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Determinants of physical activity among women treated for breast cancer in a 5-year longitudinal follow-up investigation

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Abstract

***Objective*: To estimate the 5-year trajectory of physical activity among women with breast cancer, and to evaluate biopsychosocial variables (health status, physical symptoms, health-related quality of life (HRQL), depressive symptoms, and social support), measured soon after breast cancer diagnosis, as predictors of the 5-year trajectory.**

***Methods*: Women diagnosed with Stage II or III regional breast cancer ($n = 227$), surgically treated and awaiting the start of adjuvant therapy completed baseline assessments of medical, psychological, and behavioral functioning. Follow-up evaluations were conducted every 4 months during the first year and every 6 months during the subsequent 4 years (12 assessments total during the 5-year study). Mixed-effects modeling was utilized to estimate the baseline level of physical activity as well as rate of change over time. Measures of physical health status, HRQL, depressive symptoms, and social support were included as predictors of the physical activity trajectory.**

***Results*: A curvilinear pattern of change in physical activity was evident over the 5-year follow-up ($p = 0.002$). Physical activity increased gradually during the first 18 months, then declined steadily over the subsequent 42 months. Poor physical health, depressive symptoms, and lower emotional HRQL were associated with less physical activity. Higher family support was associated with a slower decline in physical activity in the latter 42 months of the study.**

***Conclusions*: Emotional HRQL following diagnosis with breast cancer appears to be important for sustaining physical activity in the first 1–2 years following diagnosis. Physical activity interventions among breast cancer survivors should address depressive symptoms early in the course of treatment.**

Keywords: breast cancer; physical activity; depression; social support; quality of life; oncology

Introduction

Among patients with chronic health problems such as cancer, physical activity may be especially important as a means of reversing illness-related declines in physical endurance, increasing capacity for engaging in activities of daily living, improving emotional well-being, enhancing regulation of physiological systems, and prolonging survival [1,2]. From the perspective of the biopsychosocial model, there are likely to be multiple factors influencing the decision to engage in physical activity and, in the context of chronic illness, substantial barriers may prevent individuals from engaging in exercise. Psychosocial factors associated with exercise non-adherence among healthy adults include low levels of social support [3–5] and higher levels of psychological distress [6,7]. Among adults with cancer, barriers to physical activity may include not only low social support [8] and neurobehavioral effects of depression [9], but also symptoms of disease and treatment-related symptoms affecting quality of life [10].

Breast cancer diagnosis and treatment are associated with reduced quality of life [11–13] and increased risk of depression. Estimates of depressive disorders in this population range from 15 to 30% (e.g. [14–16]). Depression, in turn, is associated with reduced exercise adherence among women with breast cancer undergoing chemotherapy [10,17]. Social support also appears to be an important predictor of physical activity among cancer patients. Absence of social support was a significant barrier to physical activity among

colorectal cancer patients who participated in a 4-month longitudinal investigation [8]. Among women with breast cancer, cross-sectional data indicate that lack of support for exercise is a significant barrier to physical activity [18].

There is now convincing evidence of numerous positive outcomes associated with physical activity among women with breast cancer (e.g. increased physical endurance, reduced fatigue, improved quality of life, reduced psychological distress [1,19–21]). Long-term survivors of breast cancer who regularly engaged in moderate intensity physical activity reported greater vigor as well as lower fatigue and depressive symptoms [22,23]. Despite positive outcomes associated with physical activity interventions and with engaging in regular physical activity, there are limited data documenting the natural trajectory of physical activity among women with breast cancer following diagnosis, during the period of treatment and recovery.

Prior studies examining physical activity among women with breast cancer have not utilized longitudinal data to identify longer-term (i.e. >12 months) predictors of physical activity in this population. Evaluation of predictors will help determine individual difference factors that may be associated with physical activity, as well as help generate hypotheses for future research and interventions designed to increase physical activity among women with breast cancer.

This study was designed to estimate the 5-year trajectory of physical activity in a cohort of women who had been diagnosed with breast cancer and had participated in a randomized psychosocial intervention during the first year of the follow-up period. The primary purpose of the study was to employ components of the biopsychosocial model to evaluate the influence of biomedical, psychological, and social factors on exercise behavior among women with breast cancer. Health status, symptoms, fatigue, health-related quality of life (HRQL), depressive symptoms, and social support were assessed at baseline, prior to random assignment, as well as at all subsequent assessments. All biopsychosocial variables were evaluated as predictors of physical activity participation during the 5-year follow-up, controlling for the participant's initial randomized condition.

Methods

Participants

Women diagnosed with Stage II or III regional breast cancer, surgically treated and awaiting the start of adjuvant therapy were eligible for participation in the initial randomized study. Description of eligibility and procedures of accrual and randomization have been detailed previously [24,25]. Briefly, exclusion criteria were: prior cancer diagnosis, treatment refusal, age <20 or >85 years, residing >90 miles from the research site, or diagnoses of mental retardation, severe or untreated psychopathology (e.g. schizophrenia), neurological disorder, dementia, or any immunologic condition/disease. A total of 227 women (mean age 51 years; age range: 28–84 years) were recruited for the randomized study. Additional demographic and health data for the sample are included in Table 1.

Procedures

Following diagnosis, participants were randomized to one of two study arms: Intervention with assessment, or Assessment only. All participants provided written informed consent for the study procedures approved by the Ohio State University Institutional Review Board. As described in prior reports [24,25], there were no significant differences between study arms in sociodemographic, disease, prognostic factors, type of surgery received, or adjuvant treatments scheduled to begin or eventually received.

Intervention with assessment

Women assigned to this condition participated in a psychoeducational group for 18 weeks (90 min/week), followed by eight additional sessions at monthly intervals. Participants attended sessions in small cohorts of 8–12 patients. Sessions addressed a range of relevant topics including stress reduction *via* progressive muscle relaxation, identifying social support, and assertive communication skills. One of the initial 18 sessions addressed increasing daily exercise activity (especially walking), and one of the eight monthly sessions included a follow-up refresher on maintaining exercise activity.

Table 1. Sociodemographic, prognostic, and treatment received variables ($n = 227$)

Variable	Mean ($\pm$SD)/%
Sociodemographic	
Age (years)	50.9 (10.8)
Race (% Caucasian)	89.9
Education (years)	14.7 (2.7)
Marital Status (% married)	67.0
Employed	66.5
Family income (1000 $/year)	66.4 (71.3)
Prognostic	
Stage (II versus III, %II)	90.3
ER/PR (% positive)	68.3
Menopause status (% Pre)	53.7
Treatment	
Surgery (% Modified Radical Mastectomy)	57.3
Radiation therapy (% yes)	54.2
Chemotherapy (% yes)	84.1
Tamoxifen (% yes)	75.3

ER/PR = Estrogen receptor and progesterone receptor status.

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Baseline assessments were conducted of all participants following breast surgery but prior to randomization and adjuvant treatment. Assessments included psychological and behavioral data obtained through in-person interviews and questionnaires completed with a research assistant. In addition, a research nurse conducted a health assessment, with inspection of patients' medical records and/or discussion with the treating physician as needed. Participants were paid $25 per assessment. Follow-up evaluations were conducted every 4 months during the first year and every 6 months during the subsequent 4 years, for a total of 12 assessments during the 5-year study. Of interest for this investigation are the assessments of physical activity, health status, physical symptoms, fatigue, HRQL, depressive symptoms, and social support at each of the 12 assessments.

Assessment only

Participants completed the same assessments as the intervention group, but did not participate in any intervention components.

Measures

Physical activity

Seven-Day Physical Activity Recall (PAR; [26]) provides a retrospective account of moderate and vigorous physical activity during the prior week. Standard energy expenditure (MET) values [27] were used to calculate a summary index of energy expenditure for the prior week at each assessment. One MET is equivalent to the energy required for sitting quietly, approximately 1 kcal/kg/h. With recommendations of at least 150 min/week of moderate intensity physical activity, an approximate MET equivalent would be 23 METs per week.

Physical health status and symptoms

Research nurses completed two measures based on patient interview, medical chart review, and physician consultation when needed. (1) Karnofsky Performance Status (KPS) is a functional status scale ranging from 100 (Normal, no complaints, no evidence of disease) to 0 (Dead) with 10-point intervals [28]. Inter-rater reliability ranges from 0.70 to 0.97 [29,30]. (2) Southwest Oncology Collaborative Group rating (SWOG; 1994 version) [31] is a toxicity measure incorporating symptoms, signs, and illnesses. Items are grouped within 22 body categories (e.g. gastrointestinal), with 4–6 items for each (e.g. nausea) rated on an individualized severity scale. Items were averaged for a total score. (3) Symptoms of fatigue were evaluated with the Fatigue subscale of the Profile of Mood States (POMS; [32]), a 65-item self-report inventory with seven items addressing symptoms of fatigue during the prior week. Alpha reliability for the Fatigue subscale was 0.91.

Health-related quality of life

The Medical Outcomes Study-Short Form (SF-36) assesses physical and psychological dimensions of HRQL [33]. Because of extensive reliability, validity, and normative data [34,35], the SF-36 is frequently used in cancer clinical trials and studies of chronic illness populations (e.g. [36]). The SF-36 yields eight primary subscales and two component scores: Physical Component Score (PCS) and Mental Component Score (MCS). Both component scores are standardized with a mean of 50 and a standard deviation of 10 based on the general US population. In the present sample, the alpha reliability of both MCS and PCS was greater than 0.85.

Depressive symptoms

The Iowa short form [37] of the Center for Epidemiological Studies—Depression Scale (CES-D; [38,39]) was used to identify current symptoms of depression. This form of the CES-D consists of 11 items rated on a 3-point Likert scale (0–2) during the prior week. Total scores range from 0 to 22, with higher scores reflecting greater depressive symptoms. The alpha reliability was 0.74, consistent with prior research [37,40]. The CES-D is relatively unaffected by physical symptoms and is, therefore, commonly used in research with medical patients [41].

Social support

Two 20-item instruments, Perceived Social Support from Family (PSS-Fa) and Friends (PSS-Fr) [42], measure the degree to which support needs are fulfilled by a network of friends and family. Each item is rated either 'yes' or 'no' and scale scores range from 0 to 20 for each of the two scales (PSS-Fa and PSS-Fr), with higher scores reflecting greater perceived social support. The alpha reliabilities were 0.82 and 0.88, respectively, for the PSS-Fr and PSS-Fa.

Statistical analysis

The primary objective of the study was to evaluate predictors of physical activity at the 5-year follow-up assessment among women who had participated in the randomized intervention during the first year. Thus, preliminary analyses were conducted to evaluate differences in exercise activity across the two arms of the study. Following the intensive phase of the intervention (after 4 months), there was a trend toward greater physical activity in the Intervention arm versus the Assessment only arm ($p = 0.08$), as reported previously [25]. However, there was no group difference in physical activity at

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the end of the maintenance phase (i.e. 1 year), or at the 5-year follow-up. Thus, for all analyses in this study, data were combined across the two groups and group assignment was included as a covariate.

Mixed-effects modeling [43] was used to estimate the baseline level of physical activity as well as rate of change over time. The mixed-effects modeling procedure accounts for correlations among repeated assessments within an individual and allows the number of repeated assessments to vary across individuals making it ideal for analysis of longitudinal data. Both the fixed effects (group average effects) and random effects (within and between individual variability) were estimated. Determination of linear versus quadratic change was made by comparison of relative fit of models using a likelihood ratio test. The linear model was retained unless the fit of the quadratic model was significantly better ($\alpha = 0.05$) than that of the linear model.

Model testing was conducted in three steps. Step 1 estimated the unconditional growth curve of physical activity including baseline level (intercept) and the rate of change (linear slope and/or quadratic term). Step 2 introduced control variables. Relevant covariates of physical activity [age, education, body mass index (BMI), cancer stage, hormone receptor status, surgery type, chemotherapy, radiation, and initial randomized study arm] and their interaction with Time were added into the model specified in Step 1. A backward elimination process was employed in which non-significant covariates ($p > 0.05$) were eliminated from the model. In Step 3, each baseline predictor of physical activity and the interaction of the predictor with Time were added into the model separately to determine significant physical and psychosocial predictors of the physical activity trajectory. For the models testing psychosocial predictors, physical functioning status (KPS) was included as a control variable to evaluate the effects of psychosocial factors on exercise activity above and beyond any effects of functional status.

As indicated above, in addition to repeated assessments of physical activity, the study included repeated assessments of all of the biopsychosocial predictors of physical activity. Thus, each of the mixed-effect models was conducted a second time utilizing the available time-variant predictors. All continuous variables were centered at the mean for easier interpretation. All statistical tests were two sided.

Results

As shown in Table 2, mean MET levels reflected a significant increase in reported weekly physical activity over time from baseline to 1 year, followed by a reduction in exercise activity at 5 years. At baseline, 20% of participants were found to be achieving or exceeding the goal of approximately 23 METS per week, with 37% above that level at 1 year, and 18% at 5 years. At baseline, participants reported reduced HRQL (MCS and PCS) and elevated symptoms of fatigue, but mean scores for depressive symptoms and social support from family and friends were within normal limits, as indicated in Table 3.

As shown in Table 4 and Figure 1, there was a curvilinear pattern of change (i.e. significant quadratic effect) in physical activity over the 5-year follow-up ($p = 0.002$). Physical activity increased gradually during the first 18 months (when participants were recovering from surgery and receiving adjuvant treatment) to a peak level that was consistent with recommended guidelines for physical activity (approximately 23 METS weekly), then declined steadily over the subsequent 42 months. There were wide individual differences in baseline physical activity ($p < 0.001$), but rate of change in physical activity over time was consistent across participants ($p = 0.570$).

Table 2. Mean (±SD) for 7-day Physical Activity Recall in METS at each of 12 assessments during the 5-year follow-up

Assessment	N	Mean (±SD)
Baseline	227	16.6 (27.1)
4 months	197	24.5 (39.3)
8 months	194	26.6 (42.2)
1 year	186	31.3 (49.7)
18 months	176	25.4 (47.6)
2 years	168	22.3 (35.7)
30 months	160	23.2 (42.5)
3 years	148	19.6 (28.6)
42 months	142	21.0 (35.4)
4 years	133	16.8 (29.5)
54 months	134	13.8 (17.4)
5 years	128	14.3 (22.5)

Table 3. Mean (±SD) for baseline physical health status, quality of life, depressive symptoms, and social support ($n = 227$)

Variable	Mean (±SD)
Physical health status	
Karnofsky Performance Status	85.1 (7.9)
SWOG	0.2 (0.1)
Profile of Mood States-Fatigue	9.6 (6.3)
Quality of life	
SF-36 Physical Component Score (PCS)	40.4 (8.0)
SF-36 Mental Component Score (MCS)	42.4 (11.4)
Depressive symptoms	
CES-D	6.1 (3.7)
Social support	
Perceived Social Support from Family	16.4 (4.3)
Perceived Social Support from Friends	16.9 (3.4)

SWOG = symptoms, signs, and illnesses measure from the Southwest Oncology Group; SF-36 = Medical Outcomes Study Short Form; CES-D = Center for Epidemiologic Studies—Depression Scale.

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Table 4. Fixed effects from mixed-effects models estimating physical and psychosocial predictors of physical activity trajectory during 5 years after breast cancer diagnosis ($n = 214$)

Model/Variable	Estimate	SE	*t*	*p*
Step1: Unconditional growth curve model				
Intercept	20.867	1.921	10.865	<0.001
Time	0.250	0.138	1.807	0.071
Quadratic term	−0.007	0.002	−3.066	0.002
Step 2: Conditional growth curve model				
Intercept	19.695	4.550	4.328	<0.001
Education	1.040	0.361	2.878	0.004
Body Mass Index	−0.439	0.157	−2.793	0.006
Surgery type	−4.454	1.924	−2.315	0.022
(mastectomy versus lumpectomy)				
Chemotherapy (yes versus no)	6.391	4.433	1.442	0.150
Psychological intervention (yes versus no)	−4.021	1.930	−2.083	0.039
Time	0.446	0.165	2.697	0.007
Quadratic term	−0.007	0.002	−3.143	0.002
Chemotherapy × Time	−0.215	0.104	−2.075	0.039
Step 3: Baseline predictor and/or additional control added				
Physical health status				
KPS	0.461	0.223	2.067	0.039
KPS × Time	−0.008	0.005	−1.595	0.111
SWOG	−33.646	13.682	−2.459	0.014
SWOG × Time	0.586	0.301	1.946	0.052
POMS-Fatigue	−0.799	0.326	−2.451	0.015
POMS-Fatigue × Time	0.010	0.007	1.291	0.197
Quality of life				
PCS	0.091	0.195	0.464	0.643
PCS × Time	−0.001	0.004	−0.115	0.908
KPS	0.366	0.226	1.616	0.107
MCS	0.314	0.140	2.246	0.025
KPS × Time	−0.006	0.005	−1.142	0.254
MCS × Time	−0.008	0.003	−2.319	0.021
Depressive symptoms				
KPS	0.372	0.225	1.655	0.098
CES-D	−1.008	0.424	−2.378	0.018
KPS × Time	−0.007	0.005	−1.290	0.198
CES-D × Time	0.015	0.010	1.534	0.126
Social support				
KPS	0.506	0.224	2.258	0.024
PSS-Family	−0.494	0.369	−1.339	0.181
KPS × Time	−0.010	0.005	−1.883	0.060
PSS-Family × Time	0.017	0.009	2.039	0.042
KPS	0.415	0.229	1.812	0.071
PSS-Friends	0.198	0.472	0.419	0.675
KPS × Time	−0.008	0.005	−1.576	0.116
PSS-Friends × Time	0.008	0.011	0.741	0.459

SE = standard error; KPS = Karnofsky Performance Status; SWOG = Symptoms, signs, and illnesses assessment from the Southwest Oncology Group; POMS = Profile of Mood States; PCS and MCS = Medical Outcomes Study Short Form, Physical and Mental Component Score; CES-D = Center for Epidemiologic Studies—Depression Scale; PSS = Perceived Social Support. Sample size reduced due to missing physical activity data for 13 subjects.

Analysis of covariates indicated higher physical activity at baseline among women with more years of education, lower BMI, women who had undergone lumpectomy (versus mastectomy), and those randomized to the Assessment only arm (all p values <0.039). Rate of change in physical activity differed significantly for women receiving chemotherapy versus women not receiving chemotherapy ($p = 0.039$). Women treated with chemotherapy gradually increased physical activity during the first 18 months followed by a steady decline thereafter. In contrast, women not receiving chemotherapy exhibited a steady increase in physical activity during the first 3 years followed by a gradual decline during the subsequent 2 years.

Results of the mixed-effects model identifying baseline physical and psychosocial predictors of the physical activity trajectory are included in Table 4. Higher performance status (KPS) was a significant predictor of baseline physical activity ($p = 0.039$), but KPS was not associated with rate of change in physical activity, indicating a main effect of KPS on physical activity that remained throughout the 5-year follow-up. Higher baseline SWOG scores

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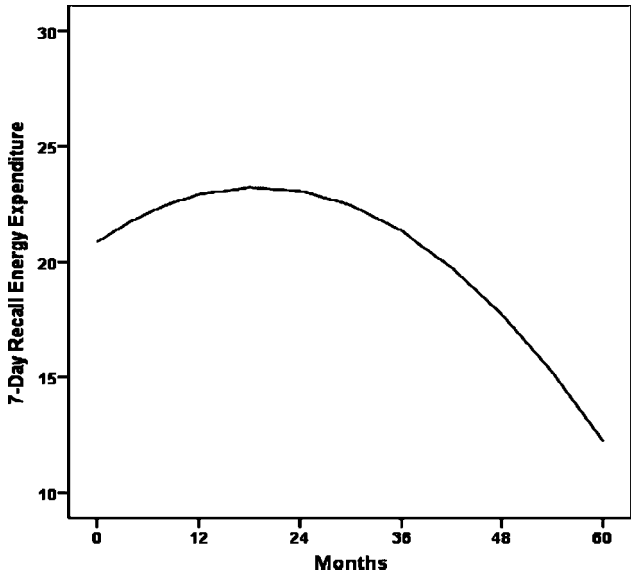

Figure 1. Estimated 5-year trajectory of physical activity among breast cancer survivors

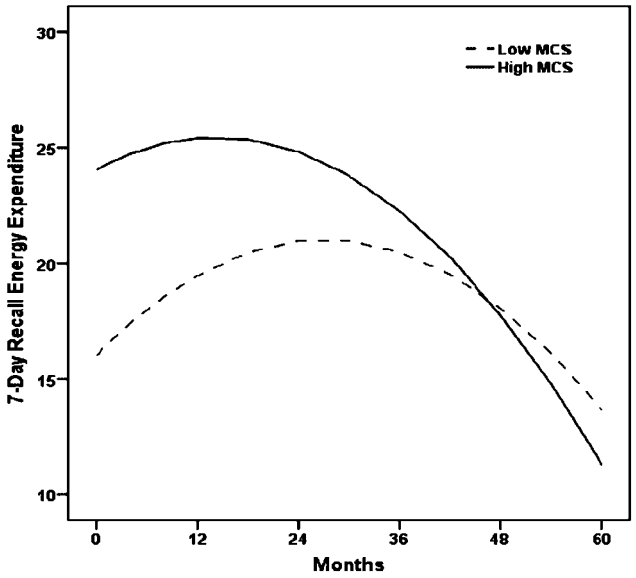

Figure 2. Estimated 5-year trajectory of physical activity for women with high versus low initial SF-36 Mental Component Scores (MCS). Median split was used to identify groups for illustration

(i.e. signs/symptoms) were associated with lower physical activity at baseline ($p = 0.014$), but symptom level did not predict the rate of change in physical activity over time ($p = 0.052$). Likewise, greater fatigue (POMS-Fatigue) was associated with lower physical activity at baseline ($p = 0.015$), but baseline fatigue was not a predictor of change in physical activity over time. When analyses were conducted with time-variant predictors, similar results emerged. KPS ($p = 0.016$) and POMS-Fatigue ($p = 0.014$) were negatively associated with physical activity, but did not influence the rate of change in physical activity over time. In the time-variant analyses, there was no effect for SWOG.

Baseline PCS was not a significant predictor of baseline physical activity or rate of change in physical activity. MCS scores were positively associated with greater physical activity at baseline ($p = 0.025$), after controlling for the covariates and KPS. When MCS was entered in the model, KPS did not remain a significant predictor of baseline physical activity. MCS was also a significant predictor of the rate of change in physical activity ($p = 0.021$). As shown in Figure 2, higher MCS was associated with stable, elevated physical activity during the first 2 years and a steady decrease during the subsequent 3 years. In contrast, lower MCS was associated with an increase in physical activity during the first 2 years and a gradual decrease thereafter. Analyses with time-variant predictors revealed that PCS was significantly associated with physical activity ($p < 0.001$), and with the rate of change in physical activity

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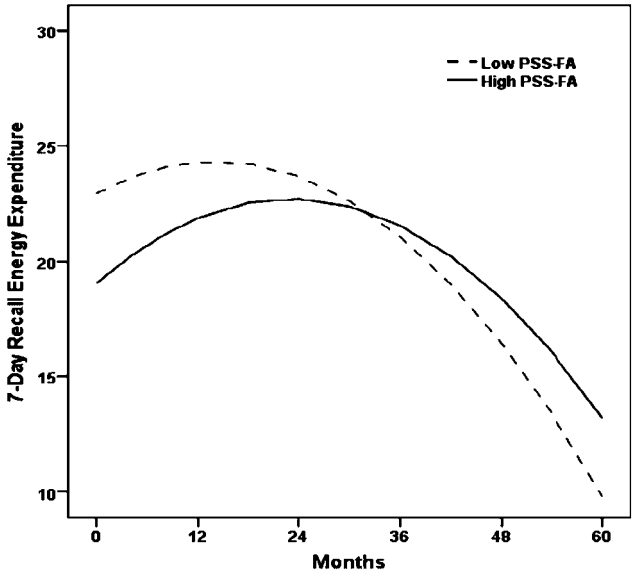

Figure 3. Estimated 5-year trajectory of physical activity for women with high versus low initial Perceived Social Support from Family (PSS-Fa). Median split was used to identify groups for illustration

($p = 0.021$). Similarly, MCS was associated with physical activity ($p < 0.001$) and rate of change in physical activity ($p = 0.013$).

Greater depressive symptoms (CES-D) were associated with lower physical activity at baseline ($p = 0.018$). KPS did not remain a significant predictor of physical activity when depressive symptoms were included in the model. Depressive symptoms were not a significant predictor of rate of change in physical activity. Thus, there was a main effect of depressive symptoms on physical activity throughout the 5-year follow-up. Analysis of time-variant predictors indicated the same effects, with depressive symptoms predicting lower physical activity ($p = 0.006$), but not rate of change in physical activity.

Perceived support from family (PSS-Fa) was not a significant predictor of baseline physical activity, after controlling for the covariates and KPS. However, PSS-Fa was significantly associated with rate of change in physical activity ($p = 0.042$). Specifically, as illustrated in Figure 3, participants with greater family support reported increased physical activity during the first 2 years and a gradual decrease during the subsequent 3 years. In contrast, participants with lower family support reported stable, higher physical activity during the first 2 years and a steady decrease thereafter. During the longitudinal follow-up, higher family support was associated with greater physical activity over a longer time frame. Baseline perceived support from friends (PSS-Fr) was not a significant predictor of baseline physical activity or rate of change in physical activity. Analyses with time-variant predictors revealed no effects for either PSS-Fa or PSS-Fr.

Discussion

This investigation revealed that physical health status, HRQL, depressive symptoms, and social support influenced physical activity over a 5-year follow-up among women newly diagnosed with breast cancer. Higher functional status (KPS) and lower symptoms (SWOG; POMS-Fatigue) at baseline were significant predictors of physical activity over the 5-year follow-up. Interestingly, baseline physical HRQL (PCS) was not a predictor of physical activity possibly because PCS at baseline reflects self-evaluation of physical capabilities and indicators of role functioning that are not related to long-term physical activity. In contrast, the time-variant analysis revealed that PCS predicted changing physical activity over time, suggesting that PCS may become more relevant for physical activity as time progresses. Emotional HRQL (MCS) predicted baseline physical activity and was associated with change in activity over the 5-year follow-up. Consistent with prior studies [17], depressive symptoms were associated with lower physical activity at the baseline assessment. The present data are unique in documenting a sustained association of baseline depressive symptoms with physical activity over the 5-year follow-up period. These results underscore the importance of further evaluating the interrelationship of depressive symptoms and physical activity over time. To the extent that depressive symptoms impede patients from engaging in positive health behaviors such as physical activity, assessment and treatment of depression early in the course of illness is likely to be a critical component of treatment, affecting both mental and physical health.

The general trajectory of physical activity observed in this study is not surprising. By 1 year

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post-diagnosis most women had completed adjuvant treatments and were likely to have greater interest in physical activity than at baseline, immediately following diagnosis. By 5 years, however, physical activity was lower than baseline levels. Additional data were available to help elucidate these results. At the baseline assessment, participants also completed retrospective accounts of exercise activity during the 3 months prior to baseline. Not surprisingly, the baseline 7-day PAR was more highly correlated with physical activity during the prior month ($r = 0.49$, $p < 0.001$) than with physical activity reported 2 months earlier ($r = 0.25$, $p = 0.003$) or 3 months earlier ($r = 0.27$, $p = 0.001$). Mean weekly MET levels during the period of 2 months and 3 months prior to baseline were very similar to weekly activity reported at the 1-year follow-up, suggesting that physical activity at the 1-year assessment reflects a return to premorbid levels of physical activity, and that the decline in physical activity occurring especially after 2 years reflects a further downward trend toward the levels patients reported at baseline (soon after first diagnosis). The downward trend in physical activity during the latter 3 years of follow-up is concerning because it reflects a level of activity below public health recommendations. The downward trend is associated not only with impaired physical function and elevated physical symptoms, but also with greater depressive symptoms.

This study utilized a generic indicator of social support that did not specify social support for physical activity. Prior research has documented that social support for exercise contributes to enhanced physical activity [8]. However, the data suggest that general social support from family members may be important over time for encouraging physical activity among women being treated for breast cancer. Interestingly, general social support from friends did not influence the physical activity trajectory. These results require replication and extension in future research to determine the degree to which inclusion of family members in educational programs related to health behavior change may be important. However, the results highlight the importance of identifying and encouraging social support mechanisms among family members of patients due to the apparent beneficial influence of support on long-term engagement in physical activity.

Strengths of the study include the relatively large sample size with repeated assessments of physical activity over a 5-year period of time. No prior study has examined exercise behavior among women with breast cancer in a longitudinal study of this duration. Although the measure of physical activity relied on participant self-report, the measure is a reliable and valid indicator, and improves upon single-item measures often used in large-scale studies. In addition, to minimize self-report bias, the physical activity assessments were conducted by trained assessors who provided structured cues to help participants with accurate recall of physical activity during the prior week at each assessment. A potential weakness of the study is that the first 12 months of data collection occurred in the context of a randomized study. Therefore, the intervention may have influenced physical activity and other outcomes via mechanisms that are not readily apparent. To control for this effect, initial randomized group assignment was included as a control variable in all data analyses. However, it is possible that statistical control of initial group assignment does not account for the influence of intervention non-specifics that may be relevant to physical activity. In addition, the study sample was quite homogeneous (approximately 90% White, above average income), which may limit the extent to which results are relevant for ethnic minority patients and underserved groups.

During the early months of the study, emotional HRQL and chemotherapy treatment predicted patterns of physical activity, but in the latter months of follow-up, patterns of physical activity became increasingly similar regardless of treatment or HRQL. Instead, family support became increasingly important during the latter months. Thus, the data suggest the importance of emotional HRQL following diagnosis with breast cancer for increasing and sustaining exercise behavior in the first 1–2 years following diagnosis. Depressive symptoms and physical functioning appear to be consistently relevant over time, and family support becomes more important over time. The concurrent influence of biological, psychological, and social factors supports the relevance of the biopsychosocial model for understanding exercise behavior among breast cancer survivors. Other models may be relevant for future study in this population, incorporating specific factors, such as self-efficacy and health beliefs, that have been found to influence physical activity in other groups. These data indicate that future interventions designed to increase physical activity among breast cancer survivors should incorporate components of the biopsychosocial model, especially addressing depressive symptoms early in the course of treatment and further exploring factors such as changes in HRQL that may have a negative influence on physical activity 18–24 months following breast cancer diagnosis.

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