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## Taking the Next Step: A Systematic Review and Meta-Analysis of Physical Activity and Behavior Change Interventions in Recent Post-Treatment Breast Cancer Survivors

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### Abstract

**Purpose**—Research has shown that recent post-treatment breast cancer survivors face significant challenges around physical activity as they transition to recovery. This review examined randomized controlled trials targeting physical activity behavior change in breast cancer survivors <5 years post-treatment and describes 1) characteristics of interventions for breast cancer survivors as well as 2) effect size estimates for these studies.

**Methods**—A systematic search was conducted following PRISMA guidelines with Medline, PubMed, PsycINFO, CINAHL, and Scopus databases. Data were abstracted for primary intervention strategies and other details (e.g., setting, duration, theory use). A subgroup analysis was conducted to assess intensity of exercise supervision/monitoring and intervention effectiveness.

**Results**—The search produced 14 unique behavior intervention trials from the US and abroad published 2005-2013. The mean sample size was 153 participants per study. All interventions included moderate-intensity activities plus various behavioral change strategies. Most interventions were partially or entirely home-based. The overall standardized mean difference was 0.47 (0.23, 0.67) with  $p < 0.001$ .

**Conclusion**—Most interventions were effective in producing short-term behavior changes in physical activity, but varied greatly relative to intervention strategies and intensity of supervision/monitoring. Highly structured interventions tended to produce larger behavior change effects overall, but many larger effect sizes came from interventions supported by phone counseling or email. We observed that ‘more’ may not be better in terms of direct supervision/monitoring in

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physical activity behavior interventions. This may be important in exploring less resource-intensive options for effective behavior change strategies for recent post-treatment survivors.

## Keywords

breast cancer; survivorship; physical activity; behavior change; cancer rehabilitation

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## Introduction

The completion of primary treatment for breast cancer is a major milestone for its survivors. However, studies have shown that the time post-treatment represents a new period of vulnerability, one in which breast cancer survivors (BCS) face important health promotion challenges and often get “lost in the transition” from patient to survivor, the theme of the Institute of Medicine’s sentinel report on survivorship care [1]. Physical activity initiation, reinitiation and maintenance are particular challenges in the post-treatment population. Authorities from the Institute of Medicine (IOM), American Cancer Society, American College of Sports Medicine and others [2-4] have recommended physical activity (PA) as a critical, safe and effective part of survivorship planning. Substantial benefits of PA may include reducing recurrence risk, mitigating cancer treatment side effects and enhancing quality of life outcomes [5-7]. Despite these benefits, surveillance data have suggested that only 10% of BCS meet PA recommendations [8, 9].

Physical activity in survivorship has generated significant research interest, but much of the literature focuses on physiological and psychosocial outcomes, rather than behavior change. Several recent reviews and meta-analyses have examined a variety of PA benefits related to health outcomes in the survivor population, most notably in quality of life [10-13], but the specific intervention components that facilitate behavior change in post-treatment BCS require further study. Assessing research conducted following the release of the 2005 IOM report [1] is also useful in assessing recent contributions to evidence specific to behavior change in this population.

The purpose of this systematic review and meta-analysis is to rigorously assess the effectiveness of PA interventions among recent, post-treatment BCS using data from experimental and quasi-experimental studies. Given evidence for the timeliness of interventions in the post-treatment period [14-16], this study included BCS who were five years or less from completion of active treatment, and thus transitioning to lifestyle changes that may impact long-term recovery. The aims are to: 1) describe the characteristics of PA behavior interventions for BCS, including targeted populations, intervention features, and use of behavior theory and to 2) determine effect size estimates for behavior change from these PA interventions.

For the purposes of this paper, intervention is defined as a strategy or set of strategies, often derived from behavior change theories, to influence health behaviors, such as PA [17]. We chose the term PA, rather than exercise, to include interventions that target moderate- to vigorous-intensity physical activity (MVPA) but may not require access to exercise facilities or equipment. As PA is the behavior of interest, the terms “behavior intervention” and “PA intervention” are equivalent descriptors and will be used interchangeably.

## Methods

### Search Strategy

A systematic search was conducted based on the Preferred Reporting of Systematic Reviews and Meta-Analysis (PRISMA) guidelines [18] and with assistance from a trained public health librarian. Four databases were used in the search: Medline (via Ovid; 1948 to September Week 2 2013; In-Process & Other Non-Indexed Citations; searched September 19, 2013); PubMed (National Library of Medicine; searched September 20, 2013); PsycINFO (via Ovid; 2002 to September Week 4 2013; searched October 1, 2013); and CINAHL Plus with Full Text (via Ebsco; 2001 to present; searched October 4, 2013).

Several general database-adapted concepts were utilized in the initial search, including: breast cancer/breast neoplasm, PA, exercise, movement, motor activity, interventions, RCTs and survivors. A detailed listing of search terms is available in Figure 1. Strategies were pretested and refined through an iterative process in which abstracts and citations were screened for fulfillment of eligibility criteria. As an additional measure, reference lists of relevant articles were hand searched and compared to lists produced by the four databases. Scopus (via Elsevier) was searched as a final step to ensure that no eligible articles had been previously overlooked.

All eligible studies were 1) published in English in a peer-reviewed journal January 2005-October 2013; 2) utilized a randomized controlled trial or quasi-experimental design with comparison groups; 3) studied BCS who were approximately five years or less from completion of active cancer treatment (i.e., transitioning from completion of treatment to long-term recovery); 4) reported a PA behavior intervention (including language that describes strategies and an intent to change lifestyle behaviors) and 5) reported PA behavior change outcomes.

To verify that the intent of interventions was PA behavior change, we searched first for PA behavior as a stated trial outcome, and second, for key terms in the study description, such as changes in “active lifestyle,” “exercise habits” and “PA patterns,” which confirmed that broader lifestyle changes were central to study goals. Studies that did not meet these or the aforementioned eligibility criteria were excluded.

### Study Selection

Studies were chosen through a multi-step screening strategy. First, citations and abstracts were screened by the lead author for fulfillment of eligibility criteria. Any study that did not meet one or more criterion was excluded, assigned a reason for exclusion (e.g., population, study type or outcome) and reported back to the other co-authors. Remaining articles were given a “maybe” rating and referred to co-authors for independent review. Discrepancies in ratings across co-authors occurred in less than five percent of abstracts reviewed; all disagreements were resolved through discussion until consensus was reached. Final selection of studies was based on full-text review of potential studies by the authors. All authors agreed with the final choice of studies for this review. A PRISMA-based study selection flowchart is shown in Figure 2.

## Data Abstraction

Data were collected using coding procedures described by Lipsey and Wilson [19]. Two codebooks were created for study-level outcomes and effect-size information. The original coding instruments were previewed by two authors, revised and presented to all co-authors for approval prior to data collection. Two independent coders abstracted data. Any discrepancies were compared against the full-text articles and resolved through discussion. For one study [20], outcomes specific to BCS were obtained through the lead author.

Data abstraction was completed through review of 28 coded study-level descriptors of sample, research design and intervention characteristics and 18 pieces of data describing measurement and effect size information for each study. Meta-analysis parameters were calculated using the “metan” function in Stata 13.0 software (StataCorp, College Station, Texas).

Additionally, to evaluate study quality, ten criteria adapted from the CONSORT checklist for reporting of RCTs ([www.consort-statement.org](http://www.consort-statement.org)) were applied and customized to PA interventions. These criteria addressed details about intervention implementation, determination of sample size, details about randomization procedures, attrition and response rates post-intervention, behavior measurement tools and summary results with estimated effect sizes. A similar procedure for quality assessment in PA interventions was recently published in a separate review [21].

## Data Analysis

Post-intervention change values (typically either mean minutes of MVPA or mean MET hours per week) were used to calculate standardized mean differences (SMD). The Hedge's *g* method was applied to reduce positive bias [22]. Where possible, samples were analyzed on an intent-to-treat basis, regardless of the original study method, to provide a more conservative estimate of the effect in the population [23]. Based on evidence of heterogeneity (assessed using the I-squared statistic) [24], weighted effect sizes were analyzed. Meta-analytic assumptions followed a random effects model [25]. Meta-funnel procedures were used to statistically assess publication bias [26].

Because high variability was noted for intensity of exercise supervision/monitoring in these studies, an exploratory subgroup analysis was added to meta-analytic procedures, in which studies were stratified by low, medium and high levels of supervision/monitoring intensity during the intervention. High levels of supervision/monitoring included multi-component, structured interactions with participants; medium supervision/monitoring included counseling but not supervised exercise sessions; low supervision/monitoring included little or no individual PA oversight.

## Results

Based on our search strategy (Figure 2), 14 unique RCTs described over 24 articles fully met the eligibility criteria. Four studies were conducted internationally (in the United Kingdom, Finland, Canada and South Korea). The remaining studies were conducted in the

United States. A summary of participant and intervention characteristics is provided in Table 1.

### Study Population Description

The total number of participants across the 14 studies was 2,140 with a mean sample size of 153 post-treatment BCS per study. The majority of participants in the review were white with a mean age of 49 years. Two studies included only non-white participants [27, 28], while the remaining studies included white or ethnically mixed populations (Table 1). Based on reported data, the estimated mean time since diagnosis across studies was 2.6 years.

Most participants in the 14 studies reported receiving an early cancer diagnosis at Stage I or Stage II of disease. Most studies excluded women diagnosed at Stage IV. The majority (> 60%) of participants in all studies had received multiple treatment modalities, including surgery plus one or more forms of adjuvant therapy. The participants across the studies in the review reported high levels of education; most (65%) had attended some college, received a college degree and/or pursued graduate level education. Income level was specified as a coding item, but insufficient data was available to report on this descriptor.

### Intervention Design

Intervention design was assessed by examining the primary mode(s) of intervention (e.g., PA type, method), level of supervision, as well as intervention setting, duration, number of treatment sessions and behavioral theory use.

Consistent with literature that supports walking as an acceptable form of PA for BCS [29], most studies used a walking component in their intervention design. Seven studies provided either a pedometer or accelerometer to participants. In seven cases, some form of behavior counseling was offered by phone [20, 27], by e-mail [30], in person [31, 32] or a combination of these [33-35]. Coaching strategies varied, but included activities such as in-person PA demonstrations [34, 35], counseling from a healthcare provider [35], supervised exercise sessions combined with cognitive-behavioral therapy [31], tailored counseling sessions [27] and group discussions about perceived barriers and goals related to PA [32, 36].

Five studies [31, 32, 37-39] offered group exercise options and alternatives to walking in their intervention design. For example, Irwin (2008) reported that, in the home-based portion of the study, participants were asked to walk or do another aerobic activity of their choice. Bloom (2008) offered three group workshops, of which group exercise (Qigong, yoga or walking) was a part. Greenlee (2013) reported an intervention offered entirely in a commercial exercise studio (Curves for Women), though walking or similar MVPA using exercise equipment was still the focus.

Despite the similarities in PA type and intervention methods, the level of interaction with the research team and other intervention characteristics (duration, setting and use of theory) varied highly across the studies. The mean duration of the RCTs was 17 weeks, but the supervised exercise and/or counseling sessions associated with each intervention ranged

from 3 sessions (1×/month over 12 weeks) [37] to 78 sessions (3×/week for 26 weeks) [28, 38, 40]. Most studies reported sessions that were 45 minutes or less.

The majority of the intervention designs relied on a home-based setting, in whole or in part. Half of the interventions were entirely home-based [20, 27, 30, 33, 34, 41]; two took place exclusively in a clinic or research-setting [31, 37]; the remaining studies took place in mixed settings, combining clinical/research sites with community or home-based environments. Though most of the home-based designs involved some form of ongoing interaction or counseling with the research team, one study [41] used only printed materials and pedometers to guide participants on PA.

Finally, theory use was assessed via identification of a specific behavior theory in program development. Twelve studies cited at least one theory or theoretical construct that was used in intervention design. For example, Kim (2011) used the Transtheoretical Model [42] to develop a stage-matched intervention using counseling and stage-based workbooks. Hatchett (2013) and Rogers (2009) also described the use of Social Cognitive Theory [43] to match intervention methods to theoretical constructs. But, most other studies mentioned relevant theories or theoretical constructs without extensive discussion of theory application.

### Heterogeneity, Measures and Quality Assessment

Statistical testing revealed a moderate to high level of variability in effect size attributable to heterogeneity (I-squared = 76.6%) but a relatively low estimate of between-study variance (Tau-squared = 0.10). The heterogeneity may be due to the differences in population and intervention design previously described or methods of measurement for PA behavior change. For example, seven studies used a researcher-administered PA recall questionnaire, such as the 7-day PA Recall Questionnaire [44]. The remaining studies used another validated self-report instrument, such as the Godin Leisure-time Questionnaire [45] or CHAMPS Survey [46] to collect data on PA performed by participants. These surveys vary on several factors, such as units to calculate PA summary estimates (e.g., METs per week or kcal per week) and recall strategies (e.g., prompts) or time frame, which may also affect estimates.

Based on the previously described quality assessment procedures derived from CONSORT criteria, a quality score (n/10) was assigned to each study (Table 1). Most studies (k=10) achieved 80% or more of 10 quality indicators. However, there was some variation in transparency of reporting, especially related to randomization procedures and between-group differences, which may have affected how effect sizes were calculated.

### Synthesis of Results

The overall SMD was 0.47 (0.23, 0.67) with a  $p < 0.001$ . The range for effect sizes was -0.02 (-0.41, 0.37) to 1.85 (1.15, 2.6) at the 95% confidence level. Out of 14 studies, all but one [20] positively favored the treatment group and eight were statistically significant. The effect sizes for the four studies with non-significant results all approached zero, as illustrated in Figure 3.

To isolate variability related to interaction with the research team, an additional exploratory analysis was conducted in which studies were stratified by low, medium and high intensity levels of supervision/monitoring during the intervention, as previously described. The studies in the high intensity group had the largest effect, with an overall SMD of 0.69 (-0.08, 1.5),  $p=0.08$  (not significant). The low intensity group had the lowest overall SMD of 0.23 (0.09, 0.38),  $p < 0.002$ . The details of this subgroup analysis are reported in Table 2.

## Discussion

This review is one of the first to evaluate evidence for PA behavior change interventions generated exclusively from RCTs, looking only at recent post-treatment BCS. The purpose was to describe the features of PA behavior change interventions for post-treatment BCS and to assess the impact of these interventions in effecting behavior change. With a statistically significant overall SMD of 0.47 (0.26, 0.67), it can be inferred using conventional criteria that the interventions collectively suggest a moderate but positive effect on behavior change in participating survivors.

There were many similarities in intervention designs that appeared to enhance their success. Most interventions used self-monitoring or coaching techniques in various combinations, with varying media. For example, several studies supplied research-grade pedometers or accelerometers to participants, in addition to self-report tools, a strategy known to support measurement validity and help participants monitor their progress [47]. Half of the studies gathered survivors in workshops or peer support groups of some kind during the intervention. Additionally, individual counseling was frequently used to motivate participants and address barriers to PA. Both strategies are well-supported in PA literature with older women and with cancer survivors [48, 49]. The home-based environment and walking as the primary type of exercise were emphasized in all the interventions in some form, which has also been a successful component in lifestyle studies with similar populations [50-53].

A notable finding in this review was the wide variation across studies in terms of direct supervision/monitoring of the participants during the intervention. Based on this finding, the studies were stratified by supervision/monitoring level, using procedures previously described. From this, it was observed that more intense supervision (i.e., in-person, frequent interactions) tended to produce larger effects on behavior change. However, it should also be noted that five of the six largest effect sizes came from trials in the “medium” intensity supervision/monitoring group, which included home-based programs and counseling delivered by telephone or e-mail. This may be an important insight in exploring less resource-intensive options for effective behavior change strategies for recent post-treatment survivors. Similar behavioral interventions delivered by telephone were found to be moderately effective in increasing PA in recent systematic review papers for various chronic health conditions [54, 55]. Telephone-based delivery of PA counseling may also be advantageous in outreach to older adults and underserved populations [56, 57].

It should be noted that the largest individual intervention effect sizes in our review did not generally come from the studies with the largest sample size or the longest exposure to the

intervention. In fact, the largest (n=500) and longest trial (12 months) reviewed [39, 58, 59] showed almost no effect on PA behavior in participants post-intervention. This information is instructive in planning behavior interventions that balance the benefits of program structure and supervision with other components that may stimulate behavior change.

A few questions remain after this literature review. As most of these studies captured only PA changes during the intervention period, more information about the sustainability of these behavior changes in real world settings, outside of carefully controlled trials, is needed [60]. A few trials in this review [31, 31, 61-63] included additional follow-up measures post-intervention (e.g. 6 month). In these cases, modest gains in PA post-intervention were generally not sustained. In most other cases, the long-term effects of these interventions could not be evaluated based on available data. Sustainability of behavior changes remains a critical question in behavioral research. Additionally, many of the studies recruited BCS who were identified as sedentary at the start of the trial. It has been argued that the change mechanism in active versus inactive survivors is different and should be thoughtfully addressed as part of intervention design [64]. Finally, cancer events such as diagnosis and completion of primary treatment have been suggested as unique windows of opportunity or 'teachable moments' to influence behavior [65]. Most women in the studies reviewed were 3 years or less from initial diagnosis and demonstrated largely similar PA patterns. However, there may be additional opportunities to investigate the role of time since diagnosis and teachable moments relative to health behaviors in cancer survivors.

Another important unanswered question is the role of behavior theory in intervention development. In this review, studies were evaluated only on whether or not behavior theory was cited in relation to intervention design. Most of the studies mentioned a specific theory or theoretical construct in intervention development. However, experts suggest that researchers frequently describe behavior interventions as theory-based, though theory application in development of interventions for complex behaviors requires careful planning beyond simply identifying an appropriate theory [66]. Further investigation of theory application using a systematic coding framework could be beneficial [67, 68].

This review had several limitations. The search strategy included only articles published in peer-reviewed journals, in English, and which focused on BCS who had recently completed cancer treatment. There may be additional studies published in other languages or in journals not available through the chosen databases that may have contributed to knowledge of behavior change interventions for BCS within five years of completing cancer treatment. Additionally, although several steps were taken to reduce bias and increase estimate accuracy, the reported effects are estimates only and are a reflection of the accuracy and consistency of the data as originally reported. In at least one case [31], it is believed that the incomplete reporting of trial data may have inflated the effect size estimate, but lack of data impeded additional adjustments. Incomplete or inconsistent reporting in RCTs has been identified as a common barrier in similar translational research, especially with PA studies [69].

Many studies used self-reported PA measures which may be subject to reporting bias [70], but half of the studies also included objective measurement methods (e.g., accelerometer or



pedometer) to validate or confirm self-reported measures. Matthews et al, for example, found a strong correlation ( $\rho=0.65$ ) between measures obtained by accelerometer and those self-reported in the CHAMPS survey in the Breast Cancer Walking Study [33]. Others [32] found similar improvement trends in objective and self-reported measures, but noted that estimated PA counts were higher in self-reported data. But, in order to calculate a pooled effect size for our meta-analysis, we were limited to the common measure (self-report) that was provided in all studies. Self-reported data measures are also especially useful in establishing context for physical activity behavior, which is valuable to understanding behavioral factors but not always well represented by mechanical devices [71].

More generally, this review highlights challenges of the literature itself on this subject. There were surprisingly few RCTs that have tested PA interventions with post-treatment BCS in the eight-year time frame covered by our literature search. Of these studies, most included only white women, in their 40s or 50s, diagnosed at an early stage of disease and living in medium or large metropolitan areas. Findings within these populations may not be generalizable to older or younger survivors, women diagnosed at later stages of disease, or to survivors that live in rural or inner-city settings [72]. It was also observed that study quality, even for a group of RCTs, varied widely. While some studies carefully reported randomization procedures and between-group differences, for example, others were less transparent in how some of the effect size estimates were made.

Despite these challenges, this analysis represents one of few studies of its kind to comprehensively and rigorously assess experimental studies testing PA behavioral interventions in recent post-treatment BCS. It was also observed that many of the developments in this literature have occurred in the last few years. In fact, although many of the trials started earlier, nearly half were not published until 2011-2013. As such, this paper offers specific and timely insights on PA behavior research that will contribute in a meaningful way to the growing survivorship literature.

## Conclusion

The 2005 IOM survivorship report challenged the medical and scientific community to change the experience of cancer survivors, especially as they transition to long-term recovery. This review and meta-analysis systematically captured results from domestic and international RCTs from 2005 to the present, offering insight on progress in developing effective interventions to help BCS adopt a physically active lifestyle as part of the path to recovery. Data from these studies suggest that they produced modest but positive effects on PA levels in post-treatment BCS. They also offer timely and relevant information about the features and success of behavior interventions in changing PA in BCS in the critical period following active treatment.

Despite the promising results, these findings reveal a lack of literature on empirically tested interventions for this vulnerable population. PA is a complex behavior even for healthy adults. For post-treatment BCS, the prospect of initiating, re-initiating or maintaining an active lifestyle following primary cancer treatment is fraught with challenges that are not yet

fully understood. More research, especially in large experimental studies, is needed to better understand the needs of post-treatment BCS and to facilitate sustainable lifestyle changes.

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1. (physical activit\* or exercise or jogging or walking or running or swimming or biking or bicycling or aerobics or ((strength or resistance) adj3 training) or yoga or dance).ti,ab.
2. exp Exercise/ or exp Exercise Movement Techniques/ or exp Exercise Tolerance/ or exp Exercise Therapy/
3. exp Motor Activity/
4. or/1-3
5. breast neoplasms/ or (breast adj4 (cancer\* or neoplasm\*)).ti,ab.
6. 4 and 5
7. evaluation studies/ or evaluation studies as topic/ or program evaluation/ or validation studies as topic/ or (effectiveness or (pre- adj5 post-)).ti,ab. or (program\* adj3 evaluat\*).ti,ab.
8. intervention\*.ti,ab.
9. exp Health Promotion/
10. exp Clinical Trial/ or double-blind method/ or (clinical trial\* or randomized controlled trial or multicenter study).pt. or exp Clinical Trials as Topic/ or ((randomi?ed adj7 trial\*) or (controlled adj3 trial\*) or (clinical adj2 trial\*) or ((single or doubl\* or tripl\* or treb\*) and (blind\* or mask\*))).ti,ab.
11. or/7-10
12. 6 and 11

**13. limit 12 to english language**

**14. limit 13 to yr="2005 - 2013"**

**Figure 1. Search Terms Used with Medline Database**

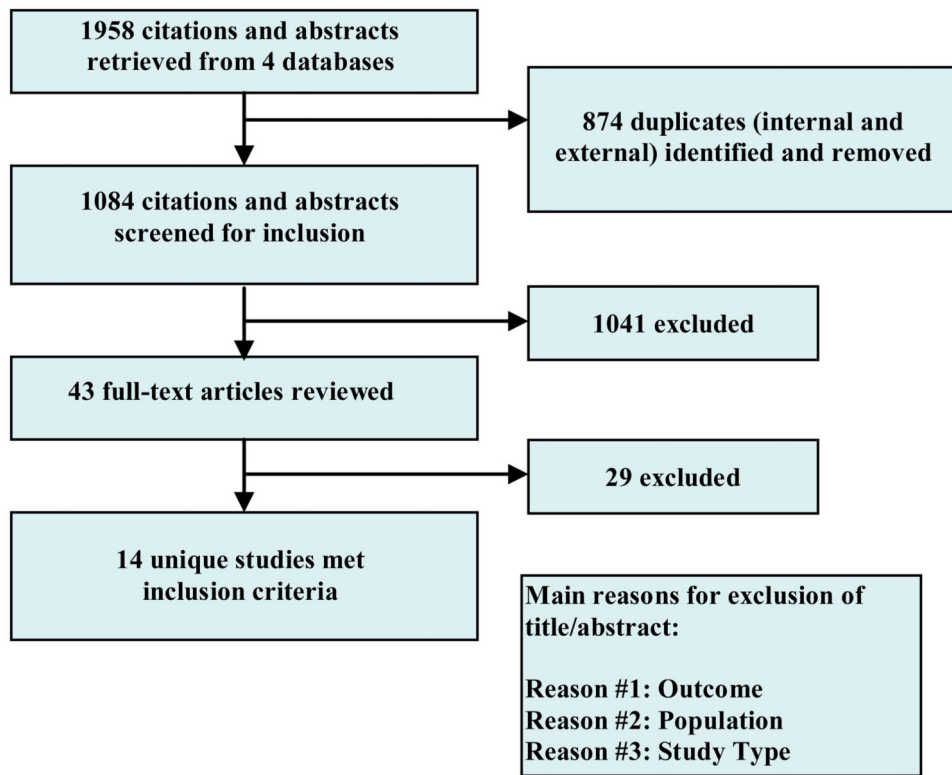
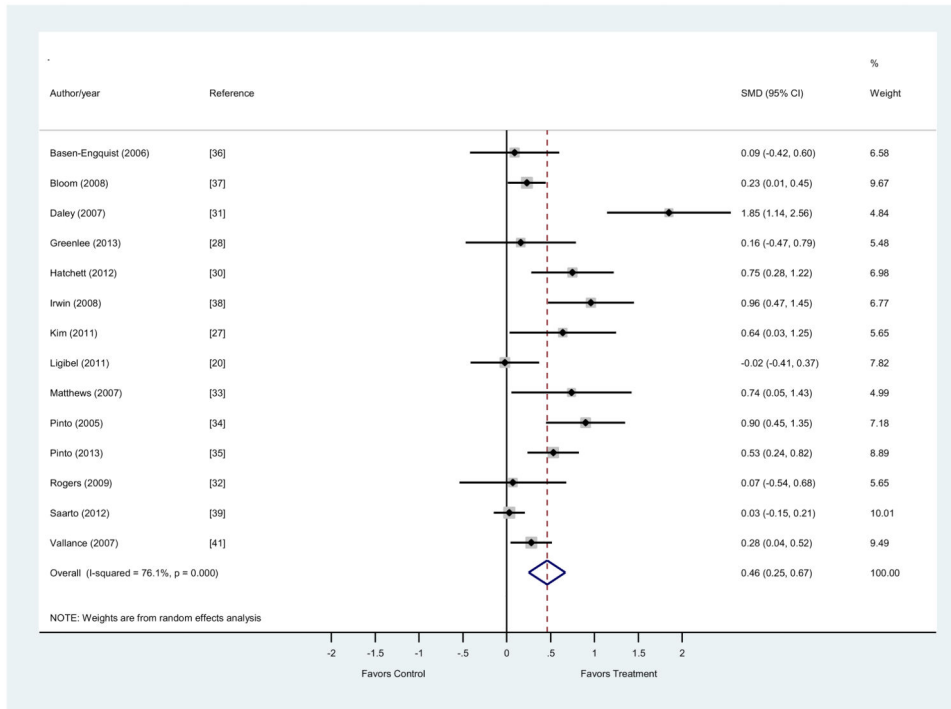


Figure 2. PRISMA-based Study Selection Flowchart



**Figure 3. Forest plot for effects of physical activity interventions on behavior change** Studies (n=14) measured changes in physical activity behavior comparing results from control to treatment groups. The size of the shaded boxes around each study represents the relative weight assigned to the study in calculating an overall estimate of standardized mean difference (SMD), which in this case was calculated using Hedge's g to reduce positive bias. Larger boxes indicate that greater weight was assigned to each study. Lines going through each box represent the confidence interval for each estimate.



Table 1

Characteristics of Participants and Physical Activity Interventions

Study First author (year)	Year(s) of trial <sup>f</sup>	Sample Size	Mean age of Participants (in years) <sup>b</sup>	Main Race/Ethnicity	Primary Intervention Components	Intervention Setting	Intervention Duration (in weeks)	Number (Frequency) of Intervention Sessions	Theory Use Mentioned (Y/N)	Primary Method of PA Behavior Assessment <sup>d</sup>	Quality Score <sup>e</sup> (n/10)
Basen-Engquist (2006)	2003-2004	N = 60	55	Mixed <sup>c</sup>	Workshops, group exercise, walking (pedometers provided)	Clinic, community (local church), home-based	24	21 (group meeting 1x per wk for 16 wks, alternating wks for 8 wks)	Y	Researcher-administered questionnaire (7-DPARQ)	8/10
Bloom (2008)	NR <sup>g</sup>	N= 404	45	White	Workshops, group exercise	Community, home-based	12	3 (1 6-hour workshop per month)	Y	Self-administered survey (created by authors)	4/10
Daley (2007 <sup>a</sup> , 2007)	2005	N = 108	51	White	Behavioral counseling (in person), group exercise	Clinic (university center)	8	24 (3 supervised exercise sessions per wk)	Y	Self-administered survey (GLTEQ)	9/10
Kim (2011)	NR	N = 45	46	Asian	Behavioral counseling (by phone), walking (pedometer s provided)	Home-based	12	12 (1 phone counseling session per wk)	Y	Researcher-administered questionnaire (IPAQ)	8/10
Greenlee (2013)	2007-2008	N = 42	50.6	Latino	Behavioral counseling (in person and by phone), walking or similar activity	Community (health club)	26	78 (3 supervised exercise sessions per wk)	N	Self-administered survey (Kaiser PA Survey)	7/10
Hatchett (2012)	NR	N = 74	NR	White	Behavioral counseling (by e-mail), any aerobic activity	Home-based	12	8 (1 e-mail per wk for 5 wks, alternating wks for 6 wks)	Y	Researcher -administered questionnaire (7 day PAR)	6/10
Irwin (2008 <sup>h</sup> , Latka (2009)	2006	N = 75	55.8	White	Behavioral counseling (in group), group exercise, walking or similar activity	Community (health club), home-based	26	78 (3supervised exercise sessions per wk)	Y	Researcher-administered Questionnaire (PAQ)	9/10
Ligibel (2011)	2009	N = 100	54.3	White	Behavioral counseling (by phone), walking (pedometer provided)	Home-based	16	10 (1 phone counseling session per 1-1.5 wks)	Y	Researcher-administered questionnaire (7-day PAR)	7/10
Matthews (2007)	NR	N = 36	54.1	White	Behavioral counseling (in person and by phone), walking (accelerometer provided)	Home-based	12	6 (1 in-person, 5 phone counseling sessions spread over 12 wks)	Y	Self-administered survey (CHAMP S)	8/10
Pinto (2005 <sup>a</sup> , 2008 and 2009)	NR	N = 86	53.14	White	Behavioral counseling (by phone and in person), walking or similar activity (pedometer provided)	Home-based	12	13 (1 in-person PA demo, 12 wky phone counseling sessions)	Y	Researcher -administered questionnaire (7-day PAR)	7/10

Study First author (year)	Year(s) of trial <sup>f</sup>	Sample Size	Mean age of Participants (in years) <sup>b</sup>	Main Race/Ethnicity	Primary Intervention Components	Intervention Setting	Intervention Duration (in weeks)	Number (Frequency) of Intervention Sessions	Theory Use Mentioned (Y/N)	Primary Method of PA Behavior Assessment <sup>d</sup>	Quality Score <sup>e</sup> (n/10)
Pinto (2013)	NR	N = 192	60	White	Behavioral counseling (by health provider and by phone), walking or similar activity (pedometer provided)	Clinic, home-based	12	14 (1 doctor contact, 1 in-person PA demo, 8 phone counseling sessions, wkly for 4 wks, alternating wks for 4 wks)	Y	Researcher -administered questionnaire (7-day PAR)	9/10
Rogers (2009)	2007	N = 41	53	White	Behavioral counseling (group and individual), group exercise, walking (accelerometer provided)	Clinic, home-based	12	21 (6 discussion groups, 12 supervised exercise sessions, 3 in-person counseling, spread over 12 wks)	Y	Self-administered survey (GLTEQ)	9/10
Nikander (2007), Penttinen (2009), Saarto (2012 <sup>g</sup> )	2005-2008	N = 500	52	White	Behavioral counseling (in person), group exercise, walking or similar activity	Clinic (university center), home-based	52	52 (1 supervised exercise session per week)	N	Self-administered log (7-day PA record)	10/10
Vallance (2007 <sup>a</sup> , 2008 and 2010)	2006	N = 377	58	White	PA guidebook, walking (pedometer provided)	Home-based	12	No structured intervention sessions	Y	Self-administered survey (GLTEQ)	9/10

<sup>a</sup>Indicates main outcomes paper used for analysis, in addition to related papers.

<sup>b</sup>Where not explicitly reported (e.g., provided mean age by treatment arm), overall mean age was estimated based on other data provided.

<sup>c</sup>Predominant racial/ethnic descriptors applied when participants from a specific group represented 60% or more of the sample. In cases where less than 60% of any one group was represented, the study population was described as a "mix" of racial/ethnic groups.

<sup>d</sup>Assessment tool listed provided appropriate data to calculate effect size estimates for PA behavior change.

<sup>e</sup>A quality score for each study was calculated using 10 criteria derived from CONSORT, as described in the methods section.

<sup>f</sup>Years trial was conducted. If not directly reported, timeframe estimated based on reported completion of trial recruitment.

<sup>g</sup>Items not reported listed as "NR."

**Table 2**  
**Results of Sub-group Analysis by Intensity of Direct Supervision/Monitoring**

<b>Low Supervision/Monitoring<sup>a</sup></b>				
<b>Author (year)</b>	<b>SMD (g)<sup>b</sup></b>	<b>[95% CI]</b>		<b>% Weight</b>
Basen-Engquist (2006)	0.09	-0.42	0.59	8.45
Bloom (2008)	0.23	0.01	0.45	46.14
Greenlee (2013)	0.16	-0.47	0.8	5.32
Vallance (2007)	0.23	0.09	0.38	100
<b>Pooled Effect Size</b>	<b>0.23</b>	0.09	0.38	100
<b>Medium Supervision/Monitoring</b>				
<b>Author (year)</b>	<b>SMD (g)</b>	<b>[95% CI]</b>		<b>% Weight</b>
Hatchett (2012)	0.75	0.28	1.22	16.48
Kim (2011)	0.64	0.04	1.24	12.91
Ligibel (2011)	-0.02	-0.41	0.37	19.24
Matthews (2007)	0.74	0.05	1.42	10.87
Pinto (2005)	0.90	0.46	1.35	17.39
Pinto (2013)	0.53	0.24	0.82	23.12
<b>Pooled Effect Size</b>	<b>0.56</b>	0.28	0.85	100
<b>High Supervision/Monitoring</b>				
<b>Author (year)</b>	<b>SMD (g)</b>	<b>[95% CI]</b>		<b>% Weight</b>
Daley (2007)	1.85	1.14	2.55	22.79
Irwin (2008)	0.96	0.48	1.44	25.43
Rogers (2009)	0.07	-0.55	0.68	23.92
Saarto (2012)	0.03	-0.15	0.2	27.86
<b>Pooled Effect Size</b>	<b>0.69</b>	-0.08	1.45	100

<sup>a</sup> Low = minimal/no individual oversight  
 Medium = counseling but no supervised exercise sessions  
 High = highly structured program with in-person supervision

<sup>b</sup> Standardized mean differences (SMD) for behavior change effects calculated using Hedge's g