original contributions

Cost-Savings Analysis of an Individualized Exercise Oncology Program in Early-Stage Breast Cancer Survivors: A Randomized Clinical Control Trial

Karen Y. Wonders, PhD[1,2]; Kathryn Schmitz, PhD, MPH[3]; Robert Wise, BS[2]; and Ronald Hale, MD[4]

QUESTION ASKED: Do patients with early-stage breast cancer who exercise during their treatment have lower health care utilization than those patients who do not exercise during treatment?

SUMMARY ANSWER: A supervised, individualized 12-week exercise intervention led to significant improvements in fitness parameters and Eastern Cooperative Oncology Group scores, as well as a decrease in health care utilization among early-stage breast cancer survivors. In short, patients in the control group (CG) had the highest total mean health care utilization across all measures ($8,598 US dollars (USD) compared with the exercise group, $6,356 USD) for emergency visits, outpatient visits, office-base visits, and other medical costs.

WHAT WE DID: Patients with early-stage breast cancer (stage I to II) were randomly assigned into two groups: the CG (n = 120) and the exercise training group (EX, n = 123). Patients in the exercise intervention group completed 12 weeks of prescribed, individualized exercise that aligned with American College of Sports Medicine exercise guidelines for cancer survivors. The CG received the current standard of care, which includes a resource guide with various options available to the cancer survivor. Physical fitness was assessed for both groups before and after. Health care costs other than planned cancer care were measured and stratified across comorbidities. Finally, baseline and follow-up Eastern Cooperative Oncology Group scores were collected.

WHAT WE FOUND: A supervised, individualized 12-week exercise intervention led to significant improvements in fitness parameters and ECOG scores. In addition, a significant decrease in unplanned health care utilization was measured in early stage breast cancer survivors who participated in the exercise intervention.

BIAS, CONFOUNDING FACTORS: Despite numerous investigations that have supported the efficacy of exercise during cancer treatment, nationally, < 5% of patients are ever referred to a cancer rehabilitation program. Public funding and lack of resources has been identified as a significant barrier to national exercise oncology programs. Other known barriers include lack of general knowledge about the need to stay physically active during and after cancer therapy, qualified personnel, and available programs.

REAL-LIFE IMPLICATIONS: This study demonstrated both lower health care utilization and associated costs for patients who were randomly assigned to our exercise group, compared with controls. Therefore, this system of exercise oncology has the potential to contribute to a national standard of care for individuals battling cancer. Furthermore, the cost savings attributed to patients with increased comorbidities has implications into other disease states as well, and can serve as a potential joint-effort with Population Health initiatives.

CORRESPONDING AUTHOR

Karen Y. Wonders, PhD, Maple Tree Cancer Alliance, 425 N Findlay St, Dayton, OH 45404; e-mail: Karen.wonders@mapletreecanceralliance.org.

ASSOCIATED CONTENT

Appendix

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abstract

PURPOSE In an attempt to promote the integration of exercise oncology as a standard part of clinical practice, economic evaluations are warranted. Thus, the purpose of this study was to prospectively analyze cost savings of an individualized exercise oncology program when patients were randomly assigned.

METHODS For this open-label, randomized, prospective, comparative clinical trial, patients with early-stage breast cancer (stage I-II) were randomly assigned into two groups: the control group (CG, n = 120) and the exercise training group (EX, n = 123). Patients in the exercise intervention group completed 12 weeks of prescribed, individualized exercise that aligned with ACSM exercise guidelines for cancer survivors. The CG received the current standard of care, which includes a resource guide with various options available to the cancer survivor.

RESULTS In the EX group, all physical fitness measures significantly improved compared with baseline ($P < .001$), while remaining unchanged for the CG ($P > .05$). Patients in the CG had the highest total mean health care utilization across all measures (CG: $8,598 US dollars, compared with EX: $6,356 US dollars) for emergency visits, outpatient visits, and office-base visits that were not a part of their treatment plan. At baseline, the mean Eastern Cooperative Oncology Group (ECOG) scores did not significantly differ ($P > .05$); however, at follow-up, a larger proportion of the EX group had ECOG scores of 0 or 1, compared with the CG ($P < .05$). Finally, patient-reported outcomes were significantly higher in the exercise group, compared with the CG at the 12-week follow-up ($P < .001$).

CONCLUSION A supervised, individualized 12-week exercise intervention led to significant improvements in fitness parameters and ECOG scores, as well as a decrease in unplanned health care utilization among early-stage breast cancer survivors.

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INTRODUCTION

In 2018, it was estimated that there were 1.7 million new cancer diagnoses in the United States.[1] For all types of cancer, mortality rates are on the decline[1] and patients are living longer with the chronic and late effects of treatment.[2] Unfortunately, with improved survival rates, the trade-off has been a dramatic increase in health care utilization and associated costs. Hospitalization is the primary driver of cancer-related health care spending,[3,4] as recent data suggest that hospitalization for cancer lasts longer and costs more than for those with other chronic conditions.[5] Furthermore, in the year following a cancer diagnosis, up to half of all hospitalizations are unplanned, and therefore potentially avoidable.[6]

The decrease in physical functioning brought on by treatment-related side effects can impede the quality of life and autonomy of patients with cancer. Published data would suggest that unplanned hospitalizations account for more than half of cancer costs.[7] Reasons for unplanned hospitalization included fever (15.8%), gastrointestinal distress (5.8%), and cardiovascular (5.8%) and respiratory (4.3%) distress.[8,9] About 67% of the unplanned hospitalizations originated in the emergency department (ED), highlighting the costly and disruptive nature of these encounters.[7] Consequently, reducing unplanned hospitalizations has been an important strategy in increasing value in cancer care.

Being that early breast cancer is considered potentially curable, therapy concepts with a curable intent as part of a multidisciplinary setting are considered backbones of treatment.[10] Even so, these associated treatments have physiologic effects that extend well beyond the curative therapy. Therefore, a primary goal of treatment should be to maintain patient quality of life. Several meta-analyses report that exercise interventions are beneficial for patients undergoing cancer treatment, in that they reduce symptom severity[11] and improve cancer-related fatigue,[12-14] cardiac function,[15] muscle weakness,[16] and overall quality of life.[17] Yet, it still remains that $< 5\%$ of patients are ever referred to an exercise oncology program during treatment.[17] Therefore, economic evaluations of exercise oncology are warranted, in an attempt to promote the integration of exercise oncology as a standard part of clinical practice.

Maple Tree Cancer Alliance[18] has developed an exercise oncology program, which results in improved health outcomes. Our retrospective data demonstrate that individualized exercise during cancer treatment significantly reduced ED visits, 30-day readmissions, and length of hospital stays,[19] resulting in a payer benefit of $3,000 US dollars (USD)/patient over the first 6 months of enrollment into the Maple Tree Exercise Oncology program.[2] As a follow-up to this research, the purpose of this study was to prospectively analyze the cost savings of an individualized exercise oncology program when patients were randomly assigned. Specifically, we analyzed unplanned health care utilization expenditures. Spending measures were ED visits, unplanned hospitalizations, nonchemotherapy cancer-related outpatient services (including supportive medications/premedications for chemotherapy, but excluding chemotherapy and radiation services themselves), and office visits. We also measured Eastern Cooperative Oncology Group (ECOG) scores for both groups and hypothesized that individualized exercise training during cancer treatment would improve performance scores and a decrease in health care–related expenditure.

METHODS

Study Design and Subjects

This study was an open-label, randomized, prospective, comparative clinical trial (ClinicalTrials.gov identifier: NCT04106609). The project was approved by the Institutional review board of Kettering Health Network before the onset of data collection. All patients provided their consent to participate before enrollment.

Patients were selected according to the Consolidated Standard of Reporting Trials criteria (Fig 1). The eligibility criteria included the following: (1) patients with early-stage female breast cancer age between 30-80 years, (2) with a diagnosis of stage I-II, (3) without musculoskeletal injuries or other exercise-limiting comorbidities, (4) with physician clearance to participate in exercise, and (5) not having participated in

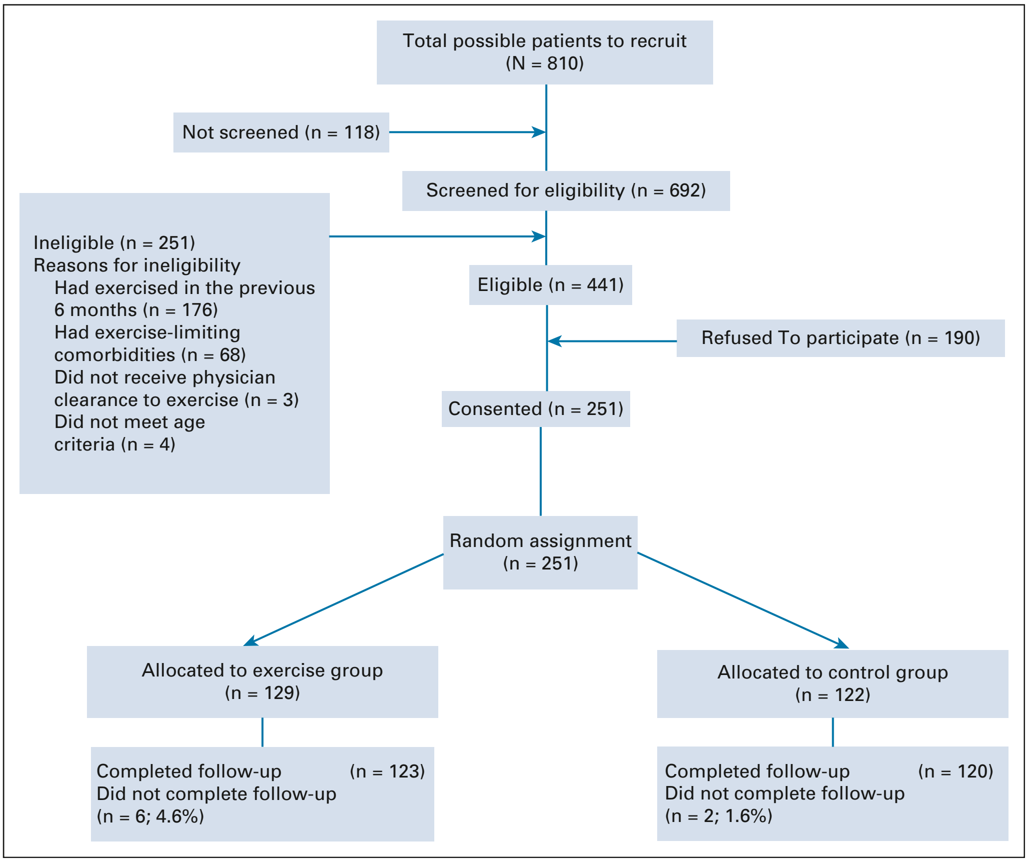

FIG 1. CONSORT diagram.

supervised physical exercise for at least 6 months before enrollment in the study. Patients who met the preliminary criteria, and provided consent, were randomly assigned into two groups: the control group (CG, n = 120) and the supervised exercise training group (EX, n = 123). Recruitment occurred between October 1, 2019, and December 31, 2020, from Kettering Health Network. Patients were randomly assigned into one of the two groups following the completion of the baseline testing using concealed randomization lists.

Experimental Design

This randomized controlled trial compared individualized exercise training versus standard care, which was a handout given to patients at the time of diagnosis, on baseline to 12-week changes to physical fitness and patient-reported outcomes. To enhance participation, standard care participants were offered the exercise program following the study period.

Measurements

The medical record of each patient constituted the data source for this study. Specific variables that were collected include fitness parameters, patient-reported outcomes, ECOG, length of hospital stays, ED visits, and outpatient and office-based visits for supportive purposes, but not the actual cancer treatments themselves. In addition, demographic characteristics of subjects, including age, sex, type of cancer, body mass index (BMI), comorbid conditions, and ethnicity were collected.

At the initial visit, all patients underwent a comprehensive fitness assessment. Cardiovascular fitness was measured via the University of Northern Colorado Rocky Mountain Cancer Rehabilitation Institute Treadmill Protocol.[20] Muscular strength was measured via handgrip dynamometer. Modified sit and reach measured flexibility. Muscular endurance was assessed via partial curl up test, and body composition was measured using skinfold calipers. The results from this fitness assessment were used to create an individualized exercise program for the EX group that focused on each patient's strengths and weaknesses.

Patient-Reported Outcomes

Quality of life was assessed using the Functional Assessment of Cancer Therapy-Breast (FACT-B) and the Short Form-36 Health Survey (SF-36). The Brief Fatigue Inventory (BFI) was used to assess fatigue, where a lower score indicates a lower level of fatigue.[21]

Exercise Protocol

Patients in the supervised exercise intervention group completed 12 weeks of prescribed, individualized exercise that aligned with American College of Sports Medicine exercise guidelines for cancer survivors.[22] Total dose of exercise was one time weekly, with cardiovascular, resistance training, and flexibility components. Cardiovascular exercise was performed on a treadmill. The intensity level for the aerobic exercise began with 30 minutes at 30% of the individual's predicted VO_{2max}, assessed by heart monitors (model S810i; Polar Electro, Kempele, Finland). Each week, intensity was progressed until the participant reached 45%. Strength training involved a full-body workout, with emphasis on all major muscle groups and used machines, free weights, and tubing. Patients completed three sets of 10 repetitions for each exercise. Each exercise program was individualized for each patient, but included the following resistance exercises: chest press, seated row, overhead press (when the patient was able), leg extension, leg curl, and leg press. Resistance intensity was set at a minimum of 30% of the individual's 1 repetition maximum, or when the patient felt sufficiently fatigued after 10 repetitions completed with proper form. As the patient's ratings of perceived exertion values decreased with each exercise, intensity was progressively increased, accordingly. Flexibility training involved static stretching of all major muscle groups for 15-20 seconds at the completion of each workout. Each session lasted approximately 60 minutes.

CG

The CG received the current standard of care, which includes a resource guide with various options available to the cancer survivor. Within this guide are tips for healthy eating and images of standard exercises to improve fitness.

Health Care Utilization Costs

The mean health care utilization for each time a patient used a health care service for the purpose of managing health problems in addition to the planned cancer care was determined using the medical record of each patient. Specific encounters that were included in this were the length of hospital stay, ED visits, and all cancer-related outpatient and office-based services, including supportive medications and excluding the actual chemotherapy and radiation visits themselves. Unplanned ED visits included patients treated and released from the ED. ED presentations that led to an unplanned hospitalization was used in the determination of unplanned hospitalizations, on the basis of admission date. Episodes of hospitalization were determined by taking into consideration interhospital transfers to avoid double counting. These transfer-adjusted length of stay (in days) for each inpatient hospitalization was used to calculate the total number of days spent in the hospital because of the initiation of unplanned admissions to the hospital, as well as the average length of stay of unplanned admissions to hospital. Purely administrative ED presentations were excluded, as they were placeholders for transfers.

The cost of each episode of care was assigned on the basis of the average cost of the Diagnosis Related Group code recorded using data as reported by Centers for Medicare & Medicaid Services (CMS) to the Healthcare Cost Report Information System. Total ED charges were converted to costs using data from the Healthcare Cost

TABLE 1. Patient Demographics

Demographic	CG Group	EX Group
Average age, years	57.1 ± 0.15	55.9 ± 0.19
Ethnicity, %		
Non-Hispanic White	63.89	62.29
African American	17.02	13.57
Hispanic	9.46	10.74
Asian	7.32	8.24
Unknown	2.31	5.16
BMI (kg/m^2)	30.24	28.74
Time since diagnosis, months	2.1 ± 0.82	1.2 ± 0.88
Stage I, %	41	42
Stage II, %	59	58

NOTE. EX (N = 129) and CG (N = 122). Values are mean scores ± SE.
Abbreviations: BMI, body mass index; CG, control group; EX, exercise group.

and Utilization Project (HCUP) cost-to-charge ratios on the basis of hospital accounting reports from CMS.

Statistical Analysis

Data consisted of numerical and categorical variables corresponding to patient characteristics. Numerical variables were expressed in the form of the mean ± standard deviation, whereas the categorical variables were expressed as frequency. Data were analyzed using IBM SPSS Statistics version 25.0. Continuous variables were described using mean, median, standard deviation, and range. Nominal variables were described using frequency and percentage.

Baseline demographic and clinical characteristics were compared between treatment and CGs to establish equivalence; any statistically significant differences between study groups were controlled statistically in the main results analysis. Continuous end points were tested for normality using Shapiro-Wilk tests. Differences between study groups on continuous end points were evaluated using independent-samples *t*-tests for normally distributed end points and Mann-Whitney *U* tests for non-normally distributed end points. Nominal end points were compared between groups using chi-square tests.

Within-group differences in mean changes for individual outcomes measured at postintervention were evaluated using general linear model, repeated-measures analyses of variance. Between-group differences in mean changes for individual outcomes at postintervention were evaluated using mixed-model repeated-measures analysis. Alpha was set to .05, two-tailed for all tests.

TABLE 2. Comparisons of Breast Cancer–Specific Quality of Life Between EX and CG

	Baseline	Postintervention		Between-Group Differences Postintervention	
Outcome Variable	Mean (SE)	Mean (SE)	P^a	Mean (95% CI)	P^b
Physical well-being					
EX	19.1 (1.7)	23.1 (1.6)	< .001	3.8 (7.3 to 1.8)	.001
CG	19.2 (1.8)	19.2 (1.9)	.74		
Social well-being					
EX	19.6 (1.6)	23.1 (1.6)	< .001	3.2 (6.7 to 1.1)	.003
CG	19.5 (1.7)	19.3 (1.6)	.81		
Emotional well-being					
EX	18.7 (1.5)	20.2 (1.7)	.01	1.7 (3.3 to 0.9)	.01
CG	18.7 (1.4)	18.6 (1.2)	.76		
Functional well-being					
EX	19.8 (1.5)	23.2 (1.5)	.01	2.2 (4.4 to 0.8)	.01
CG	19.9 (1.6)	19.8 (1.7)	.83		
Fact-breast					
EX	98.2 (3.4)	114.2 (3.7)	< .001	14.3 (18.3 to 9.4)	< .001
CG	98.3 (3.5)	96.7 (3.5)	.43		

NOTE. EX (n = 123) and CG (n = 120).
Abbreviations: ANOVA, analysis of variance; CG, control group; EX, exercise group.
[a] *P* value for repeated-measures ANOVA comparing changes in the EX group from baseline to postintervention, and in the CG from baseline to postintervention.
[b] *P* value for mixed-model analysis comparing changes between the EX and CG from baseline to postintervention.

TABLE 3. Comparisons of Health Status and Fatigue Between EX and CG

	Baseline	Postintervention		Between-Group Differences Postintervention	
SF-36 Subscores	Mean (SE)	Mean (SE)	P^a	Mean (95% CI)	P^b
Physical functioning					
EX	65.2 (3.08)	74.3 (3.1)	.001	9.3 (12.2 to 7.5)	.001
CG	65.1 (3.1)	64.1 (3.2)	.74		
Role-physical					
EX	68.3 (2.9)	75.8 (3.1)	.001	7.2 (10.8 to 4.8)	.001
CG	67.9 (3.01)	66.8 (2.9)	.55		
Bodily pain					
EX	50.4 (3.1)	62.3 (3.3)	.001	13.3 (17.3 to 9.5)	.001
CG	50.5 (3.16)	49.7 (3.2)	.27		
General health					
EX	60.2 (3.3)	68.2 (3.4)	.001	7.4 (11.9 to 4.1)	.001
CG	59.9 (3.4)	57.3 (3.2)	.47		
Mental health					
EX	69.2 (3.5)	77.7 (3.5)	.001	8.5 (12.8 to 5.3)	.002
CG	69.5 (3.3)	68.7 (3.6)	.61		
Role-emotional					
EX	70.0 (3.4)	84.7 (3.5)	.001	12.1 (15.5 to 7.4)	.001
CG	70.1 (3.3)	68.7 (3.6)	.48		
Social functioning					
EX	79.1 (3.8)	88.2 (3.8)	.001	8.4 (14.8 to 5.6)	.001
CG	79.2 (3.9)	79.1 (3.4)	.67		
Vitality					
EX	49.4 (3.04)	56.9 (3.2)	.001	7.3 (12.8 to 4.2)	.001
CG	49.3 (3.1)	48.6 (3.2)	.57		
Physical component summary					
EX	65.8 (3.1)	72.8 (3.2)	.001	6.6 (12.3 to 4.1)	.001
CG	66.1 (3.0)	64.1 (3.07)	.27		
Mental component summary					
EX	68.2 (3.4)	72.8 (3.3)	.003	5.5 (9.3 to 3.1)	.001
CG	68.8 (3.2)	68.6 (3.4)	.62		
BFI					
EX	7.1 (1.4)	2.8 (1.2)	< .001	–4.2 (–5.4 to –2.3)	< .001
CG	7.2 (1.4)	7.7 (1.5)	.3		

NOTE. EX (n = 123) and CG (n = 120).

Abbreviations: ANOVA, analysis of variance; BFI, Brief Fatigue Index; CG, control group; EX, exercise group; SF-36, Short Form-36 Health Status.

[a] *P* value for repeated-measures ANOVA comparing changes in the EX group from baseline to postintervention, and in the CG from baseline to postintervention.

[b] *P* value for mixed-model analysis comparing changes between the EX and CG from baseline to postintervention.

RESULTS

Patient Demographics

Patient demographics are displayed in Table 1. Of the 810 possible patients, 692 were screened for eligibility. Reasons the 118 patients were not screened include interference with COVID-19 restrictions and time to ramp up study recruitment with staff. Of those screened, 190 refused to participate in the study. Reasons cited include COVID-19 concerns, overwhelm with treatment/diagnosis, and lack of

TABLE 4. Pre to Post Changes in Fitness Parameters Within and Between Groups

Fitness Parameter	CG (%)	EX (%)	Between-Group Difference (%)	P Value for Between-Group Difference
Cardiorespiratory fitness	–1.3	9.2	10.5	.0128
Muscular endurance	2.4	13.7	11.3	.017
Muscular strength	–3.1	3.1	6.2	.03
Flexibility	1.5	14.6	13.5	.001

NOTE. EX (n = 123) and CG (n = 120). Values are mean percent change.
Abbreviations: CG, control group; EX, exercise group.

interest in the study. A total of 251 were consented and randomly assigned into the exercise or CG group. Six participants in the exercise group and two participants in the CG group did not complete the study. Baseline characteristics were similar across the two groups. On average for the EX, women were age 55.9 years, postmenopausal (63%), non-Hispanic White (62%), and 1.3 months from diagnosis, with a BMI of 28.74 kg/m^2. Women were diagnosed with stage I (42%) or II (58%) breast cancer and largely treated with chemotherapy/hormonal and/or radiation therapy (94%). Patients in the CG were of average age 57 years, non-Hispanic White (63.9%), a BMI of 30.24 kg/m^2, 2.1 months from diagnosis, stage I (41%) or II (59%), and treated with chemotherapy/hormonal and/or radiation therapy (96.7%). The average time since diagnosis was 1.2 (0.88) months for the EX group and 2.1 (0.82) months for the CG.

Adherence and Attrition

Retention across both groups was 96.5%, with 95.3% for the EX group and 98.4% in CG. Exercise adherence within the EX group was 95%, assessed by dividing the total number of possible appointments by the number of actual appointments attended. Exercise adherence did not significantly differ within the group across comorbidities. No adverse events were reported over the duration of the study.

Patient-Reported Outcomes

Tables 2 and 3 display patient-reported outcomes. Postintervention, FACT-B scores were significantly improved in EX versus CG (Table 2, between-group difference: 14.3, 95% CI, 18.3 to 9.4; $P < .001$). All SF-36 subscores significantly improved in the EX group when compared with CG (Table 3, $P < .001$). Fatigue was significantly reduced in the EX group compared with baseline ($P < .01$) and CG ($P < .001$; Table 3).

Physical Fitness

Fitness outcomes within and between the two groups are displayed in Table 4. At follow-up, CG did not experience any significant changes in any fitness parameters from baseline ($P > .05$). Conversely, in the EX group, all physical fitness measures significantly improved compared with baseline ($P < .001$). Specifically, cardiorespiratory fitness improved by 8%, muscular endurance increased by 13%, muscular strength by 3%, and flexibility by 14%.

Health Care Utilization

Total charges were averaged across all encounters to understand the average total charges per encounter; in this case, this is the bill received by the payer before adjustments. This included total unplanned expenditures, emergency room visits, hospital inpatient care, and all cancer-related outpatient and office-based visits (including supportive medications under other planned medical), and finally, total number of events. The utilization frequency of health care is summarized in Table 5. Patients in the CG had the highest total mean health care utilization across all measures (CG: $8,598 USD, compared with EX: $6,356 USD) for emergency visits, outpatient visits, office-base visits, and other medical costs. Cost of hospital inpatient care was the greatest contributor to total expenditures with mean values that ranged between $9,447 USD for EX and $11,443 USD for CG. The mean utilization frequency was also highest among patients in the CG group, with 12 events, a 58% increase over the average number of events among those in the EX group ($P < .001$). The maximum number of medical events was 27 for the entire sample. It is important to note that these expenditures were in addition to the cost of cancer care. In other words, these were unanticipated costs.

Table 6 presents the total comorbidities across the CG and exercise group at baseline. The arms were balanced in terms of comorbidity distribution, highlighting no differential bias between groups at the start of the intervention. When within-group differences were analyzed, it was determined that those with two or more comorbidities had significantly higher health care expenditures than those with one or zero ($P < .05$). Likewise, those with 2 or more

TABLE 5. Mean Unplanned Medical Expenditure and Utilization, for Each Time a Patient Used a Health Care Service for the Purpose of Managing Health Problems in Addition to the Planned Cancer Care

Health Care Utilization	CG	EX
Total unplanned expenditures, USD	$8,598 ± 2,567	$6,356 ± 1,392*
Emergency room, USD	$989 ± 241	$661 ± 210*
Hospital inpatient care, USD	$11,443 ± 4,673	$9,447 ± 5,018*
Outpatient visits, USD	$4,191 ± 1,632	$3,292 ± 1,748*
Office-based visits, USD	$3,259 ± 2,269	$1,898 ± 2,583*
Other unplanned medical, USD	$7,332 ± 1,007	$5,382 ± 1,323*
Total No. of events	12 ± 6	7 ± 7*

NOTE. This included total unplanned expenditures, emergency room visits, hospital inpatient care, and all cancer-related outpatient and office-based visits (including supportive medications under other planned medical), and finally, total number of events. CG (N = 122) and EX (N = 129). Values are mean scores.
Abbreviations: CG, control group; EX, exercise group; USD, US dollars.
*$P < .05$ (between group).

TABLE 6. Total Comorbidities

	CG		EX	
Total Comorbidities	**Frequency**	**Percent**	**Frequency**	**Percent**
0	40	33.3	38	30.9
1	43	35.8	47	38.2
2	37	30.8	38	30.8

NOTE. CG (n = 120) and EX (n = 123).
Abbreviations: CG, control group; EX, exercise group.

comorbidities in the CG had significantly higher health care utilization costs than those in the EX group ($P < .05$; Appendix Table A1, online only). Although there was a trend toward reducing health care utilization costs in the EX group for individuals with one or zero comorbidity, these differences were not significant between the groups (Table 7).

ECOG Score

At baseline, the ECOG scores did not significantly differ between the two groups. There were a total of 86 patients in the CG (71.6%) and 91 patients in the EX group (73.9%) with an ECOG score of 0 or 1. The CG had 34 patients (28.4%) and the EX group had 31 patients (26.1%) with an ECOG score of 2 or more at baseline ($P > .05$). At the follow-up, the CG had 66 patients (54.8%) with and ECOG score of 0 or 1, and 54 patients (45.2%) with ECOG scores of 2 or more. The EX group had 81 patients (66.2%) with ECOG scores of 0 or 1, and 42 patients (33.8%) with ECOG scores of 2 or more ($P < .05$). Interestingly, when the groups were stratified according to their cancer stage, the significant differences between the two groups were found among those patients with stage II breast cancer ($P < .05$), but not with those who had stage I breast cancer ($P = .07$; Table 8).

TABLE 7. Total Health Care Expenditures Across Comorbidities

Total Comorbidities	CG (USD)	EX (USD)
0	$1,458 ± 214	$1,139 ± 189
1	$2,567 ± 362	$2,224 ± 310
2	$4,573 ± 461	$29,932 ± 378*

NOTE. CG (N = 122) and EX (N = 129). Values are mean scores ± SE.
Abbreviations: CG, control group; EX, exercise group; USD, US dollars.
*$P < .05$.

TABLE 8. ECOG Scores Between and Within Groups

		CG		EX	
Timeframe	**ECOG Scores**	**Stage I (%)**	**Stage II (%)**	**Stage I (%)**	**Stage II (%)**
Baseline	0-1	42.1	29.5	43.8	30.1
	2	11.7	16.7	12.3	13.8
Follow-up	0-1	37.4	17.4	37.2	29*
	2	17.3	27.9	14.3	19.5*

NOTE. CG (n = 120) and EX (n = 123). Values are mean percentages.
Abbreviations: CG, control group; ECOG, Eastern Cooperative Oncology Group; EX, exercise group.
*$P < .05$.

DISCUSSION

A supervised, individualized 12-week aerobic and resistance exercise intervention led to significant improvements in fitness parameters and ECOG scores, as well as a decrease in health care utilization among early-stage breast cancer survivors, compared with a CG. These findings are impactful, given the cost of health care and physical deconditioning often reported by breast cancer survivors,[23] and support the work of the American Cancer Society/American College of Sports Medicine guidelines for cancer survivors.[22]

Significant improvements in fitness parameters that were observed for the patients who participated in the 12-week supervised, individualized exercise intervention align with numerous previous reports.[24-29] The ability of an individual to perform common daily activities, known as physical function, has been shown to predict survival and mortality in breast cancer survivors.[30] One predictor of this is the individual's fitness level. Therefore, improving one's physical fitness can positively affect physical function, and thereby survival rates for early-stage breast cancer survivors. This is supported by the ECOG scores measured by our EX group, which were significantly lower than the CG after the 12-week exercise program, after not differing at baseline. Our adherence of 95% exceeds the 70%-80% reported in other trials,[31-33] and may have contributed to our significant findings.

This study demonstrated both lower unplanned health care utilization and associated costs for patients who were randomly assigned to our exercise group, compared with controls. Included in this was ED visits, unplanned hospitalizations, and the cost of each episode of care that was a nonchemotherapy and/or nonradiation service. This finding is in line with previous, retrospective investigations completed by our research team,[2,34] which found that participants who exercised during cancer treatment had fewer emergency room visits, 30-day readmissions, and length of hospital stay than their sedentary counterparts. These findings appear to be driven by those with two or more comorbidities, highlighting the need for targeted exercise interventions in this population.

There is a growing demand to reduce health care costs and implement care delivery models that are patient-centered, evidence-based, and of high quality. It is thought that the positive impact of exercise on biologic and physiologic mechanisms during cancer treatment lead to a reduction in health care costs for the patient, payer, and provider alike. Despite numerous investigations that have supported the efficacy of exercise during cancer treatment, nationally, < 5% of patients are ever referred to a cancer rehabilitation program.[17] Public funding and lack of resources have been identified as significant barriers to national exercise oncology programs.[17,35] Other known barriers include lack of general knowledge about the need to stay physically active during and after cancer therapy, qualified personnel,[36] and available programs.[37] This study validates these findings by comparing our patients against themselves and showing significant cost savings. Therefore, this system of exercise oncology has the potential to contribute to a national standard of care for individuals battling cancer.

In summary, a supervised, individualized exercise intervention in early-stage breast cancer survivors demonstrated significant improvements in fitness parameters, patient-reported outcomes, and ECOG scores, as well as decreases in health care utilization. Our high adherence rate and attrition rates in both groups are believed to have contributed to the success of our study.

AFFILIATIONS

[1]Department of Kinesiology and Health, Wright State University, Dayton, OH
[2]Maple Tree Cancer Alliance, Dayton, OH
[3]Penn State College of Medicine, Hershey, PA
[4]Kettering Medical Center, Dayton, OH

CORRESPONDING AUTHOR

Karen Y. Wonders, PhD, Maple Tree Cancer Alliance, 425 N Findlay St, Dayton, OH 45404; e-mail: Karen.wonders@mapletreecanceralliance.org.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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AUTHOR CONTRIBUTIONS

Conception and design: Karen Y. Wonders, Ronald Hale
Collection and assembly of data: Karen Y. Wonders, Robert Wise
Data analysis and interpretation: Karen Y. Wonders, Kathryn Schmitz, Ronald Hale
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Cost-Savings Analysis of an Individualized Exercise Oncology Program in Early-Stage Breast Cancer Survivors: A Randomized Clinical Control Trial

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Open Payments is a public database containing information reported by companies about payments made to US-licensed physicians (Open Payments).

Kathryn Schmitz
Patents, Royalties, Other Intellectual Property: Fees from the educational program I developed that is now offered through Klose Training and Consulting

No other potential conflicts of interest were reported.

APPENDIX

TABLE A1. Total Health Care Expenditures Across Comorbidities

Total Comorbidities	CG (USD)	EX (USD)
0	$1,458 ± 214	$1,139 ± 189
1	$2,567 ± 362	$2,224 ± 310
2	$4,573 ± 461	$29,932 ± 378*

NOTE. CG (n = 122) and EX (n = 129). Values are mean scores ± SE.

Abbreviations: CG, control group; EX, exercise group; USD, US dollars.

*$P < .05$.