigue on the SCFS also recorded fewer steps. Patients with stage I breast cancer tended to record fewer steps per day than patients who had stage II or III breast cancer. When the four factors were entered simultaneously into the multivariate analysis, only chemotherapy day ($p < 0.0001$) and hours per week spent sleeping or reclining at baseline ($p = 0.04$) were significant predictors of the mean number of steps per day (see Table 4).

Discussion

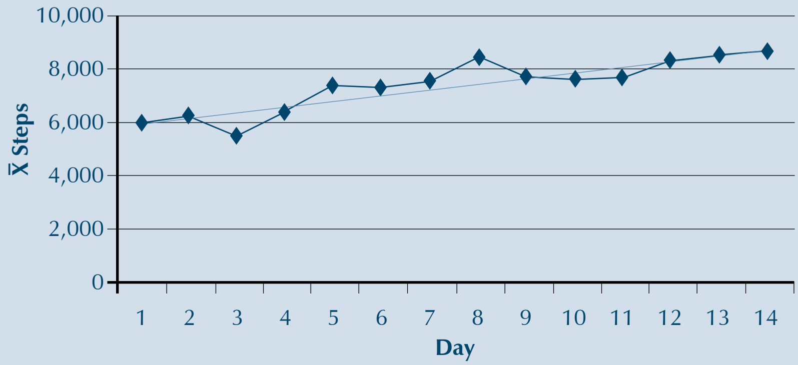
Previously published data support that participating in regular physical activity provides physical and psychological benefits to patients with breast cancer. However, initiating or sustaining activity such as walking is challenging during active cancer treatment. In this study, researchers asked participants to walk 10,000 steps per day during their treatments. This proved to be difficult for participants and may have been an overly ambitious goal given the symptoms experienced during chemotherapy. A significant proportion of patients (19%)

Table 3. Adherence Measures Over Time

Time	Total Steps: N	$\bar{X}$	SD	Adherence[a] (%)	Steps Per Day: $\bar{X}$	SD	Adherence[b] (%)
Week 1	29	48,442	17,584	69	7,453	2,519	75
Week 2	29	46,395	20,587	66	7,315	2,746	73
Week 3	29	46,721	20,417	67	7,249	2,889	72
Week 4	29	45,087	22,556	64	7,498	2,620	75
Week 5	29	46,102	19,685	66	7,200	2,637	72
Week 6	29	51,179	24,639	73	7,924	3,135	79
Month 3	25	61,110	15,465	87	8,730	2,209	87
Month 6	26	63,994	18,884	91	9,402	2,653	94
Month 9	24	67,861	19,990	97	9,838	2,758	98
Month 12	23	62,959	24,559	90	9,429	3,488	94

[a] $\bar{X}$ divided by 70,000
[b] $\bar{X}$ divided by 10,000

withdrew from the study after enrollment in the physical activity arm, reporting that the demands of their treatments made participating in the intervention too difficult. Among patients who completed the study, adherence was less than ideal, averaging less than 75% of steps prescribed during the first six weeks. After treatment was completed, adherence increased to 87%–98% at 3, 6, 9, and 12 months.



Note. A positive linear increase exists between the steps per day and the number of days after chemotherapy treatment ($p < 0.0001$).

Figure 2. Average Number of Steps Taken on Days 1–14 Following First and Second Chemotherapy Treatments

When comparing indices of adherence, correlations between pedometer-based measures and the PPAQ were in the expected direction. Only two of the correlations were statistically significant, possibly because of a small sample and perhaps also because several items on the PPAQ address aspects of physical activity that are not step-based. Correlations between pedometer steps per day and blocks walked per day from the PPAQ were moderately strong, ranging from 0.19–0.38. Pedometer readings have been shown to be an accurate measurement of daily physical activity. Future studies should be cautious in relying on self-report and include biophysical measurements such as those obtained by pedometers. Additional data on the relationship between self-reported walking and pedometer readings would be useful.

The most important predictor of adherence was the day of cycle during chemotherapy. Fatigue levels increase sharply in the first days after chemotherapy administration (Schwartz, 2000a). Although participants were engaged in the study and motivated to remain physically active during treatment, doing so was impossible during the days immediately following chemotherapy treatment because of fatigue or other treatment-related symptoms. Other factors such as activities of daily living may have influenced adherence. Most women who participated in this study were working full-time and had childcare responsibilities in addition to their multiple clinic appointments for treatment and follow-up care.

Previous studies have reported that physical activity levels prior to beginning a study predicted the degree of engagement in regular exercise after study enrollment (Courneya & Friedenreich, 1997; Pickett et al., 2002). In the current study, the baseline measure of hours per day spent sleeping or reclining was inversely related to adherence. This finding suggests that deconditioning prior to study entry interfered with participants' ability to adhere to the physical activity prescription during the study.

Other studies have personalized the exercise prescription according to participants' baseline fitness level, exercise history, and personal preferences (Courneya, Friedenreich, et al., 2004). Participants in the current study may have been more successful with a personalized exercise prescription because they would have felt a greater sense of control and accomplishment. Previous research has shown that pedometer-based interventions increase participants' steps per day, decreasing BMI, decreasing blood pressure, and improving low-density lipoprotein levels (Bravata et al., 2007). However, what "dose" of physical activity is necessary to produce an effect on BMD and other oncology-related symptoms is unknown, and personalized exercise prescriptions may make answering that question more difficult.

Motivational interviewing, focused on reinforcing the positive benefits of physical activity, was a critical component of assessment and promotion provided to all participants in the walking protocol. It provided a framework for counseling patients in a participatory format. Having the activity log available for discussion during motivational interviewing sessions was very useful. Participants were open to discussions about the barriers to fully participating and potential ways to overcome the barriers.

This was the first oncology study to use pedometer-based measurements of physical activity. Previous studies have relied on self-reported questionnaire data (Courneya, Friedenreich, et al., 2004; Courneya, Segal, et al., 2004), daily diaries (Pickett et al., 2002), or aerobic fitness testing (Kolden et al., 2002) to determine adherence. In the current study, pedometers added a degree of objectivity that enhanced the measurement of physical activity, provided a mechanism of daily feedback to participants about how physically active they had been during the course of a day, and served as a motivator for increasing activity to achieve the goal of 10,000 steps per day. Daily logs with step counts served as a beginning point for discussions about physical activity and helped direct motivational interviewing sessions.

The sample size in this study was relatively small. However, each participant provided information

Table 4. Predictors of Steps Per Day

Predictor	PAAM Category	Parameter Estimate	F
Univariate Analysis			
Age (continuous)	Physical	–162.1	1.96
Percentage body fat	Physical		
20%–35%		–112.3	0.01
More than 35%		Referent	
Body mass index	Physical		
Less than 25		–283.5	
26–30		267.7	
More than 30		Referent	
Cancer stage	Physical		3.86*
Stage I (localized)		–1,768.8	
Stage II or III (regional)		Referent	
SCFS total score	Physical	–229	4.07*
MDASI total score (continuous)	Physical	–33.2	1.68
Physical Component Scale (SF-36)	Physical	28.6	0.33
Mental Component Scale (SF-36)	Psychological	69.1	1.87
Employment status	Activity of daily life		0.37
Full-time		–768.9	
Not employed		Referent	
Children at home	Activity of daily life		0.02
Yes		130.9	
No		Referent	
Type of surgery	Treatment		0.18
Mastectomy		–411.2	
Lumpectomy		Referent	
Type of biopsy	Treatment		1.88
Axillary lymph node dissection		1,681.3	
Sentinal lymph node dissection		Referent	
Chemotherapy day	Treatment	229.1	49.74**
Chemotherapy cycle	Treatment		
Cycle 2		–145.5	0.24
Cycle 1		Referent	
Radiation therapy	Treatment		2.28
Yes		1,461.8	
No		Referent	
Hours per week (PPAQ)			
Sleeping or reclining	Previous physical activity	–111.1	14.72**
Sitting	Previous physical activity	–16	0.22
Light physical activity	Previous physical activity	–5.5	0.05
Moderate physical activity	Previous physical activity	–28.2	0.63
Vigorous physical activity	Previous physical activity	12.5	0.07
Times per week of regular activity (PPAQ)	Previous physical activity	38.8	0.02
Usual level of exertion during physical activity (PPAQ)	Previous physical activity	134.5	0.22
City blocks walked daily (PPAQ)	Previous physical activity	27.3	1.05
Walking pace (PPAQ)	Previous physical activity		0.56
Casual or strolling		–1,937.3	
Average or normal		100.3	
Fairly brisk, brisk, or striding		Referent	
Flight of steps taken daily (PPAQ)	Previous physical activity	14.6	0.06
View of exercise (PPAQ)	Previous physical activity		2.41
Do enough exercise		1,484.1	
Ought to exercise more		Referent	
Multivariate Analysis			
Chemotherapy day	Treatment	196.4	46.82**
Hours per week sleeping or reclining (PPAQ)	Previous physical activity	–75.4	4.14*
Cancer stage	Physical		0.89
Stage I		–911.9	
Stage II or III		Referent	
Fatigue (SCFS total score)	Physical	–92.4	0.69

*p < 0.05; **p ≤ 0.0001

MDASI—M.D. Anderson Symptom Inventory; PAAM—Physical Activity Adherence Model; PPAQ— Paffenbarger Physical Activity Questionnaire Item; SCFS—Schwartz Cancer Fatigue Scale; SF-36—Short Form-36 about adherence frequently over a long period of time. Sample size, duration, and frequency of observation all contribute to generalizability of findings from studies of individual change (Raudenbush & Bryk, 2002). In the current study, frequent observation of adherence was critical because adherence was expected to change rapidly over the course of a chemotherapy cycle and the change would not have been detectable without frequent observations.

The 19% dropout rate was a limitation of the study. Participants said that they dropped out because the demands of treatments, follow-up appointments, and daily life hindered their ability to participate in the protocol. This may have caused an overestimation of adherence. Participants were recruited from one medical center and were primarily Caucasian. Replication in other settings and racial and ethnics groups is needed to improve generalizability of the findings.

This study has implications for nursing practice and research. For clinical practice, physical activity interventions should be tailored to chemotherapy treatment cycle. Patients should be told that their ability to participate in physical activity will improve over time and that they should not get discouraged if they have difficulty maintaining their normal physical activity for several days after chemotherapy treatments. Additional nursing research focused on evaluation of the type, timing, and intensity of physical activity interventions in conjunction with symptom trajectories will help to elucidate the patient experience during chemotherapy and to develop tailored nursing interventions. Further nursing research also will be required to evaluate the dose and type of exercise required to produce changes in BMD in this vulnerable patient group.

In summary, adherence to a regular physical activity program was difficult to maintain during acute chemotherapy treatment but improved with each chemotherapy cycle and after chemotherapy was completed. Patients should be advised that they may have difficulty exercising immediately after chemotherapy treatments but that it should improve gradually over time until the next treatment. Motivational interviewing techniques may be a useful framework for counseling patients about exercise during cancer treatments; however, further study is needed to determine its effectiveness.

Karen K. Swenson, PhD, RN, AOCN®, is an oncology research director, and Mary Jo Nissen, PhD, MPH, is a senior health services researcher, both in the Oncology Research Department at Park Nicollet Institute in Minneapolis, MN; and Susan J. Henly, PhD, RN, is a professor in the School of Nursing at the University of Minnesota in Minneapolis. This study was supported by the Park Nicollet Foundation. Swenson can be reached at karen.swenson@parknicollet.com, with copy to editor at ONFEditor@ons.org. (Submitted January 2009. Accepted for publication May 28, 2009.)

Digital Object Identifier: 10.1188/10.ONF.321-330

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