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Effect of Home and Community-Based Physical Activity Interventions on Physical Function among Cancer Survivors: A Systematic Review and Meta-analysis

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Abstract

Objective—We reviewed randomized trials to examine the effect of home and community-based physical activity interventions on physical functioning among cancer survivors based on the most prevalent physical function measures.

Data Sources—Five electronic databases—Medline Ovid, Pubmed, CINAHL, Web of Science, and PsychINFO—were searched from inception to March 2016 for relevant articles.

Study Selection—Search terms included: *community-based interventions*, *physical functioning*, and *cancer survivors*. A reference librarian trained in systematic reviews conducted the final search. Detail protocol is registered on PROSPERO (www.crd.york.ac.uk/prospero/) CRD42016036730.

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Conflict of Interest:

While this study was funded in part by the Comparative Effectiveness Research on Cancer in Texas grant (RP140020) from the Cancer Prevention and Research Institute of Texas and the Interdisciplinary Rehabilitation Research Training Program (H133P110012) from the National Institute on Disability and Rehabilitation Research, Zakkoyya Lewis has begun to work for Beachbody on 9/9/2016, a company that may potentially benefit from the research results. Ms. Lewis has participated in study design, analysis, and completed a first draft of the manuscript prior to her Beachbody employment. This potential interest has been reviewed by UTMB's Conflicts of Interest Committee and a management plan implemented to prevent any appearance of a conflict of interest. Any inquiries regarding this management plan can be directed to UTMB's Office of Institutional Compliance, (409) 747-8701.

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Data Extraction—Four reviewers evaluated eligibility and two reviewers evaluated methodological quality. Data were abstracted from studies that used the most prevalent physical function measurement tools—Medical Outcomes Study Short Form-36, Late Life Function and Disability Instrument, European Organisation for the Research and Treatment of Cancer Quality-of-Life Questionnaire, and six minute walk test. Random or fixed effects models were conducted to obtain overall effect size per physical function measure.

Data Synthesis—Fourteen studies met inclusion criteria and were used to compute standardized mean differences using inverse variance statistical method. The median sample size was 83 participants. The majority of the studies were conducted among breast cancer survivors ($n = 7$). The interventions produced short-term positive effects on physical functioning with overall effect sizes ranging from small (0.17, 95% CI: 0.07, 0.27) to medium (0.45, 95% CI: 0.23, 0.67). Community-based interventions that met in groups and used behavioral change strategies produced the largest effect sizes.

Conclusions—Home and community-based physical activity interventions may be a potential tool to combat functional deterioration among aging cancer survivors. More studies are needed among other cancer types using clinically relevant objective functional measures (e.g., gait speed) to accelerate translation into the community and clinical practice.

Keywords

Neoplasms; Survivors; Community-Based; Physical Functioning; Interventions

Introduction

Recent projections indicate that by 2040, nearly three out of four cancer survivors will be 65 years and older.¹ Caring for this growing population is challenging, given that cancer and cancer related therapies are associated with myriad late effects that may negatively impact quality of life and cause concern among survivors.^{2–5} Cancer survivors are at greater risk of losing physical functioning and independence as they age.^{6–8} Moreover, there is a growing concern that survivors may be experiencing accelerated aging and may have a higher prevalence of frailty compared to their cancer-free peers.^{9, 10} The likelihood of functional limitations is even greater among survivors with comorbid conditions.¹¹ Functional decline has been associated with loss of independence, loss of mobility, increased mortality, and increased rate of adverse health outcomes.¹² Given these risks and concerns raised by survivors, there is a need for effective interventions to combat functional deterioration among aging cancer survivors.

Substantial evidence indicates that physical activity can prevent rapid functional deterioration, reduce mortality, and increase quality of life.^{13, 14} However, fewer than 30% of cancer survivors achieve the recommended level of exercise (150 minutes of aerobic exercise and at least two days of resistance exercise weekly).¹⁵ Consequently, a number of physical activity intervention trials have been conducted to promote physical activity among cancer survivors.¹⁶ Currently, few of the effective interventions have been translated into the community and clinical practice.¹⁶ The lack of translations may be related to the experimental design (i.e. randomized controlled trials conducted within high-resource

settings) and the intense resources required to carry out the effective activity interventions.¹⁶ Community-based and home-based physical activity interventions, on the other hand, may be a solution for accelerating the translation process by overcoming one of the barriers to dissemination.¹⁷ This is because these types of interventions are often implemented in a “real-world” setting that may have lower resources than major cancer centers or universities.¹⁶

To date, systematic reviews evaluating physical activity interventions among cancer survivors have aggregated different intervention settings together (e.g. structure, supervised, home-based, community-based).^{18–23} In addition, reviews that calculated effect sizes have also combined all measures of physical functioning together or have considered physical functioning as part of their quality of life results or physiological outcomes.^{18, 21, 24, 25} Given the translation potentials for community-based and home-based physical activity interventions and aligning with survivors and clinicians’ interest in physical functioning outcomes, it is the goal of this systematic review and meta-analysis to review randomized trials to examine the effect of home and community-based physical activity interventions on physical functioning among cancer survivors based on the most prevalent physical function measures. Our findings will help guide future home and community-based intervention development to have an emphasis on improving cancer survivors’ physical function beyond improvement of physical activity.

Methods

This review was completed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement.²⁶ The details of the protocol for this systematic review and meta-analysis, as well as a Medline Ovid search strategy example, were registered on PROSPERO (International prospective register of systematic reviews; <http://www.crd.york.ac.uk/PROSPERO/>) CRD42016036730.

Data sources and searches

The search strategy was developed by authors MCS and ZHL and conducted by a reference librarian trained in systematic reviews. Articles were collected from Medline Ovid, Medline Pubmed, CINAHL, Web of Science, and PsycINFO. “Community-based interventions,” “physical function,” “cancer survivors,” and related words were used as search terms. Searches were limited to studies including adults aged 18 years or older and published in the English language. We did not limit by publication date and had wide age range to ensure our ability to capture all possible articles. Related search terms and the complete search strategy for Medline Ovid is available on PROSPERO. Additional articles were also retrieved through searching the references of included articles and review articles that evaluated physical activity interventions among cancer survivors.

Study Selection

Duplicates were removed, and the remaining articles were screened in two phases. The first phase aimed to identify all home and community-based physical activity interventions among cancer survivors that assessed physical function. Articles were screened for

eligibility systematically by title, abstract, and then by full text. Retrieved articles were excluded for the following reasons: not in English, observational study design, review or meta-analysis, non-human subjects, abstract only, included children (17 years of age and younger), secondary analysis of an intervention, not a physical activity intervention, and physical function was not assessed. Articles not available in full text were also excluded because abstracts often provide limited information about all intervention components. Screening in this phase was conducted independently by two reviewers (DA and KD), and any disagreement was settled by discussion between the two reviewers and authors MCS and ZHL. Articles deemed eligible were included in the second phase of screening.

To inform the meta-analysis, the second phase of screening aimed to select studies that were randomized controlled trials and used the most prevalent physical function measurement tools. Articles were reviewed by authors MCS and ZHL for uses of measurement tools assessing mobility and physical performance capacity, as defined by Painter and Marcus.²⁷ Articles were eligible for the systematic review and meta-analysis if they were in English, a home or community-based physical activity intervention, conducted among cancer survivors 18 years and older, were randomized controlled trials, and used the most prevalent functional measures. Article inclusion was determined by a final screening of the full text by authors MCS and ZHL.

Quality Assessment

A risk of bias tool was used to assess the bias in all studies.²⁸ The tool identifies the quality of each study using an 11-item scale with possible responses of “yes”, “no”, “don’t know.” Appropriate cut points for low-risk of bias studies are not well established. Due to the nature of home and community-based studies (e.g., do not allow for double-blind interventions), we used a generous range of 5 or more “yes” responses to identify a high quality study.²⁸

Data Analysis

We conducted meta-analyses using the Cochrane Review Manager (RevMan) software, version 5.3. Based on the meta-analysis guidelines, a minimum of two studies for the chosen physical function measurement tools were required.²⁹ Thus, our meta-analyses considered a measurement tool as prevalent if it was included in two or more studies. Only studies with these measures were included in our analysis. Post-intervention final mean or mean change values of the aforementioned physical functioning measures from individual studies were used to calculate standardized mean differences and 95% confidence intervals (CI).³⁰ Standardized mean differences were used because this method takes into account the variability observed in the study when calculating the intervention’s effect size.³⁰ The total number of participants included in the meta-analyses was based on the final sample sizes used for analyses in the individual studies. The standardized mean differences and 95% CI were calculated using the inverse variance statistical method.³⁰ Meta-analyses were conducted to assess effect size using random or fixed effects as indicated by the I^2 . We used I^2 calculated by RevMan software to determine heterogeneity among studies. We were unable to assess publication bias due to the low number of studies ($n < 10$) available for each type of functional measures.³⁰

Results

Article retrieval and screening was conducted in January-March 2016. The screening process is outlined in Figure 1. A total of 2080 articles (Medline Ovid=441, Medline Pubmed=466, CINAHL=317, Web of Science=668, PsycINFO=188) were retrieved through database searches and three additional articles from reference searching. Of the articles retrieved from database searches, 996 were duplicates. Reviewer KD excluded 810 articles based on the title, 203 articles based on the abstract, and 37 articles based on the full text. Reviewer DA excluded 804 based on the title, 217 based on the abstract, and 24 based on the full text. The level of agreement between reviewers KD and DA on the number of excluded articles was 96%. MCS and ZHL screened the remaining 61 original articles by full text.

The second phase of screening found the most prevalent physical function measurement tools were the Medical Outcomes Study Short Form-36 (SF-36) physical-function subscale, Late Life Function and Disability Instrument (LLFDI), European Organisation for the Research and Treatment of Cancer Quality-of-Life Questionnaire—Core 30 (EORTC QLQ-C30), and the six minute walk test (6MWT). The SF-36 is a quality of life questionnaire with a 10-item subscale for physical function. This subscale includes questions about the respondent's ability to complete a variety of physical tasks.³¹ The SF-36 also has a physical component and a mental component summary score. We decided a priori to exclude articles that only reported the summary physical component score because the summary score included scores from other physical health related subscales (e.g. pain, general health) in addition to physical-function subscale score. The LLFDI is a self-report questionnaire that contains subscales for basic and advanced, lower extremity physical functioning.^{32, 33} The EORTC QLQ-C30 is also a self-report measure that evaluates quality of life with a five-item sub-scale that focuses on physical function.^{34, 35} The six minute walk test measures the distance walked in meters by participants in 6-minutes.³⁶ Although other objective measures of function (e.g. gait speed, chair stand²⁷) were evaluated, these measures were performed differently across studies. Due to the heterogeneity, we decided to exclude studies that did not include the most prevalent physical function measurement tools.

After the second phase of screening, an additional 47 articles were excluded for the following reasons: secondary analysis of an intervention (n=3),^{37–39} included children (n=3),^{40–42} not a physical activity intervention (n=3),^{43–45} observational study design (n=10),^{9, 46–54} single-arm intervention design (n=11),^{17, 55–64} non-randomized trial (n=1),⁶⁵ did not use the SF-36 physical functioning subscale (n=2),^{66, 67} did not use LLFDI, EORTC QLQ-30, or 6 MWT to assess physical function (n=13),^{68–80} and the main intervention was not home or community-based (n=1).⁸¹

Study Characteristics

The 14 studies included in this review consisted of 1,959 participants (1,768 participants included for the meta-analysis based on the final numbers used for analyses in individual studies) across six countries (USA,^{82–92} Canada,⁸⁷ United Kingdom,⁸⁷ Australia,⁹³ Norway,⁹⁴ and Korea⁹⁵). Study characteristics are presented in detail in Table 1. All interventions were randomized controlled trials that lasted for: 12 weeks,^{88–90, 92, 95} 16 weeks,⁸⁶ 6 months,^{82, 83, 85} 12 months,^{84, 87, 91, 93} or the duration of cancer treatment

(approximately 12 to 17 weeks).⁹⁴ The mean age ranged between 44 to 73 years and mean body mass index 22 to 31 kg/m². Participants were predominantly white and female. The most prevalent cancer diagnoses were breast, followed by colorectal, and prostate. The average time since cancer diagnosis ranged from 4 months to 8 years, with two studies completed exclusively during cancer treatment.^{90, 94} Two studies used objective physical activity measures (i.e., accelerometer or pedometer) in addition to self-report activity measures to assess physical activity,^{89, 93} while the other 12 studies used only self-reported measures such as the 7-day physical activity recall questionnaire,^{82, 86, 88} the Community Health Activity Model Program for Seniors (CHAMPS),^{83, 85, 87, 91} International Physical Activity Questionnaire (IPAQ),^{84, 94, 95} or exercise log.^{90, 92} Most of the studies were deemed high quality with the risk of bias score ranging from five to eight.

Intervention Components

The study components are described in three major categories of interventions below: behavioral change exercise interventions, home-based exercise interventions, and supervised exercise interventions. Most studies used more than one of these categories (Table 1). One study combined behavioral change and group-based exercise interventions.⁸² Seven studies combined behavioral change and home-based exercise interventions.^{83, 85–89, 95} One study used supervised exercise intervention,⁸⁴ three studies only used home-based exercise intervention,^{90, 92, 94} and two studies combined supervised and home-based exercise interventions.^{91, 93}

Behavioral change exercise interventions—Behavioral change interventions were based on the Transtheoretical model,^{82, 85, 87–89, 95} Social Cognitive Theory,^{82, 85–89} Stages of Motivational Readiness⁸², and a combination of stages of readiness with motivational interviewing principles.^{83, 88} In two studies participants received in-person counseling at study allocation.^{83, 88} While in others, behavioral counseling sessions were conducted through in-person group sessions⁸² or over the telephone.^{83, 85–89, 95} Participants were counseled weekly^{89, 95} or bimonthly⁸⁵ for the duration of the study. Other interventions decreased the frequency of counseling or group meetings over time.^{82, 86–88} Bennet et al. supplemented the initial counseling with three additional counseling sessions over 5 months.⁸³

During counseling, all behavioral change interventions promoted self-monitoring of behavior. Participants were encouraged to time their exercise,^{82, 86} use the pedometer provided,^{82, 83, 86–89} use the heart rate monitor provided,⁹⁵ and log their activity in a diary.^{82, 86–89} Participants also received printed materials that summarized counseling contents. They were provided activity related education, and/or were provided feedback on their activity level during counseling sessions.^{82, 85–89, 95} The RENEW study conducted by Morey et. al. provided resistance bands, an exercise poster, and a table guide for food portioning in addition to printed contents and pedometers.⁸⁷

Home-based exercise intervention—Three of the home-based exercise interventions selected for our meta-analysis did not specify the use of behavioral change theory or behavioral change strategies. These studies aimed to increase encouragement in strength and

aerobic exercise,⁹⁴ aerobic exercise alone,⁹² and resistance exercise alone.⁹² One study targeted a specific cardiovascular and whole-body conditioning program called Nia.⁹⁰ Across studies, participants were instructed to walk briskly for 30 minutes a day and perform strength training three times a week,⁹⁴ follow instructional Nia DVDs for 20 to 60 minutes a day for three days a week,⁹⁰ walk or perform other aerobic activities three days a week,⁹² and perform strength training exercises three days a week.⁹² Participants were given resistance bands⁹² and dumbbells⁹² to support strength training. One study also included biweekly phone calls for surveillance and support.⁹⁴ In the study conducted by Reis et. al., investigators met with participants in person every 6 months to enhance the movements of Nia.⁹⁰

Supervised exercise—Supervised exercises was performed one-on-one⁹¹ or in a group within a community facility.^{84, 93} Supervision was either in conjunction with home-based exercise^{91, 93} or preceded the home-based exercise maintenance portion of the intervention.^{84, 93} All the studies in this section prescribed supervised exercise twice a week. Exercise consisted of aerobic and strength-training but there was an emphasis on strength-training exercises.^{21, 91, 93} Researchers provided free weights, resistance bands,⁹¹ heart rate monitors, and pedometers⁹³ to encourage home-based exercise once⁹¹ or twice⁹³ a week in addition to the supervised activity. After supervised exercises ceased, participants were given a booklet and/or a detailed prescription for maintenance.^{84, 93}

Comparison groups—Interventions were compared to control participants that received standard care,^{82–84, 86, 90, 94} a low-impact intervention^{85, 88, 89, 91, 93} or those wait-listed to receive the intervention.⁸⁷ Low-impact interventions included: bimonthly general health counseling and printed material,⁸⁵ a pedometer and general health educational booklet,⁹³ motivational interviewing counseling at study allocation and printed survivorship educational material,^{82, 88} monitoring phone calls,⁸⁸ a combination of printed survivorship educational material and monitoring phone calls,⁸⁹ or supervised and home-based whole body stretching and relaxation exercises.⁹¹

Meta-Analysis for Mobility and Performance Capacity Outcomes

The median number of participants across the 14 studies was 83 per study, with the middle 50% (P25-P75) of study sizes falling between 41 and 182. Statistical testing for heterogeneity indicated that the estimated effect size had relatively low variability within each subtype of mobility and performance capacity measures ($I^2 = 0\%$ to 46%) (Figures 2a to 2d and Figure 3). This suggests that the effect sizes obtained from our meta-analysis are consistent across studies.

Overall, four out of the five physical functioning measures showed significant small (0.17) to medium (0.45) effect sizes (Figures 2a to 2d and 3).⁹⁶ A significant positive effect on self-reported physical functioning among 802 cancer survivors was found for eight interventions that used the SF-36 physical functioning subscale [standardized mean difference of 0.17 (95% CI: 0.07 to 0.27)] (Figure 2a). This translates to a 2.1 point increase in SF-36 physical functioning score among the experimental groups. When evaluating the studies individually,

only two interventions^{87, 97} found a significant positive effect on self-reported physical functioning.

As for the two interventions that used the LLFDI-basic lower extremities measure, a significant improvement on the self-reported basic function of lower extremities was indicated among 305 cancer survivors [standardized mean difference of 0.17 (95% CI: 0.02 to 0.33)] (Figure 2b). The raw mean difference showed a 2.5 point increase in LLFDI-basic lower extremities score among the experimental groups. However, LLFDI-advanced lower extremities measure did not show a significant effect size (Figure 2c). Two interventions that used the EORTC QLQ-C30's physical functioning subscale found a significant positive effect on self-reported functioning in 71 cancer survivors with a standardized mean difference of 0.44 (95% CI: 0.11 to 0.77) (Figure 2d). This translates to a 3.9 point increase in the EORTC QLQ-C30 physical functioning subscale.

Lastly, a significant and positive effect on 160 cancer survivors' objectively measured mobility and performance capacity was observed in the six interventions that used the 6 MWT [standardized mean difference of 0.45 (95% CI: 0.23 to 0.67)] (Figure 3). The mean difference between groups showed a 27.5 meter increase in the 6 MWT among the experimental group. Out of six studies, only two interventions^{82, 86} found a significant and positive effect on 6 MWT when considering the studies individually.

Discussion

This systematic review and meta-analysis evaluated the effect of home and community-based physical activity interventions on physical functioning among cancer survivors based on the most prevalent physical function measures. To our knowledge, we are one of the first systematic review and meta-analysis to make this evaluation. Previous reviews on physical activity interventions in cancer survivors have combined home-based, community-based, and other structured interventions.^{18–22} In addition, most reviews have focused on the physical activity outcomes or have considered physical functioning as part of the quality of life or physiological outcomes.^{18, 21, 24, 25}

Overall, we found that a majority of the interventions were conducted among breast cancer survivors followed by colorectal, and prostate. The most prevalent physical functioning measures used by interventions were SF-36, LLFDI, EORTC QLQ-30, and 6 MWT. Our findings indicate that home and community-based physical activity interventions had a positive effect on four out of the five mobility and performance capacity measures in cancer survivors, despite the variability among individual studies. The interventions produced a small to moderate positive effect on physical functioning in cancer survivors. Interventions differed widely in regards to type of exercise intervention (aerobic, resistance, or weight training), duration (12 to 52 weeks), number of sessions (3 to 104 session), and settings (home, group, or combinations).

Our results found improvement of physical functioning among survivors participating in physical activity interventions and are in agreement with previous meta-analysis⁹⁸ and systematic review on physical activity interventions that evaluated physical functioning

among cancer survivors.¹⁹ However, neither study exclusively evaluated home and community-based physical activity interventions. The previous meta-analysis⁹⁸ also differed from our current study analytically; it included mean differences while our study included standardized mean differences. The standardized mean differences we used accounted for the variability observed in the individual studies based on the measurement scales they used. Despite these differences, our results support their findings. Fong et al. indicated an increase of 3.4 points (95% CI: 0.4 to 6.4) of the SF-36 physical functioning component. In our meta-analysis we found a 2 point increase (95% CI: 0.65 to 3.51, $p=0.004$). Even though the home and community-based physical activity interventions seemed to produce a smaller increase compared to previous findings,⁹⁸ the 2 point increase still fell within the range of 2.0 to 7.8 points of minimal clinically important difference for the SF-36 physical functioning component.⁹⁹ As for the 6 MWT, Fong et al. indicated an increase of 29 meters (95% CI: 3 to 55) while we found an increase of 28 meters (95% CI: 15.14 to 39.86, $p<0.0001$). Both of our findings suggest that physical activity interventions were able to produce positive and significant increases in aerobic capacity; however, improvements fell below the conservative estimate of 54 to 80 meters of minimal clinically important difference for the 6 MWT.¹⁰⁰ Although these community-based or home-based programs have lower efficacy, their higher reach and possible greater potential for sustainability could lead to broader population-level improvements.¹⁰¹

Individual studies with the largest effect sizes from the SF-36 physical functioning subscale utilized community-based interventions that met in groups.^{82, 84} As for the 6MWT, the largest effect size also came from a community-based intervention that met in groups⁸² and a home-based intervention with telephone counseling.⁸⁶ Our results suggest that community-based interventions that met in groups and is using cognitive behavioral therapy may be the most effective physical activity intervention format for improving physical functioning among cancer survivors.

Future research

Several questions still remain after our review. We found that the majority of the studies, 10 out of 14, only evaluated physical functioning at the end of the intervention. Four interventions followed their participants either for another 12 weeks or 26 weeks in order to evaluate the maintenance of functional change after ending the intervention. Among these studies, some have found that physical functioning benefits gained from the intervention were not sustained.^{85, 87} This is similar to the findings from other systematic reviews and meta-analyses that have evaluated change in physical activity in cancer survivors.^{16, 19}

Another area that needs further exploration is the use of other objective mobility and performance capacity measures in physical activity intervention studies. These include measures of gait speed, timed up and go, and repeated chair stands.²⁷ Several studies included these objective measures, but they were excluded from our review and meta-analysis during the screening process due to inconsistencies in the chosen protocols. Using the chair rise test as an example, in some studies participants were instructed to complete five chair stands as fast as they could (using the short physical performance battery protocol),¹⁰² while other studies instructed participants to complete as many chair rises as

they could in 30 seconds (using the senior fitness test protocol).¹⁰³ The use of different protocols makes it difficult to make comparisons across studies. Additionally, only two studies out of 14 used objective physical activity measures. Self-report measures, which were used in the majority of these studies, may be subject to a reporting bias.¹⁰⁴ Studies will need to include objective mobility and performance capacity measures more consistently in order to strengthen the evidence supporting the use of home and community-based physical activity interventions by clinicians as an additional method to help improve physical functioning in cancer survivors. Future interventions may also benefit from inclusion of objective physical activity measures, for physical activity is an important contributor to maintenance of high physical functioning. By using objective activity measures, consistent reporting of the level of activity across studies may help future meta-analysis determine if sufficient activity was produced in different home or community-based intervention to increase physical function.¹⁰⁵

Strengths and limitations

Our review has several limitations. The search strategy included only peer-reviewed articles in English available in select databases. There may be other studies that were not captured by our search strategy because they were in another language or not available in a database or through reference searching. Furthermore, our review was limited to randomized trials available in full text. Our results need to be interpreted with caution because they may be subject to bias by not including observational study designs or articles that did not have full text available. Although steps were taken to address incomplete reporting in randomized controlled trials, incomplete reporting may have inflated the effect size estimates. In addition, our review may not be generalizable to all other cancer types because a majority of the interventions were conducted among breast, prostate, and colorectal cancer survivors.

Our review has several strengths. First, we focused on home and community-based physical activity interventions for cancer survivors in treatment and off treatment. Our meta-analysis also included studies that used less frequently used physical functioning measures such as LLFDI and EORTC QLQ-C30. Importantly, we also calculated the effect size using the standardized mean difference, which accounted for the variability among individual studies.

Conclusions

In conclusion, our review and meta-analysis indicate that home and community-based physical activity interventions can improve physical functioning among cancer survivors. Referring patients to existing community-based programs (e.g. LIVESTRONG at the YMCA¹⁰⁶ and Silver Sneakers¹⁰⁷) may complement physical functioning improvements gained through clinic-based rehabilitation. Given the results showing larger effect size in studies that used cognitive behavior counseling, providing cognitive behavioral interventions to supplement existing community-based programs may further improve outcomes. Research have shown that by using behavioral change theories (such as the cognitive behavioral therapy), interventions were able to produce larger and more sustain effect on behavior change.¹⁰⁸ More research is needed to provide objective evidence on improvements in physical functioning among cancer survivors engaging in home and community-based

physical activity interventions and to evaluate the sustainability of these improvements. Translating effective interventions into the community and clinical practice not only can create a public health impact by reaching more survivors, but also will ensure greater accessibility given the limited resources and transportation issues faced by many aging cancer survivors.¹⁴

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Abbreviations

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analysis
SF-36	Medical Outcomes Study Short Form-36
LLFDI	Late Life Function and Disability Instrument
EORTC QLQ-C30	European Organisation for the Research and Treatment of Cancer Quality-of-Life Questionnaire—Core 30
6MWT	six minute walk test

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Figure 1. Eligible randomized controlled studies selection process

SF-36: Medical Outcomes Study Short Form-36; LLFDI: Late Life Function and Disability Instrument; EORTC QLQ-C30: European Organisation for the Research and Treatment of Cancer Quality-of-Life Questionnaire—Core 30; 6MWT: 6-minute walk test

Figure 2.
 Figure 2a. SF-36 Physical Functioning
 Figure 2b. LLFDI-Basic Lower Extremities
 Figure 2c. LLFDI-Advanced Lower Extremities
 Figure 2d. EORTC QLQ-C30 Physical Functioning

Figure 3.
6 MWT

Table 1

Study Characteristics

Study	Functional measure	n Exp	n Con	Study population	Duration (wk)	n of sessions	Setting	Intervention components	Results (change in function)	Study Quality Score (0–11)
Behavioral and group intervention										
Basen-Engquist 2006 ⁸²	SF-36 6 MWT	35	25	Cancer Diagnosis: Female Breast Mean age: 56 y (Exp) vs. 54 y (Con) White: 20% (Exp) vs. 56% (Con)	26	21	Local church/community clinic	<ul style="list-style-type: none">Weekly group sessions x 16 wks, bi- weekly group session x 8 wks with workbook & stage-matched bookletsEncouraged 30 min of MPASelf-monitoring tool(s): pedometer, activity log	Significant improvement of 6 MWT in Exp vs. Con	7
Behavioral and home-based intervention										
Bennet 2007 ⁸³	6 MWT	28	28	Cancer Diagnosis: Breast and other Mean age: 56 y (Exp) vs. 60 y (Con) White: 96% (Exp) vs. 100% (Con)	26	3	Home	<ul style="list-style-type: none">1 in-person MI counseling & 2 telephone MI counseling sessionsEncouraged 30 min MPASelf-monitoring tool(s): pedometer	No significant difference in 6 MWT between groups	7
Demark Wahnefried 2006 ⁸⁵	SF-36	89	93	Cancer Diagnosis: Breast and prostate Mean age: 72 y (Exp) vs. 72 (Con) White: 82% (Exp) vs. 83% (Con)	26	12	Home	<ul style="list-style-type: none">Bi-monthly telephone calls with tailored print materialsEncouraged improvement of diet & activity level	No significant difference in physical functioning between groups	7
Kim 2011 ⁹⁵	EORCT QLQ-C30	23	22	Cancer Diagnosis: Breast and colorectal Mean age: 45 y (Exp) vs. 47 y (Con) Korean: 100% (Exp) vs. 100% (Con)	12	12	Home	<ul style="list-style-type: none">Weekly telephone counseling with workbook & stage-matched exercise prescription & nutritional adviceEncouraged 150+ min of MPASelf-monitoring tool(s): heart rate monitor	No significant difference in physical functioning between groups	6
Ligibel 2012 ⁸⁶	EORCT QLQ-C30 6 MWT	48	51	Cancer Diagnosis: Breast and colorectal Mean age: 53 y (Exp) vs. 56 y (Con) White: 92% (Exp) vs. 92% (Con)	16	10–11	Home	<ul style="list-style-type: none">Telephone counseling with workbookEncouraged 180+ min of MPASelf-monitoring tool(s): pedometer, activity log	Significant improvement of 6 MWT and physical functioning in Exp vs. Con	3
Morey 2009 ⁸⁷	SF-36 LLFDI	319	322	Cancer Diagnosis: Breast, colorectal, prostate Mean age: 73 y (Exp) vs. 73 (Con) White: 89% (Exp) vs. 89% (Con)	52	23	Home	<ul style="list-style-type: none">15 telephone sessions & 8 prompts with tailored workbook & quarterly newsletterEncouraged 30 min of endurance, 15 min of strength exercises, improve dietary intakeProvided exercise bands, exercise poster, & food portioning table guide	Significantly less physical functioning and basic lower extremity functioning deterioration in Exp vs. Con	7

Study	Functional measure	n Exp	n Con	Study population	Duration (wk)	n of sessions	Setting	Intervention components	Results (change in function)	Study Quality Score (0–11)
Pinto 2013a-health psych ⁸⁸	SF-36	106	86	Cancer Diagnosis: Female Breast Mean age: 56 y (Exp) vs. 56 y (Con) White: 95% (Exp) vs. 93% (Con)	12	12	Home	<ul style="list-style-type: none">Self-monitoring tool(s): pedometer, activity log1 session of exercise advice with provider, 4 weekly, 4 bi-weekly, & 3 monthly telephone sessions with progress letter, activity & survivorship tip sheetsEncouraged 150+ min MPASelf-monitoring tool(s): pedometer, activity log	Significant improvement of physical functioning in Exp vs. Con	7
Pinto 2013b-psych onco ⁸⁹	SF-36	20	26	Cancer Diagnosis: Colorectal Mean age: 60 y (Exp) vs. 56 y (Con) White: 100% (Exp) vs. 96% (Con)	12	12	Home	<ul style="list-style-type: none">Weekly & 3 monthly telephone sessions with progress letter, activity & survivorship tip sheetsEncouraged 150+ min MPASelf-monitoring tool(s): pedometer, activity log	No significant difference in physical functioning between groups	7
Brown 2015 ⁸⁴	SF-36	148	147	Cancer Diagnosis: Female Breast Mean age: 55 y (Exp) vs. 57 y (Con) White: 61% (Exp) vs. 69% (Con)	52	26	YMCA	<ul style="list-style-type: none">2x/wk weight lifting group session x 13 wks then exercise prescription for 39 wksProvided 12-month YMCA membership	Significantly less physical functioning deterioration in Exp vs. Con	8
Huesbo 2014 ⁹⁴	6 MWT	33	34	Cancer Diagnosis: Female Breast Mean age: 51 y (Exp) vs. 54 y (Con) Norwegian: 82% (Exp) vs. 88% (Con)	~17.2	~8	Home	<ul style="list-style-type: none">Telephone calls every second weekStrength training prescription with resistance bands & prescription for a daily brisk walking for 30 min (MPA)Self-monitoring tool(s): activity log	No significant difference in 6 MWT between groups	6
Reis 2013 ⁹⁰	6 MWT	22	19	Cancer Diagnosis: Female Breast Mean age: 54 y (Exp) vs. 54 y (Con) White: 91% (Exp) vs. 90% (Con)	12	3	Home	<ul style="list-style-type: none">3 in-person Nia[*] training sessions with prescription of 20–60 min of Nia 3x/wk at homeProvided Nia DVDSelf-monitoring tool(s): activity log	No significant difference in 6 MWT between groups	6
Yuen 2007-aerobic group ⁹²	6 MWT	9	9	Cancer Diagnosis: Female Breast Mean age: 53 y (Exp) vs. 55 y (Con) White: 87% (Exp) vs. 86% (Con)	12	4	Home	<ul style="list-style-type: none">1 in-person training session with exercise prescription & weekly phone call x 3 wksAerobic prescription: 20–40 min walking 3x/wk	No significant difference in 6 MWT between groups	5
Yuen 2007-resistance group ⁹²		11	9	Mean age: 54 y (Exp) vs. 55 y (Con) White: 57% (Exp) vs. 86% (Con)				<ul style="list-style-type: none">Resistance prescription: 8 exercises 3x/wk	Significant improvement of 6 MWT in Exp vs. Con	5

Study	Functional measure	n Exp	n Con	Study population	Duration (wk)	n of sessions	Setting	Intervention components	Results (change in function)	Study Quality Score (0–11)
Supervised and home-based intervention										
Galvao 2014 ⁹³	SF-36	50	50	Cancer Diagnosis: Prostate Mean age: 72 y (Exp) vs. 72 y (Con) White: NA	52	104	Exercise clinic and Home	<ul style="list-style-type: none">1 weekly Group sessions & 2 weekly home-based sessions for 26 wks then home-based for 26 additional wks with bookletEncouraged aerobic exerciseSelf-monitoring tool(s): pedometer, heart rate monitor	Significant improvement of physical functioning in Exp vs. Con	8
Winters-Stone 2012 ⁹¹	SF-36 LLFDI	52	54	Cancer Diagnosis: Female Breast Mean age: 62 y (Exp) vs. 62 y (Con)	52	104	University and Home	<ul style="list-style-type: none">2 weekly supervised training & 1 weekly home-based sessionsEncouraged resistance & impact trainingProvided resistance bands (home portion)	No significant difference in physical functioning or basic function of lower extremities between groups	7

Abbreviations: SF-36, Medical Outcomes Study Short Form-36; 6 MWT, 6-minute walk test; LLFDI, Late Life Function and Disability Instrument; EORCT QLQ-C30, European Organisation for the Research and Treatment of Cancer Quality-of-Life Questionnaire; Exp, experimental; Con, control; y, years; NA, characteristic was not reported by the author; min, Minutes; FV, fruits and vegetables; MI, Motivational Interviewing; MPA, Moderate-intensity Physical Activity;

* Nia is a type of aerobic whole-body conditioning exercise targeting strength, flexibility, mobility, agility, and stability.