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Effects of Theory-Based Behavioral Interventions on Physical Activity Among Overweight and Obese Female Cancer Survivors: A Systematic Review of Randomized Controlled Trials

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Abstract

Purpose. To determine whether theory-based physical activity (PA) interventions for overweight and obese female cancer survivors lead to increased PA and improved health. *Methods.* This systematic review examined randomized controlled trials analyzing the impact of theory-based PA interventions on overweight and obese female cancer survivors through December 2016. Searches of 5 electronic databases revealed 10 articles that included 1351 participants who met the inclusion criteria. *Results.* Participants were primarily non-Hispanic white (74%-100%) breast or endometrial cancer survivors. Intervention characteristics and PA assessment tools varied greatly. Adherence (68%-99%) and retention (79%-100%) were relatively high. Social cognitive theory was utilized as the theoretical construct in 9 of the 10 studies. Home-based interventions led to small improvements in PA (Cohen's *d* range = 0.25-0.31), whereas home-based plus center-based interventions led to moderate to large improvements (Cohen's *d* range = 0.45-1.02). Only three of the studies assessed psychosocial behavioral processes associated with PA, and the results were mixed. Health-related outcomes included improvements in aerobic fitness (Cohen's *d* = 0.32-1.1 in 5 studies), large absolute decreases in waist circumferences (>6 cm in 3 of 5 studies; Cohen's *d* = −0.31 to −1.02), and no change in inflammatory biomarkers (in 2 studies). Only one serious adverse event (pelvic stress fracture) was attributed to the interventions. *Conclusions.* Theory-based PA interventions are safe and feasible for overweight and obese female cancer survivors. Interventions that include a center-based component showed moderate to large effect sizes for PA. Future studies should evaluate behavioral variables and more health-related clinical outcomes.

Keywords

physical activity, cancer survivor, exercise, theory-based, intervention

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Introduction

There were approximately 7.6 million female cancer survivors living in the United States as of 2014, and it is expected that there will be an additional 2 million in the next 10 years.[1] Breast and endometrial cancer survivors account for nearly 50% of all female cancer survivors, and more than 25% of all cancer survivors. Observational evidence suggests that physical activity reduces the risk of lung,[2] breast,[3] colorectal,[4] and endometrial cancers[5] among women and has been shown to improve treatment outcomes for female survivors of lung,[6] breast,[3] and colorectal cancer.[7] The benefits of physical activity on endometrial cancer survivorship have not yet been established,[8] but preliminary results are promising.[9]

Although physical activity may benefit cancer survivors, female cancer survivors are not likely to improve physical activity behaviors following cancer treatment.[10] Furthermore, endometrial cancer survivors are less physically active than comparable women without endometrial cancer.[11] This may be in part because physical activity

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prescriptions are not a uniform part of the standard of care for female cancer survivors.[12] Moreover, female cancer survivors may avoid physical activity because they are too busy[13] or because of low self-efficacy and lack of enjoyment from physical activity, among other factors.[14] Some female cancer survivors also report being too self-conscious of their body image to be physically active.[13] It is vital, therefore, to identify components of effective behavioral interventions to increase physical activity among female cancer survivors.

A recent review of 10 behavioral interventions for female breast cancer survivors completed through July 2012 indicated that behavioral interventions may be an effective method for increasing physical activity,[15] although the analysis did not consider differential effects of the interventions based on baseline body mass index. Other studies report that obese women exhibit different health behavior patterns compared with healthy weight control participants.[16] Overweight and obese female cancer survivors are up to 47% less physically active[17,18] and have lower exercise self-efficacy[19] compared with healthy-weight cancer survivors. These findings indicate that an updated systematic review is warranted to explore the effects of behavioral interventions on overweight and obese female cancer survivors.

There is growing evidence that theory-based interventions are more effective at changing health behaviors than atheoretical interventions.[20] Theory-based interventions also provide a useful framework for analyzing the underlying factors that may have mediated any associated physical activity improvements. Therefore, the aim of this systematic review was to determine whether theory-based interventions for overweight and obese female cancer survivors, regardless of cancer site, led to an increase in physical activity. A secondary aim was to evaluate associated psychosocial variables and health-related outcome measures related to physical activity.

Methods

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[21]

Literature Search

Comprehensive searches of The Cumulative Index to Nursing and Allied Health (CINAHL), PsycINFO, PubMed, Scopus, and EMBASE databases were used to identify relevant English-language articles. The keywords used for the searches are detailed in Supplemental File 1 (available at: http://journals.sagepub.com/home/ict/supplemental-data). For example, using the PubMed database, an advanced Boolean search was conducted using (Cancer AND Survivor*) AND (Intervention OR Program OR Theory-based) AND (Randomized Controlled Trial) AND (Physical Activity OR Walking OR Exercise OR Sedentary). The reference lists of qualifying articles were also searched for nonindexed research sources.

Inclusion Criteria

To be included in the systematic review, studies must have met the following criteria: (1) randomized controlled trial published through December 2016; (2) administered a theory-based intervention aimed at increasing physical activity behaviors; (3) at least 90% of the participants were female cancer survivors (all sites), or physical activity results presented separately for men and women separately; (4) have a mean BMI among women of ≥30 kg/m^2; (5) assessed physical activity before and after the intervention; and (6) written in the English language. In studies that met all the inclusion criteria but did not report BMI (n = 4), the study authors were contacted to determine the baseline BMI.

Study Selection Process. A search was conducted in January 2017 of all articles published from earliest available through December 2016. The titles and abstracts of articles retrieved through the searches were preliminarily screened to assess inclusion by 2 authors (AR and CF). Articles were immediately excluded if it was clear that they did not meet the inclusion criteria described above or if they were duplicates from previous searches. The articles that passed the initial screening were further analyzed (by AR and CF) to determine whether they met the inclusion criteria. For a flow diagram, see Figure 1.

Data Extraction and Quality Assessment

Bibliographic information (authors, title, publication year), sample characteristics, intervention (type, frequency, duration, length), intervention theoretical framework (social cognitive theory, theory of planned behavior, etc), behavioral constructs incorporated (barrier identification, self-talk, goal setting), subjective and/or objective physical activity outcome measures, and health-related outcomes were extracted. In cases of incomplete or inconsistent data, study authors were contacted by AR. Each included study was assessed for quality using an adapted version of previously developed criteria,[22] which scores studies on a scale of 7 to 21 using 7 equally weighted categories (see Table 1). It was determined a priori that scores between 19 and 21 would indicate low risk of bias, scores between 16 and 18 would indicate moderate risk of bias, and scores of 15 or lower would indicate high risk of bias. In case of disagreement between the 2 primary authors (AR and CF) regarding outcome measures or study quality, a third author (LC) reviewed the data to determine the correct finding.

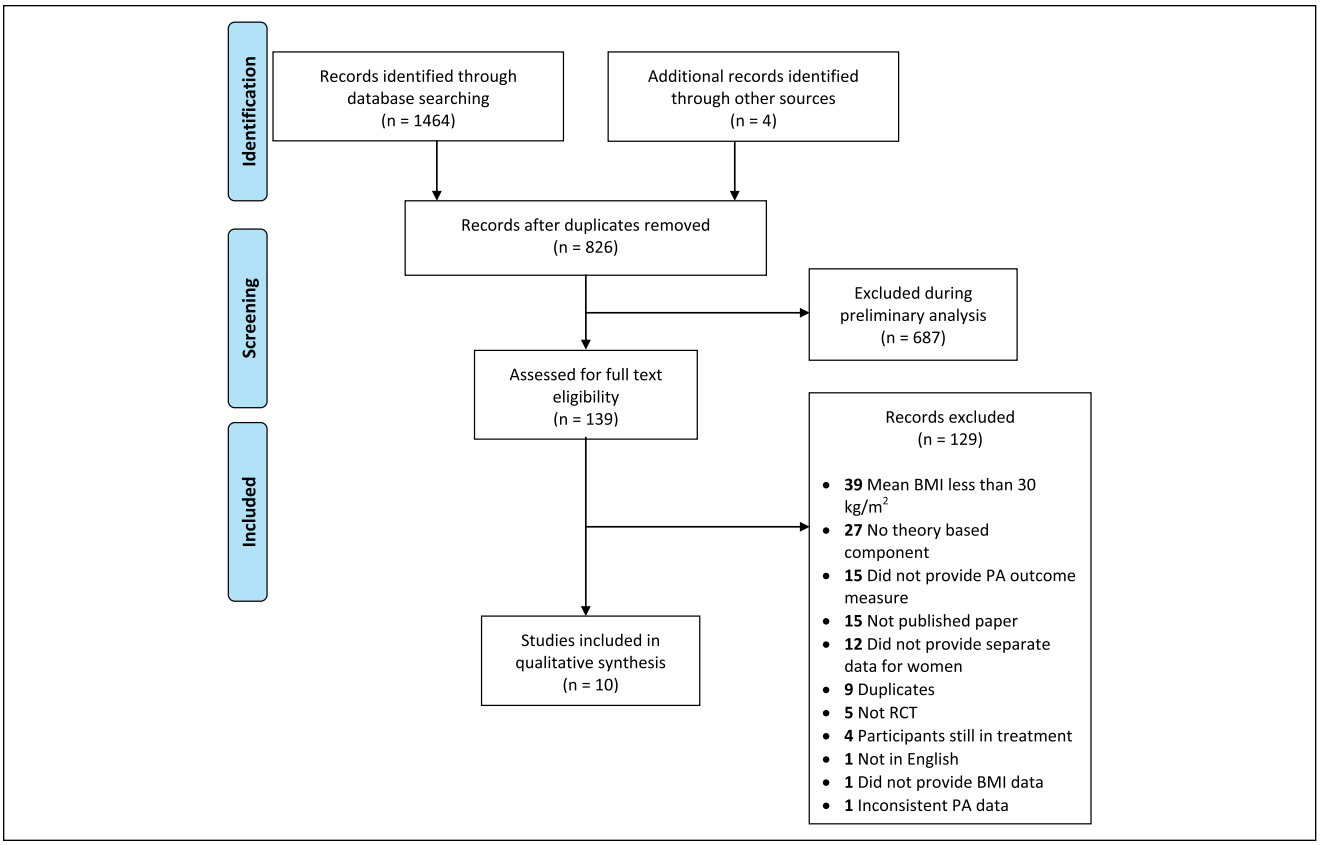

Figure 1. Systematic review inclusion flow diagram.
Abbreviations: BMI, body mass index; RCT, randomized controlled trial; PA, physical activity.

Table 1. Criteria and Grading Study Quality.[a]

Criteria	Grade	Description
Randomization	1	Groups were not randomized and presence of discrepancies in baseline characteristics
	2	Groups not randomized but were well matched
	3	Groups were randomized
Compliance with the study	1	Losses were greater than 30% or not reported
	2	Losses were between 21% and 30%
	3	Losses were 20% or less
Compliance with the intervention	1	Less than 50% or not reported
	2	Between 50% and 70%
	3	70% Or greater
Behavioral intervention	1	No specific theory basis for intervention
	2	Specific intervention but subjective measure of PA
	3	Specific intervention and objective measurement of PA
Confounding variables[b]	1	Lack of control for confounding variables (<3 variables)
	2	Control over some confounding variables (3-4 variables)
	3	Control over most confounding variables (5+ variables)
Duration of the trial	1	Less than 3 months
	2	3-6 Months
	3	Greater than 6 months
Sample size	1	Less than 20 per group
	2	20-40 Per group
	3	+40 Per group

[a]Criteria adapted from Hind and Burrows.[22]
[b]Age, body mass index, baseline physical activity, diet, stage at diagnosis, attention.

Results

Participant Characteristics

From an initial 826 articles assessed, 10 randomized controlled trials, which cumulatively included 1351 participants, met the eligibility criteria, and were analyzed in this systematic review (Figure 1). Seven of the studies assessed the impact of behavioral interventions on breast cancer survivors only,[23-29] 2 on endometrial cancer survivors only,[9,30] and 1 assessed primarily breast cancer survivors and some colorectal cancer survivors.[31] Each of the studies included only female participants, except for 1 study that included colorectal cancer survivors, in which 92% of the participants were women.[31] The mean ages of participants in the included studies ranged from 52 to 61 years, and the mean BMI ranged from 30.9 to 43.5 kg/m^2. Participants in each study were primarily non-Hispanic white (74%-100%).

Intervention Characteristics

The duration, delivery method, and frequency of the interventions varied greatly between studies (Table 2). The interventions lasted either 12 weeks,[26-29] 16 weeks,[24,31] 6 months,[9,30] or 1 year.[23,25] The primary aims of the interventions were to improve both diet and physical activity,[9,23-25,30] physical activity exclusively,[26,27,29,31] or fatigue.[28] Two of the interventions were entirely home based, 1 provided print materials sent every 2 months,[23] and 1 used near-weekly 30- to 45-minute telephone calls.[31] The other 8 studies administered interventions through a combination of home-based and center-based activities occurring semiweekly, weekly, or biweekly during the first 6 to 16 weeks and then biweekly or monthly until the intervention end point.

Of the 10 studies, 7 incorporated inclusion/exclusion criteria that participants must not have been physically active prior to enrollment, with the specific criteria being quite varied, ranging from no structured physical activity program in the preceding 6 months,[9] to <40 min/wk of moderate-intensity physical activity,[28] to <150 min/wk of moderate-intensity physical activity.[9] The reported changes in physical activity were similar for the 3 studies that did not have a physical activity enrollment criterion[24,25,30] (Cohen's d = 0.45-0.79) compared with the 7 studies that did (Cohen's d = 0.24-1.15).

Four of the studies incorporated in-person exercise classes during the first 6 or more weeks of the intervention,[26-29] and 5 studies distributed physical activity monitors[9,23,30,31] or heart rate monitors[29] as a motivational device as part of a home-based intervention. Out of the 8 included studies that incorporated both center- and home-based components, 2 administered the center-based followed by the home-based intervention,[24,25] whereas the other 6 interventions[9,26-30] had the home-based activities concurrent with the center-based portion of the intervention. In each case, the interventions were front-loaded, such that more behavioral counseling and/or exercise classes occurred during the first several weeks and then tapered off toward the end of the intervention. Only 2 of the 8 studies that included a center-based component reported on the type of facility utilized, and both those were academic centers.[28,29]

The control groups were given either usual care[9,24-31] or standard diet and exercise materials.[23] All the included studies used as a framework either the social cognitive theory alone[9,25-31] or in conjunction with the transtheoretical model,[23] except for one, which was based on the theory of cognitive behavioral therapy.[24]

Physical Activity–Related Outcomes

Physical activity outcomes in 8 of the studies were assessed using the Godin Leisure Time Physical Activity Questionnaire[9,23,25,26,29,30] or the 7-day physical activity recall.[24,31] Pedometers[9] or accelerometers[23,26-29] were used to measure physical activity in addition to questionnaires in 4 studies and as the sole measurement of physical activity in 2 studies.[27,28]

The 2 studies that provided exclusively home-based behavioral interventions failed to detect significant increases in any measure of physical activity in the intervention groups.[23,31] Effect sizes for the home-based interventions, which were calculated post hoc, ranged from a Cohen's d of 0.25 to 0.31, indicating a small, but positive effect. Of the 8 studies that administered home-based combined with center-based interventions, 5 observed significant improvements in self-reported physical activity,[30] pedometer or accelerometer physical activity counts,[26,28] or both.[9,29] The questionnaire-based physical activity assessments showed moderate- to vigorous-intensity physical activity (MVPA) improvements resulting from the interventions (range = 18-138 min/wk, Cohen's d = 0.16-0.65).[9,23-26,29,31,32] Similarly, the objective physical activity assessments indicated that the interventions led to an increase in MVPA (range = 32-84 min/wk, Cohen's d = 0.24-1.15).[9,23,26-29] Two studies had moderate to large effect sizes (Cohen's d = 0.77-0.79) but did not find significant change compared with the controls.[24,27]

The primary aim of 5 of the studies was to increase physical activity,[26-29,31] whereas the other 5 aimed to improve both physical activity and diet.[9,23-25,30] As was noted for methodological differences regarding inclusion criteria, there were no differences in the effect sizes for the physical activity outcomes between these 2 types of studies. Adherence (68%-99%) and retention (≥79%) were relatively high in each of the included studies, indicating the acceptability and feasibility of these types of physical activity interventions for this population.

Several health behavior change techniques[33] were used to maximize the effectiveness of the study. The most common behavior change strategies were the

Table 2. Summary of Main Study Characteristics and Physical Activity Outcomes of Included Studies.

	Sample Characteristics	Cancer Site	Study Design, Duration	Setting	Theoretical Framework	Intervention Details	Physical Activity Measure(s)	Physical Activity Outcome (Intervention vs Control)
Demark-Wahnefried et al[17] (2014)	• n = 68 • 100% ♀ • Age (years): 61.3 ± 7.4 • BMI: 31.0 ± 2.6 • Race: 74% white	Breast	RCT, 1 year	Home based (print materials)	SCT, TTM	• G_0: Standard diet and exercise materials, attention matched • G_1: Individual diet and exercise intervention; print materials sent every 2 months to increase self-efficacy; activity monitors distributed • G_2: Same as G_1, but diet and exercise intervention focused on achievement through mother-daughter bond	• Subjective: Godin LTE • Objective: accelerometry	• Subjective: +3 MET h/wk (NS, estimated Cohen's $d = 0.28$) • Objective: +32 min/wk MVPA (NS, estimated Cohen's $d = 0.30$)
Ligibel et al[31] (2012)	• n = 59 • 92% ♀ • Age (years): 53.1 ± 10.8[a] • BMI: 31.2 ± 6.2[a] • Race: 92% white	Breast and colorectal	RCT, 16 weeks	Home based (telephone calls)	SCT	• G_0: Usual care • G_1: 10-11 semistructured telephone calls, 30-45 minutes each, over 16 weeks to build self-efficacy for exercise behaviors; pedometers distributed	Subjective: 7-day physical activity recall questionnaire	Subjective: +2 MET h/wk (NS, estimated $d = 0.25$) +40 MVPA min/wk (NS, estimated $d = 0.31$)
Mefferd et al[24] (2007)	• n = 76 • 100% ♀ • Age (years): 56.3 ± 8.2 • BMI: 31.0 ± 4.2 • Race: 93% white	Breast	RCT, 16 weeks	Center based (group sessions) and home based (telephone calls and exercise recommendations)	CBT	• G_0: Usual care • G_1: 16 weekly group counseling sessions and weekly phone follow-ups; home-based physical activity and self-monitoring were encouraged	Subjective: 7-day physical activity recall questionnaire	Subjective: +138 min/wk of MVPA (NS, estimated $d = 0.79$)
Rock et al[25] (2015)	• n = 693 • 100% ♀ • Age (years): 56.3 ± 9.4 • BMI: 31.5 ± 4.6 • Race: 79% white	Breast	RCT, 1 year	Center based (group sessions) and home based (telephone calls, emails, and newsletters)	SCT	• G_0: Usual care • G_1: 16 weekly group counseling sessions, 4 biweekly sessions, 6 monthly sessions; monthly phone or email follow-ups; quarterly newsletters	Subjective: Godin LTE	Subjective: +72 min/wk of MVPA ($P < .001$, estimated $d = 0.45$)
Rogers et al[26] (2009)	• n = 41 • 100% ♀ • Age (years): 53 ± 9 • BMI: 30.9 ± 8.6[a] • Race: 93% white	Breast	RCT, 12 weeks	Center-based (group sessions, individual counseling) and home-based exercise	SCT	• G_0: Usual care • G_1: 6 weekly, then biweekly discussion groups; 12 supervised exercise sessions during the first 6 weeks; home aerobic physical activity prescription during weeks 3-12; 3 individual counseling sessions	Subjective: Godin LTE Objective: accelerometry	• Subjective: +18 min/wk of moderate intensity physical activity (NS, $d = 0.16$) • Objective: +54 min/wk of moderate-intensity physical activity (NS, $d = 0.57$); significantly more activity counts ($P < .01$; $d = 1.02$)

(continued)

Table 2. (continued)

	Sample Characteristics	Cancer Site	Study Design, Duration	Setting	Theoretical Framework	Intervention Details	Physical Activity Measure(s)	Physical Activity Outcome (Intervention vs Control)
Rogers et al[27] (2013)	• n = 28 • 100% ♀ • Age (years): 56 ± 10.5 • BMI: 33.9 ± 7.4[a] • Race: 87% white	Breast	RCT, 12 weeks	Center-based (group sessions, individual counseling) and home-based exercise	SCT	G_0: Usual care G_1: 6 weekly, then biweekly discussion groups; 12 supervised exercise sessions during the first 6 weeks; home aerobic and resistance training physical activity prescription during weeks 3-12; 3 individual counseling sessions	Objective: accelerometry	Objective: +84 min/wk of MVPA (NS, d = 0.76)
Rogers et al[28] (2014)	• n = 44 • 100% ♀ • Age (years): 56.2. ± 7.7 • BMI: 31.2 ± 5.7 • Race: 96% white	Breast	RCT, 12 weeks	Center-based (group counseling sessions, individual exercise sessions) and home-based exercise prescription	SCT	• G_0: Usual care • G_1: 6 biweekly group counseling sessions; 26 semiweekly supervised aerobic and resistance training sessions; 3 individual counseling sessions; home-based walking prescription	Objective: accelerometry	Objective: +103 min/wk of moderate-intensity physical activity (P < .01; d = 1.15)
Rogers et al[29] (2015)	• n = 222 • 100% ♀ • Age (years): 54.4 ± 8.5 • BMI: 30.7 ± 6.8 • Race: 84% white	Breast	RCT, 12 weeks	Center-based (group sessions, individual counseling) and home-based exercise	SCT	• G_0: Usual care • G_1: 6 group discussion sessions; 12 supervised exercise sessions during the first 6 weeks; home aerobic and resistance training physical activity prescription during weeks 3-12; 3 individual counseling sessions	• Subjective: Godin LTE • Objective: accelerometry	• Subjective: +76 min/wk of moderate-intensity physical activity (P < .001; estimated d = 0.51) • Objective: +39 min/wk of moderate-intensity physical activity (P = .01; estimated d = 0.24)
Von Gruenigen et al[30] (2008)	• n = 45 • 100% ♀ • Age (years): 54 ± 2.0 • BMI: 43.5 ± 2.1 • Race: 100% white	Endometrium	RCT, 6 months	Center-based (group sessions, individual counseling) and home-based exercise	SCT	• G_0: Usual care • G_1: 6 weekly, then biweekly, then monthly discussion groups; contact by phone during "off" weeks; pedometers distributed	Subjective: Godin LTE	Subjective: significantly higher leisure score index (estimated d = 0.65)
Von Gruenigen et al[9] (2012)	• n = 75 • 100% ♀ • Age (years): 57.0 ± 8.6[a] • BMI: 36.4 ± 5.5[a] • Race: 91% white	Endometrium	RCT, 6 months	Home based (telephone, email, newsletters) and center based (group sessions, physician and dietician consults)	SCT	• G_0: Usual care • G_1: 10 weekly group sessions, followed by 6 biweekly group sessions; each 60-minute session focused on different behavior modifications for behavior change; pedometers distributed; physician consultations at 3 and 6 months	• Subjective: Godin LTE • Objective: pedometer step count	• Subjective: significantly higher leisure score index (estimated d = 0.56) • Objective: significantly higher step count (+2362 steps, estimated d = 0.81)

Abbreviations: BMI, body mass index (in kg/m^2); RCT, randomized controlled trial; MVPA, moderate to vigorous physical activity; SCT, social cognitive theory; TTM, transtheoretical model; LTE, leisure time exercise; CBT, cognitive behavioral therapy

[a]Intervention group only.

self-monitoring of physical activity behavior,* relapse prevention,[23,25-27,29,31] specific goal setting,[9,23-25,29-31] and improving time management.[26,27,29] None of the studies presented any quantitative or qualitative data with which to evaluate the relative acceptance or impact of any of the behavior change techniques.

Only 3 of the 10 studies reported psychosocial behavioral processes, and these found conflicting results.[23,28,31] Two studies found no significant differences in self-efficacy (Cohen's d = 0.39-0.48)[23,31] or social support (Cohen's $d = -0.51$)[23] in the intervention group. The other study found significant improvements in both walking self-efficacy (Cohen's $d = 0.66$) and social support (Cohen's $d = 0.85$).[28] The latter study, which found significant and large effect size improvements in psychosocial behavioral processes, was a center-based intervention, whereas the other 2 were home-based interventions.

Five of the studies included information regarding adverse events.[23,26-29] Two studies reported no serious adverse events,[26,28] and 2 mentioned minor joint injuries/soreness related to the interventions.[23,27] Out of the 753 overweight and obese women assigned to physical activity interventions, only 1 serious adverse event, a pelvic stress fracture, was reported.[29] This corresponds to a 0.13% chance of injury for this population.

Health-Related Outcomes

The health-related outcomes are summarized in Table 3. Five of the studies assessed changes in aerobic fitness.[26-29,31] Of the 4 studies that estimated peak oxygen intake via submaximal treadmill tests,[26-29] only 2 found significant improvements compared with controls,[27,28] but each of the 4 studies found improvements in peak oxygen intake ranging from 0.6 to 3.8 mL/kg/m greater when compared with the control groups (Cohen's d = 0.32-1.1).[26-29] In the study that assessed aerobic fitness via the 6-minute walk test, a significant increase in distance walked was observed (Cohen's $d = 0.58$).[24]

Body composition was assessed by 9 studies, using total body fat,[24,26-28] waist circumference,[9,23-25,31] and/or body mass index.[9,23-28,30] Of the 4 studies that assessed body fat percentage, 3 found a decrease[24,27,28] (range = 0.1% to −4.5%, Cohen's $d = 0.01$ to -0.65), but only 2 found significant reductions.[24,28] Of the 5 studies that assessed waist circumference, 3 reported large, significant decreases (>6 cm; Cohen's $d = -0.31$ to -1.02),[23-25] but 2 other studies found no difference between groups.[9,31] For the 8 studies that assessed body mass index, only 3 observed a significant reduction.[23-25]

Systolic blood pressure, which was assessed in 2 studies,[23,25] decreased in both, but by only 1 mm Hg compared with the control group (Cohen's $d = -0.06$ to 0.05). Blood lipids improved moderately in the 1 study that assessed them,[24] and there were no apparent changes found for inflammatory markers in 2 studies (Table 4).[27,28]

Discussion

The primary finding of this systematic review was that theory-based interventions may lead to increases in physical activity among overweight and obese female cancer survivors, provided that interventions include a substantial center-based component. Additionally, each of the studies that did not achieve significant improvements in physical activity showed moderate effect size increases in physical activity, suggesting that they may also be effective,[34] although studies with larger sample sizes are needed to confirm this finding. Although these findings are promising, the lack of reported psychosocial variables limits the interpretation regarding the underlying causes of the observed increases in physical activity.

The magnitude of the observed increases in physical activity in relationship to recommended targets for healthful physical activity is somewhat difficult to determine because of the varied nature of the questionnaires utilized.[35] The current American College of Sports Medicine recommendation for physical activity is 150 min/wk of moderate to vigorous physical activity (MVPA).[36] Female breast and uterine cancer survivors normally perform approximately 60 to 90 minutes of MVPA per week,[17] such that these populations need to increase their MVPA by approximately 60 to 90 minutes to reach the recommendations. The studies included in this systematic review reported that the theory-based interventions led to approximately 30- to 100-min/wk increases in MVPA. Therefore, these interventions appear to increase physical activity enough for female breast cancer survivors to achieve the recommended MVPA per week.

The findings regarding changes in PA in this review are similar in scope to what was reported in a previous meta-analysis for cancer survivors that included healthy-weight survivors.[37] In that meta-analysis, the standardized mean effect size for social cognitive theory–based interventions on physical activity outcomes was 0.34, whereas our sample effect size estimates ranged from Cohen's d =0.16 to 1.15. This indicates that obese female cancer survivors are able to actively participate in, and benefit from, physical activity interventions.

Consistent with previous findings regarding the feasibility of cancer physical activity trials,[38] the home-based interventions did not produce significant improvements in physical activity. However, the 8 home-based plus center-based interventions produced significant improvements with moderate to large effect sizes. This difference may be a result of the differences in the scope of the interventions. Each of the home-based plus center-based interventions

*References 9, 21, 23, 24, 26, 27, 30.

Table 3. Summary Table for Main Health Outcomes.[a]

	Body Mass Index (kg/m^2)	Waist Circumference (cm)	Total Cholesterol/ High-Density Lipoprotein	Triglycerides (g/dL)	Total Body Fat (%)	Aerobic Fitness	Systolic Blood Pressure (mm Hg)	IL-6 (pg/mL)	IL-8 (pg/mL)	IL-10 (pg/mL)	TNF-α (pg/mL)
Demark-Wahnefried et al[17] (2014)	−1.4 vs −0.3[b] (*d* = −0.73)	−6.5 vs −1.0[b] (*d* = −1.02)					−2.0 vs −1.0 (*d* = 0.05)				
Ligibel et al[31] (2012)		+1.4 vs +2.3 (*d* = −0.08)				+57 vs 25 m,[b] 6-minute walk test (*d* = 0.58)					
Mefferd et al[24] (2007)	−2.0 vs −0.3[b] (*d* = −0.45)	−6.9 vs −2.7[b] (*d* = −0.34)	−0.5 vs −0.1[b] (*d* = −0.40)	−12.4 vs 8.3[b] (*d* = −0.27)	−4.5 vs −1.2[b] (*d* = −0.65)						
Rock et al[25] (2015)	−1.9 vs −0.5[b] (*d* = −0.36)	−7.1 vs −3.1[b] (*d* = −0.31)					−3 vs −2[b] (*d* = −0.06)				
Rogers et al[26] (2009)	−0.3 vs −0.4 (*d* = 0.01)				0.1 vs −0.2 (*d* = 0.01)	4.9 vs 2.0 mL/kg/min (submax treadmill test; *d* = 0.46)					
Rogers et al[27] (2013)	−0.3 vs 0.3 (*d* = −0.6)				−1.1 vs 0.6 (*d* = −0.6)	3.7 vs −0.1[b] mL/kg/min (submax treadmill test; *d* = 1.1)		3.9 vs −2.0 (*d* = 0.7)	−0.6 vs −0.3 (*d* = −0.1)	−0.2 vs 3.0 (*d* = −0.3)	−2.6 vs −1.9 (*d* = −0.2)
Rogers et al[28] (2014)	−0.2 vs −0.3 (*d* = 0.14)				−1.1 vs −0.6[b] (*d* = −0.19)	2.8 vs 1.1[b] mL/kg/min (submax treadmill test; *d* = 0.37)		0 vs −0.7 (*d* = 0.16)	−1.7 vs 0.1 (*d* = −0.40)	−1.0 vs −0.4 (*d* = −0.17)	0.6 vs −0.6 (*d* = 0.50)
Rogers et al[29] (2015)						2.6 vs 2.0 mL/kg/min (submax treadmill test; *d* = 0.32)					
Von Gruenigen et al[30] (2008)	−1.2 vs −0.3 (estimated *d* = −0.6)										
Von Gruenigen et al[9] (2012)	−1.5 vs +0.3 (estimated *d* = −1.1)	−2.5 vs − 2.3 (estimated *d* = −0.1)									

Abbreviations: TNF, tumor necrosis factor; IL, interleukin.
[a]Reported as change in intervention mean versus control mean (Cohen's *d*).
[b]Significant difference ($P < .05$).

Table 4. Methodological Quality of the Included Studies.[a]

Authors	Randomization	Study Compliance	Intervention Compliance	Intervention	Confounding Variables	Duration	Sample size	Total
Demark-Wahnefried et al[17] (2014)	3	3	1	3	3	3	2	18
Ligibel et al[31] (2012)	3	2	3	2	2	2	3	15
Mefferd et al[24] (2007)	3	3	3	2	2	2	2	17
Rock et al[25] (2015)	3	2	1	3	3	3	3	18
Rogers et al[26] (2009)	3	3	3	3	3	2	2	19
Rogers et al[27] (2013)	3	3	3	3	2	2	1	17
Rogers et al[28] (2014)	3	3	3	3	1	2	2	17
Rogers et al[29] (2015)	3	3	3	3	3	2	3	20
Von Gruenigen et al[30] (2008)	3	2	3	2	3	2	2	17
Von Gruenigen et al[9] (2012)	3	3	3	3	3	2	2	19

[a]Possible score range: 7-21.[16] Higher scores indicate higher-quality studies.

provided more contact hours with health professionals than the home-based interventions, which may have been the cause for the reported positive outcomes. For example, the home-based intervention by Ligibel et al[31] provided 10 to 11 phone calls totaling approximately 300 to 500 minutes of intervention over the course of 16 weeks. In contrast, Rogers et al[26] administered approximately 1500 minutes over the 12 weeks of the study, providing greater potential for physical activity behavior change. Future studies with overweight and obese female cancer survivors should administer home-based plus center-based components to maximize the benefits for the participants and should evaluate which psychosocial indicators best predict intervention adherence and improvement, so that it can be determined whether any improvements were a result of psychosocial changes or simply a result of having actively participated in moderate-to-vigorous intensity exercise classes.

Considering that one of the inclusion criteria for this systematic review was that the studies must be based on a theoretical framework, it was surprising to find that only 3 of the studies actually provided results regarding the associated psychosocial process variables. Because of this absence, the interpretation of the results is problematic because it is difficult to identify the factors associated with effectiveness. In addition, the 3 studies that did provide information regarding psychosocial behavioral variables found conflicting results in self-efficacy and social support, although those are proposed mediators of physical activity participation.[39] These differences in psychosocial variable changes may be ascribed to the different outcomes following home-based compared with center-based plus home-based interventions, but a detailed analysis is not possible because of the lack of data from more studies. Future theory-based interventions in this population should ensure that behavioral variables are measured and reported, so that the factors underlying the relative effectiveness of the behavioral components can be assessed.

The primary limitation of the current review was that the physical activity interventions varied greatly among the included studies, making it difficult to summarize the findings. Based on the available data, it is clear that theory-based interventions improved physical activity and aerobic fitness and that center-based interventions have a greater effect on physical activity. Study quality was moderate to high in all the included studies according to the assessment methods used in this systematic review.[22] However, several studies did not achieve top scores for intervention duration and sample size. Given the heterogeneity of the studies, and subsequent difficulties of pooling data from varied studies, future interventions should aim to enroll sufficient participants and administer lengthy interventions in order to determine effectiveness with a greater degree of certainty.

This review provides evidence that home-based plus center-based physical activity interventions may increase physical activity more than home-based programs alone among overweight and obese female cancer survivors. More studies will need to be conducted to determine the mediating and moderating factors and the most effective behavior change techniques in this population. Health care centers should consider administering physical activity programs for cancer survivors to increase physical activity and improve health of their patients.

Authors' Note

Supplementary materials such as search terms and results may be accessed by contacting the corresponding author.

Declaration of Conflicting Interests

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