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Original Research

Sustained effects of theory-based physical activity intervention for socioeconomically diverse obese endometrial cancer survivors: A Longitudinal analysis

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Summary

Purpose of Investigation: Assess the sustained effects of a 12-week physical activity intervention on physical activity, physical function, waist circumference, and quality of life among urban, socioculturally diverse endometrial cancer survivors. *Materials and Methods:* Twenty-three obese women with a history of endometrial cancer within the previous five years with no evidence of cancer recurrence volunteered for a 12-week physical activity intervention based on social cognitive theory. Classes were offered 2x/week and included 30 minutes of behavioral counseling and 60 minutes of exercise. Pedometers were distributed, and participants were instructed to walk $\geq$ 90 min/week at home. A longitudinal analysis of baseline, post-intervention and 12-week follow-up response profile model was fitted using restricted maximum likelihood estimation approach. *Results:* Mean participant age was 64 $\pm$ 8 years, and BMI was 37 $\pm$ 6 kg•m^{-2}. Seventy-eight percent of participants were non-white. Improvements in waist circumference (-4.8 cm, p = 0.009), and the six-minute walk test (13 m, p = 0.042) persisted 12 weeks after the completion of the intervention. Among the psychosocial variables, walking self-efficacy (p = 0.022), and outcome expectations (p = 0.040) also retained improvements at follow-up. Quality of life, assessed using the Functional Assessment of Cancer Therapy, improved post-intervention ($p < 0.001$), but this improvement was not sustained at follow-up (p = 0.14). *Conclusion:* This physical activity intervention led to meaningful sustained improvements in physical function, waist circumference and physical activity-related psychosocial variables. Replication of these results using controlled design with larger samples sizes should be conducted to confirm these findings and determine the long-term effectiveness of physical activity interventions.

Key words: Exercise Therapy; Exercise; Quality of life; Cancer survivors.

Introduction

Approximately 62,000 new cases of endometrial cancer were diagnosed in 2019, accounting for approximately 7% of all cancers in women [1]. Furthermore, the incidence rate in the United States is predicted to increase by 50% over the next 15 years [2]. Because the survival rate is over 80%, the prevalence is high: there were approximately 635,000 women with a history of endometrial cancer in 2013 [1].

Endometrial cancer reduces physical function and quality of life, especially among obese survivors [3]. Furthermore, middle-aged endometrial cancer survivors are 50% more likely to be insufficiently active, and they perform approximately 45 minutes less moderate-intensity physical activity per week than their counterparts without cancer [4]. The rate of obesity among socioculturally diverse endometrial cancer survivors (73%) [5] is considerably higher than the rate of obesity among predominately non-Hispanic white endometrial cancer survivors (37-47%) [4], and in the general population (26-29%).

A theory-based physical activity intervention for socioculturally diverse endometrial cancer survivors was shown to be feasible, and it resulted in promising short term effects on body composition, physical function and quality of life [6]. Other physical activity intervention studies, in samples of more homogenous cancer survivors, have shown inconsistent *sustained* effects on physical activity, waist circumference and physical function [7-9], likely due to reduced physical activity following the intervention completion. Sustained adherence to a program of regular physical activity may be even lower in socioculturally diverse population due to environmental, language, and societal barriers, but this has not been well studied [10, 11]. Therefore, it is important to determine whether physical activity can be sustained after the completion of a physical activity intervention among socioculturally diverse endometrial cancer survivors.

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Table 1. — *Characteristics of 23 Endometrial Cancer Survivors at Baseline*

Age (years)	64 ± 8
Body Mass Index ($kg \cdot m^{-2}$)	37 ± 6
Time Since Cancer Diagnosis (months)	32 ± 19
Stage at Cancer Diagnosis	
Stage I	18 (78%)
Stage II	1 (6%)
Stage III	2 (12%)
Stage IV	2 (12%)
Race/Ethnicity	
Non-Hispanic Black	9 (39%)
Hispanic	8 (35%)
Non-Hispanic White	5 (22%)
Asian	1 (4%)
Education	
High School Graduate or less	8 (35%)
Some College/College Graduate	8 (35%)
Some Graduate School or Graduate Degree	7 (30%)
Employment Status	
Retired	16 (70%)
Unemployed	2 (9%)
Employed	2 (9%)
On disability	2 (9%)
Homemaker	1 (4%)
Household Income	
< $40,000	10 (43%)
$40,000 – 79,999	4 (17%)
$80,000 or more	7 (30%)
No Answer	2 (9%)

Data expressed as Mean $\pm$ Standard Deviation or as Frequency (Percentage of total).

The aim of this study was to assess the short-term sustained effects of a 12-week physical activity intervention on physical activity, physical function, waist circumference, quality of life, and psychosocial factors in a diverse sample of endometrial cancer survivors.

Materials and Methods

The methods and procedures for this study were approved by the institutional review boards of Albert Einstein College of Medicine and Teachers College, Columbia University. Informed consent was obtained from all participants prior to study enrollment. This study reports the single-group longitudinal results (baseline, post-intervention, and follow-up) of participants who completed a 12-week theory-based physical activity wait-list intervention.

Details about the protocol have been previously published [6]. The study was a pragmatic, wait-list control trial where participants were placed into one of the 2 groups: an immediate intervention group (n = 13) and wait-list (control) intervention group (n = 15). Five participants from the wait-list control intervention cohort chose not to participate in the intervention after the control period and were not included in this study analysis. Both cohorts completed identical 12-week physical activity programs, beginning in April and September, respectively. Each cohort was tested prior to the intervention (baseline), the week after the intervention (post-intervention), and 12 weeks following the completion of the intervention (follow-up). The data from the two groups were pooled for the repeated measure analysis where there was no interaction effect between group and time (Figure 1).

Women who had been diagnosed with endometrial cancer between 6 months and 5 years prior, showed no current signs of cancer, had a body mass index $\geq$ 30 $kg \bullet m^{-2}$, spoke English, and resided in Bronx, NY were recruited for this study. Participants were excluded if they had any physical or health limitation that limited physical activity participation or if they were already regularly physically active (regular moderate- to vigorous-intensity physical activity of 30 minutes $\geq$ 3x/week in the previous 3 months).

Recruitment was conducted via telephone calls to a list of 155 potentially eligible participants provided by gynecologic oncologists at Montefiore Medical Center in Bronx, NY. After confirming eligibility according to BMI and residence in the medical record, phone calls were made to 140 women. Contact was made with 83 of those women, of whom 43 declined to participate, primarily due to being too

Table 2. — *Model predicted means, standard error and p-values over time by cohort: Physical activity, waist circumferences, physical function and quality of life at baseline, immediately following (post-intervention) and 12 weeks after (follow-up) a physical activity intervention for 21 endometrial cancer survivors.*

Outcome Measure Group	Baseline	Post-intervention	Follow-up	Difference between baseline–post intervention *p*-value*	Difference between baseline–Follow-up *p*-value*
YPAS Summary Index					
Imm. Intervention	27.3 ± 5.6	69.2 ± 6.6	47.8 ± 7 .3	< 0.001	0.07
Del. Intervention	57.8 ± 6.6	58.5 ± 7.2	44.4 ± 8.4	1	0.68
Log Waist Circumference‡					
Imm. Intervention	3.8 ± 0.03	3.7 ± 0.03	3.7 ± 0.03	< 0.001	0.009
Del. Intervention	3.8 ± 0.03	3.7 ± 0.03	3.8 ± 0.03		
6 MWT (meters)					
Imm. Intervention	428 ± 22	447 ± 23	438 ± 23	< 0.001	0.042
Del. Intervention	424 ± 26	447 ± 26	439 ± 26		
Chair stands (repetitions)					
Imm. Intervention	11.3 ± 0.8	13.8 ± 0.9	14.0 ± 0.9	0.002	0.001
Del. Intervention	12.6 ± 0.9	13.1 ± 1.0	12.7 ± 1.1	1	1
FACT-En					
Imm. Intervention	141.8 ± 3.3	152.8 ± 3.6	148.5 ± 3.9	< 0.001	0.14
Del. Intervention	143.3 ± 3.8	154.4 ± 3.9	150.0 ± 4.2		
FACT-G					
Imm. Intervention	86.9 ± 2.2	92.6 ± 2.5	92.1 ± 2.7	0.014	0.11
Del. Intervention	89.6 ± 2.6	95.3 ± 2.7	94.8 ± 2.9		
Physical Well Being					
Imm. Intervention	22.6 ± 0.7	21.9 ± 0.8	22.4 ± 0.9	0.75	1
Del. Intervention	21.5 ± 0.7	20.8 ± 0.8	21.3 ± 0.8		
Social Well Being					
Imm. Intervention	22.5 ± 1.0	24.9 ± 1.1	24.5 ± 1.2	0.027	0.22
Del. Intervention	22.9 ± 1.1	25.2 ± 1.2	24.8 ± 1.3		
Emotional Well Being					
Imm. Intervention	19.9 ± 0.6	22.2 ± 0.6	20.9 ± 0.7	< 0.001	0.41
Del. Intervention	22.1 ± 0.6	24.3 ± 0.7	23.0 ± 0.7		
Functional Well Being					
Imm. Intervention	21.8 ± 0.9	23.5 ± 1.0	24.0 ± 1.1	0.05	0.06
Del. Intervention	23.2 ± 1.1	24.9 ± 1.1	25.4 ± 1.2		
Endometrial Subscale					
Imm. Intervention	55.0 ± 2.0	60.3 ± 2.1	56.5 ± 2.5	< 0.001	0.91
Del. Intervention	53.7 ± 2.3	59.0 ± 2.3	55.2 ± 2.5		

Data expressed as Mean ± Standard Error

For variables with a statistically significant interaction effect ($p \leq 0.05$), pairwise comparisons were conducted within each cohort. In cases where the interaction effect was not significant, the data from both groups were pooled for the pairwise comparisons.

*Bold values indicate statistically significant Bonferroni adjusted *p*-values for pairwise comparison of outcomes over time ($p \leq 0.05$).

YPAS: Yale Physical Activity Survey; 6MWT: Six-minute walk test; FACT-En: Functional Assessment of Cancer Therapy – Endometrial Cancer; FACT-G: Functional Assessment of Cancer Therapy – General; Imm.: Immediate; Del.: Delayed

‡ WC was log-transformed for the analysis

All models are adjusted for adherence (< = 18 classes *vs.* > 18 classes)

busy or being unwilling to exercise. Six women agreed to participate but did not attend the baseline testing, and six others were excluded due to BMI below 30 kg•m^{-2} or not speaking English.

The intervention was developed based on social cognitive Theory [12]. Ninety-minute exercise and health behavior change counseling classes were offered twice each week for 12 weeks. Participants were instructed to attend at least one class each week, but they were encouraged to attend both classes if possible.

Table 3. — *Model predicted means, standard error and p-values over time by cohort for social cognitive theory health behavior change at baseline, immediately following (post-intervention) and 12 weeks after (follow-up) a physical activity intervention for 21 endometrial cancer survivors.*

Outcome Measure Group	Baseline	Post-intervention	Follow-up	Difference between baseline–post intervention p-value*	Difference between baseline–Follow-up p-value*
Walking self-efficacy (1-5)†					
Imm. Intervention	2.4 ± 0.3	3.4 ± 0.4	3.4 ± 0.4	0.001	0.022
Del. Intervention	2.6 ± 0.4	3.7 ± 0.4	3.7 ± 0.4		
Barrier self-efficacy (1-5)†					
Imm. Intervention	3.2 ± 0.2	3.7 ± 0.3	3.2 ± 0.3	0.26	1
Del. Intervention	2.9 ± 0.3	3.4 ± 0.3	2.9 ± 0.3		
Self-regulation (RAI) †					
Imm. Intervention	10.4 ± 1.7	14.2 ± 1.8	12.8 ± 1.8	0.002	0.11
Del. Intervention	9.4 ± 1.9	13.2 ± 2.0	11.8 ± 2.1		
Outcome Expectations (1-5) †					
Imm. Intervention	3.5 ± 0.1	3.8 ± 0.2	3.8 ± 0.2	0.03	0.04
Del. Intervention	3.5 ± 0.2	3.8 ± 0.2	3.8 ± 0.2		
Social Support (20-100) †					
Imm. Intervention	32.1 ± 3.2	31.8 ± 3.8	32.2 ± 3.8	1	1
Del. Intervention	43.1 ± 3.5	42.9 ± 3.8	43.3 ± 4.1		

Data expressed as Mean ± Standard Error †Higher values indicate more positive attribute

RAI: Relative Autonomy Index

***Bold values** indicate statistically significant Bonferroni adjusted p-values for pairwise comparison of outcomes over time by groups ($p < 0.05$)

Imm.: Immediate; Del.: Delayed

All models are adjusted for adherence (<=18 classes *vs.* >18 classes)

Each class began with 30 minutes of health behavioral counseling, during which time the instructor led group discussions about practical methods for improving the underlying psychosocial constructs that mediate physical activity behavior change consistent with Social Cognitive Theory, such as self-efficacy, social support, and outcomes expectations. Following the 30-minute discussion, participants were led through a 60-minute exercise class, which included a warm-up, dance fitness, body weight resistance exercises and stretching.

Pedometers and individualized walking route maps from the participant's home addresses were distributed to each participant in order to facilitate home-based walking. Participants were instructed to walk at least 90 minutes per week in order to achieve 150 minutes per week of moderate- to vigorous-intensity physical activity as recommended by the American College of Sports Medicine [13].

The Yale Physical Activity Survey (YPAS) [14], which has been validated among culturally diverse older adults was used to assess physical activity [15]. The YPAS Summary Index assesses several domains of physical activity, including vigorous activity, walking, and activities of daily living, and also adjusts the scores for participant perceptions of seasonal variations in physical activity, which was important for this study due to the length of the intervention and follow-up periods.

Height and post-urination weight were measured using a Detecto 439 Mechanical Scale with height rod. Waist circumference (WC) was measured in duplicate according to the protocol described by Lopez de la Torre *et al.* [16], in which the circumference is measured at the midpoint between the last rib and the iliac crest. Body Mass Index (BMI) was calculated from measured height and weight ($m \bullet kg^{-2}$).

Several tests measuring physical function, and indirectly fitness, were used to assess the potential impact of the intervention on activities of daily living. The six-minute walk test (6MWT) is a valid and highly reliable test among overweight and obese women [17] that assesses cardiorespiratory and walking function, and was administered following the guidelines from the American Thoracic Society [18]. Using a 30.5-meter hallway section, the distance participants walked in 6 minutes was recorded. The 30-second chair stand test, which is a reliable and valid measure among high functioning older adults similar to our sample [19], was administered following the 6MWT as an indirect assessment of lower body function and strength. The number or times participants reached complete standing position in 30 seconds was recorded.

Quality of life was assessed using the Functional Assessment of Cancer Therapy – Endometrial Cancer (FACT-En) questionnaire, which is comprised of the FACT-General (FACT-G), plus 16 endometrial cancer-specific questions. The FACT-G is comprised of 27 questions querying physi-

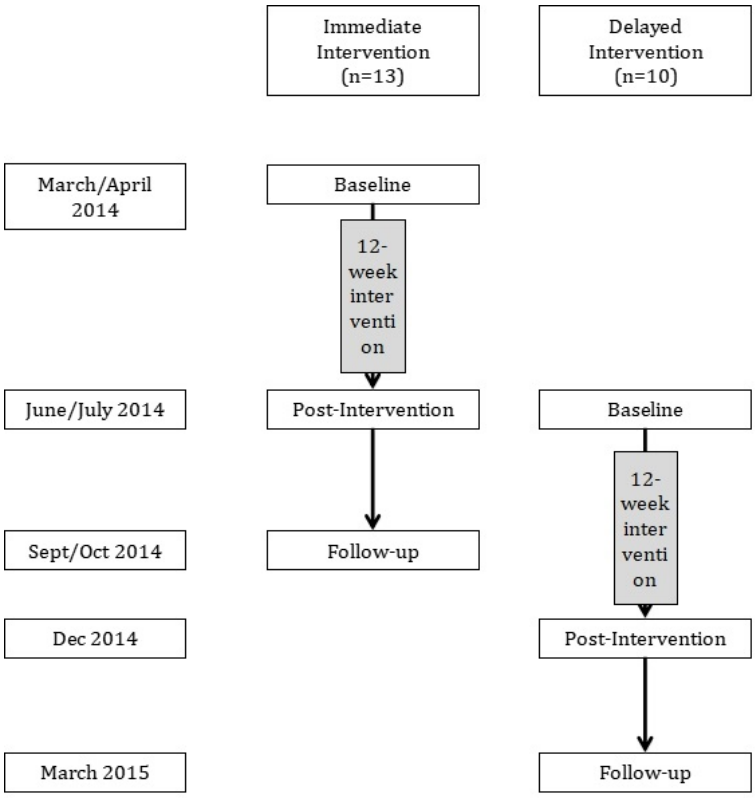

Figure 1. — Flow diagram for study participation.

cal, social, emotional, and functional well-being for all cancer survivors. The FACT questionnaires are validated measures of physical, social, emotional, and functional well-being among cancer survivors [20].

Several parameters associated with Social Cognitive Theory were measured in order to evaluate some of the processes underlying physical activity behavior change. A ten-item Self-Efficacy of Walking Scale [21], which asks participants how confident they are that they will be able to walk at a moderately fast pace for different time frames, was used to asses exercise self-efficacy. The 9-item Self-Efficacy for Exercise Scale [22], which asks participants how confident they are that they would continue their physical activity when confronted with barriers such as a boring program or poor weather, was used to assess barrier self-efficacy. The second version of the Behavioral Regulations in Exercise Questionnaire [23] was administered to assess self-regulation. Social support was assessed using the Social Support and Exercise questionnaire [24]. Outcome expectations were assessed using the 9-item Outcome Expectations for Exercise questionnaire [25]. For each measure, higher scores indicate higher expression of the attribute.

Demographic variables, including age, education level, socioeconomic status, marital status, employment status, and ethnicity, were self-reported via questionnaire. Cancer stage, histopathology and previous treatments were obtained from review of medical records. The data were summarized numerically using descriptive statistics and graphically for each arm. Normality was assessed using the Anderson-Darling test; transformation was used when normality was not satisfied. The endpoint of 150 minutes per week of physical activity pre-and post-intervention was tested using the exact McNemar chi-square test. Post-intervention physical activity between the groups was tested using Fisher's exact test. In order to assess the impact of theory-based intervention and its sustained effect on physical activity, body composition, physical function, quality of life and socio-behavioral variables, a longitudinal analysis of covariance pattern model was fitted using the restricted maximum likelihood estimation approach. The within-subject correlation was examined using different covariance structures and the best model was selected using Akaike Information Criterion (AIC) criteria. Each response model adjusting for adherence was fitted with the intervention group, with time as a categorical variable and group-by-time interaction to adjust for cohort and period effect. When the interaction effect was not statistically significant, a reduced model with group and time was fitted. We also examined difference post estimation means and multiple hypotheses were adjusted using Bonferroni correction. Two participants, one in each cohort, had influential observations, so a sensitivity analysis was performed excluding those two participants. All results presented in this paper are based on the reduced sample.

Initial power analysis was conducted by comparing between two intervention arms in which participants per-

formed 150 minutes of physical activity at the end of the intervention. It was estimated that 12 participants per group by binomial enumeration (13 participants/group by normal approximation) would be required. Assuming 20% attrition, a total of 30 participants would be required to achieve 80% power to detect a difference of 60% proportion change (wait-list control vs intervention: 20% *vs.* 80%) at 5% level of significance. An interim power analysis was conducted nearing the end of recruitment with 21 participant providing both measurements. The interim analysis focused on assessing sustainability of 150 minutes per week of physical activity (baseline to post intervention) given that the intervention was identical except for the implementation delay. It was estimated that a total sample size of 16 (20 with 20% attrition) would achieve 99% power to detect the difference of 60% improvement (post-baseline) using a two-sided exact test (binomial enumeration method) with a 5% level of significance.

Results

Participant characteristics are summarized in Table 1. The data show a socioculturally diverse sample with 78% non-white participants, varied educational backgrounds, and household income. Only 2 of the 23 participants were employed. Twelve participants were Class 1 Obese (BMI: 30-34.9 kg•m^{-2}), five were Class 2 Obese (BMI: 35-39.9 kg•m^{-2}), and six had BMI over 40 kg•m^{-2}.

Of the 23 participants who started the 12-week intervention, 4 (17%) women dropped out within the first 4 weeks or never attended class. Two others completed the intervention but did not attend the post-intervention session. Of the remaining 17 participants, 13 missed one week or less, and four others attended during 7-10 of the 12 possible weeks. Furthermore, several participants attended both available classes each week, such that the mean (SD) number of classes attended was 17 [4].

There was a significant difference in the proportion of patients performing at least 150 minutes per week of physical activity at baseline (18%, 5 out of 28) and post-intervention (76%, 16 out of 21) ($p < 0.01$).

Participants were tested at baseline, immediately following the 12-week intervention (post-intervention), and 12 weeks after the end of the intervention (follow-up). The post estimation means, standard errors and p-values of the findings for physical activity, waist circumference, physical function and quality of life are presented in Table 2.

We examined the effects of cohort and period effects on all the outcomes by modeling group and time interaction. Significant group x time interaction effects were found for the YPAS Summary Index ($p < 0.001$), and 30 second Chair Stands ($p = 0.047$). There was no significant interaction effect for any of the other outcome variables, so the data were reduced to estimate the effects as single cohort.

The YPAS Summary Index in the immediate intervention cohort increased approximately 42 points post-intervention ($p < 0.001$) and was still over 20 points higher at 12-week follow-up compared to baseline ($p = 0.07$). However, similar effects were not observed in the wait-list control. Similarly, sustained improvement in 30-second chair stand repetitions was statistically significant only in the immediate intervention group, with an average increase of 2.5 and 2.7 repetitions at post-intervention ($p = 0.002$) and follow-up period ($p = 0.001$) compared to baseline, respectively.

Statistically significant improvements in waist circumference and the six-minute walk test were observed at post-intervention and follow-up. Waist circumference decreased by 5.4 cm at post-intervention ($p < 0.001$) and remained 4.8 cm smaller than baseline at follow-up ($p = 0.009$). Six-minute walk test distance improved by 21 meters at post-intervention ($p < 0.001$) and remained 13 meters farther at follow-up ($p = 0.042$).

There were significant improvements in quality of life scores post-intervention for the FACT-En, FACT-G, as well as four out of five subscales ($p \leq 0.05$). Though quality of life scores showed improvements at the follow-up assessment, they were not statistically significantly different from baseline.

Among the Social Cognitive Theory variables (Table 3), walking self-efficacy and outcomes expectations each improved following the intervention and remained significantly elevated at follow-up ($p < 0.05$). Self-regulation improved approximately 4 units at post-intervention ($p = 0.002$), and remained elevated by 2.5 units at follow-up compared to baseline, but the sustained improvement was not statistically significant ($p = 0.11$).

Higher Adherence (> 75% attendance; 19-24 classes) was associated with increased YPAS index score (11.5 units, $p = 0.08$), 30-second chair stands (11.5 stands, $p = 0.03$), FACT-Endometrial scale (1.5 units, $p = 0.007$), FACT-General (11.4 units, $p = 0.001$) compared to those with lower adherence (<= 18 classes). Higher adherence was also associated with increased quality of life subscales: physical well-being (3.7 units, $p = 0.005$), social well-being index (2.4 units, $p = 0.06$), emotional well-being (1.8 units, $p = 0.03$), functional well-being (3.5 units, $p = 0.01$). Of the behavioral variables, walking and barrier self-efficacy variables were associated with adherence.

Discussion

Improvements in physical function and body composition were sustained, as were walking self-efficacy and outcomes expectations related to exercise 12 weeks after the completion of the intervention, even though physical activity increases were not sustained. These findings illustrate the potential for theory-based interventions result in longer-term improvements in health-related outcomes among obese socioculturally diverse endometrial cancer survivors.

The results from our study with respect to waist circumference and six-minute walk test distance were similar to previously published reports, with large effect sizes for the

sustained improvements observed in waist circumference and the six-minute walk test. A previous study of obese endometrial cancer survivors found that waist circumference decreased over the course of the intervention and was maintained for 6 months [26]. However, that study provided significant additional feedback support such as newsletters and telephone calls during the follow-up period whereas the current study did not. These findings also confirm previous results that improvements in endurance walk tests are maintained, as was reported by Pinto *et al.* [27] in breast cancer survivors three months after the intervention. These improvements in abdominal adiposity and physical function suggest that even a short-term intervention may have long-lasting implications on cardiovascular disease risk and the ability to maintain activities of daily living, even without sustained physical activity increases.

Sustainment of physical activity following this intervention was less robust than found by other studies. For example, a recent systematic review of randomized controlled trials that administered exercise in academic health care settings for cancer survivors found that intervention-related improvements in physical activity and other health related indices were maintained for 3-12 months in seven of the eight studies [28]. There are a number of possible reasons for the discrepancies in the results; these include differences in the sociodemographic characteristics of the study samples, the nature and dose (e.g., frequency and length) of the interventions, and outcome measurements employed. The current study sampled a socioculturally diverse population in which only 22% of the participants where non-Hispanic white, whereas the participants in the studies included in the systematic review were predominately ($\geq$ 88%) non-Hispanic white [28]. Furthermore, previous interventions with cancer survivors in which physical activity remained elevated [9, 26, 29-32] utilized objective assessments such as accelerometers or pedometers. In the current study, the Yale Physical Activity Survey may not have been sensitive enough to detect small changes, given the small sample size and variability in scores. Lastly, other studies provided more individualized support via telephone calls, one-on-one counseling sessions and personal training sessions [9, 26, 29, 31, 32], which may have led to greater sustained adherence to increased physical activity.

In the current study, which offered only minimal incentives, such as parking/travel reimbursement, t-shirts, and fitness DVDs, the total attrition was 39% (9 out of 23); six dropped out during the intervention, and another three who completed the intervention could not be reached for the 12-week post-intervention follow-up. Although the current follow-up period (12-weeks) was relatively short, the attrition was toward the high end of the previously reported dropout rates (10-44%), which was expected, given the higher rate of attrition observed in previous interventions with racial minority groups [33]. This relatively high rate of attrition, combined with the small sample size, may have reduced the ability to detect health-related changes in the current study. Subsequent studies with similar populations should enroll more participants in order to account for a higher dropout rate.

In the current study, health-related quality of life assessed using the FACT-En improved following the intervention, but the magnitude sustained during the follow-up was not statistically significant. These results are difficult to put in context because of the lack of studies regarding the effects of physical activity and quality of life among endometrial cancer survivors. Previous studies with the same population have found a significant, moderate-strength association between physical activity and the FACT-En and FACT-G [34]. In breast cancer survivors, quality of life decreased in a control group over the course of six-months [9], such that even a small increase in quality of life observed in the current study may have been an improvement compared to not having completed any intervention. Future sustained effects studies should include a control group in order to determine the sustained effects of physical activity interventions on quality of life.

In the current study, among psychosocial variables, walking self-efficacy and outcomes expectations remained significantly elevated at follow-up, indicating that the walking portion of the intervention and the lessons learned during the intervention were retained by the participants. Since walking is the primary mode of physical activity in similar populations [5], future interventions with socioculturally diverse populations may try to include comparable walking self-efficacy components in order to maintain the sustained benefits of physical activity interventions.

The primary limitations of the current study were the lack of a control group for the 12-week follow-up part of the study, and relatively small sample size. The time from baseline test to the follow-up was nearly 6 months long. Since this population is highly sedentary and obese, it is likely that physical activity and the other outcome measures would have decreased over the course of the study in a control group in the absence of the intervention. Additionally, wait-list controls can induce cohort and period effects in outcomes, but this was not observed in the current study. Future studies should include a concurrent control group for the entire follow-up period and recruit more participants in order to confirm the positive outcomes observed in the current study and clarify the sustained impact of similar interventions on physical activity.

Conclusion

Improvements in the six-minute walk test, waist circumference, and two health behavior change variables were sustained for twelve weeks following the intervention, indicating the promise of such interventions. Similar studies using controlled design with larger samples sizes should be conducted to confirm these findings.

Authors' contributions

AR contributed to all parts of the study. CEG contributed to the study design, data analysis and manuscript preparation. MO contributed to the study implementation, data collection and manuscript preparation. VS contributed to the data analysis and manuscript preparation. DYK contributed to the study design, study implementation, and manuscript preparation. NSN contributed to the study design, participant recruitment, study implementation, data analysis and manuscript preparation.

Ethics approval and consent to participate

Written informed consent, including the opportunity to ask questions, was obtained from each participant prior to study enrollment. The institutional review board of Montefiore Medical Center approved this study (IRB# 2013-2089).

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Conflict of interest

The authors report no conflicts of interest.

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