



Published in final edited form as:

Geriatr Nurs. 2016 ; 37(5): 340–347. doi:10.1016/j.gerinurse.2016.04.013.

An integrative review of physical activity/exercise intervention effects on function and health-related quality of life in older adults with heart failure

Theresa A. Floegel¹ and G. Adriana Perez²

¹University of North Carolina-Chapel Hill, School of Nursing, 5007 Carrington Hall, CB#7460, Chapel Hill, NC 27599

²University of Pennsylvania, School of Nursing, 418 Curie Boulevard, Philadelphia, PA 19104

Abstract

This paper reviews randomized, controlled trials (RCTs) that have used a physical activity/exercise intervention in older adults with heart failure and reported outcomes of physical function and/or health-related quality of life. An integrative review was necessary because a literature search indicated no reviews have been done regarding these outcomes which are deemed very important by the older adult population. Computerized database search strategies by authors between 2002 and 2015 resulted in 163 studies, with 12 meeting inclusion criteria. Interventions were performed in clinic and home-based, group and/or individual settings with durations from three to 12 months. Interventions were varied. Common methodological weaknesses of the studies include lack of theory guiding the intervention, small sample and low minority representation. Strengths included detailed intervention methods. There was a moderate effect of interventions with no reported adverse effects. Further work is essential to identify successful strategies to support older adults with heart failure to increase their physical activity levels.

Introduction

Aging is associated with a higher prevalence of chronic disease that can negatively affect physical and functional abilities in older persons.¹ An estimated 80 percent of older adults (65+) in the United States (U. S.) currently suffer from one or more chronic conditions.² Heart failure—a major chronic health condition of older age—greatly contributes to decline in the older adult's physical function level, thus affecting self-care abilities. As heart failure progresses older adults often experience frequent exacerbations from which they may not fully recover. This continued decline places the older heart failure population at a high risk for dependence on others and is a catalyst to frequent hospitalization and long-term institutionalization.^{3,4} In spite of modern therapies, half of older adults diagnosed with heart failure will die within five years⁵ and quality of life deteriorates quickly in another one-third

Corresponding author: Theresa A. Floegel, tfloegel@email.unc.edu, ph: 919-966-3733.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

of this population.³ The current medical cost of caring for heart failure patients in the U. S. is \$32 billion annually and due to the continued growth of the older population, costs are predicted to be more than \$77 billion by 2030.⁶ Many pharmacologic and medical treatments are critical elements in managing heart failure in older adults, however one area that receives less attention—but may be as important—is the role of physical activity in promoting cardiovascular health, and improving symptoms, function, and health-related quality of life in this population. In light of the deleterious effects of heart failure on the older adult’s functional abilities, coupled with the staggering costs of care for this population, a greater depth of understanding is needed regarding the structure and efficacy of existing physical activity interventions that promote physical function in older adults with heart failure. Thus the purpose of this integrative literature review was to synthesize current tertiary physical activity interventions promoting improved physical function and quality of life in older adults with heart failure, and to offer recommendations to promote physical activity/exercise in this population to improve outcomes.

Background

It is well known that physical activity such as walking greatly improves health in older adults.^{7,8} Moreover, physical activity can slow physiologic changes associated with aging and assist with the management of chronic disease.⁹ Physical function and the ability to perform self-care are also closely tied to physical fitness level.^{10,11} Unfortunately physical activity levels among older U.S. adults are alarmingly low. Less than 20 percent of the older adult population meets the U.S. physical activity guidelines.^{12,13} As older adults age they continue to decrease their level of engagement in physical activity. Additionally, symptoms associated with heart failure often further limit participation in physical activity. Lastly, older adults with heart failure often have multiple comorbid conditions compared to younger adults, thus contributing to further decline in the ability to be active and maintain physical function.⁴ Because of these unique characteristics of older adults with heart failure, proven physical activity interventions in younger patients with heart failure¹⁴ may not translate to this population.

As low physical activity level is among the most important risk factors for cardiovascular disease,¹⁵ primary prevention has been a key area targeted for interventions. However, older adults who have progressed to a diagnosis, and even complications, of heart failure may benefit also from physical activity/exercise interventions. Once a disease such as heart failure is established and has been treated in its acute clinical phase, tertiary prevention aims to reduce the impact of the disease on the individual’s function, health, and quality of life through restoring them to the highest level of function and minimizing complications.¹² Tertiary health promotion activities for heart failure extend into rehabilitation of the heart failure condition.

Development of tertiary physical activity interventions for older adults with heart failure supports the *Healthy People 2020* initiative to “improve the health, function, and quality of life of older adults”¹⁶ through two primary objectives:

1. Older Adult Objective 5: Reduce the proportion of older adults who have moderate to severe functional limitations and,
2. Older Adult Objective 6: Increase the proportion of older adults with reduced physical...function who engage in light, moderate, or vigorous leisure-time activities.¹⁶

In order to support the *Healthy People 2020* objectives, researchers must determine effective interventions for the chronically ill older adult population. There is limited and possibly conflicting evidence related to physical activity/exercise intervention outcomes in older adults with heart failure thus there is not a consensus regarding appropriate physical activity prescription for this special population. Furthermore, many studies report cellular or physiologic outcomes such as arterial diameter changes, and $\text{VO}_{2\text{max}}$, or blood pressure improvements related to interventions, but do not translate how these changes may affect functional abilities or quality of life in the older adult. The lack of outcome measures meaningful to the older adult may limit adoption and use by clinicians, caregivers, and patients themselves. Evaluation of interventions that support and measure function and quality of life provides direction for clinicians to develop and/or encourage appropriate physical activity programs for older adults with heart failure.

Methods

Literature Search and Inclusion Criteria

The authors searched PubMed, Web of Science, and CINAHL research databases using the terms *older adult, heart failure, exercise, physical activity, physical function, and quality of life* for studies published between January 2002 and December 2015. A total of 163 studies were identified for further review. Abstracts were reviewed for the following criteria: 1) randomized controlled trial, 2) participant mean age of 65 years or older, 3) diagnosis of heart failure at time of intervention, 4) intervention included (but may not be limited to) physical activity or exercise, 5) sample size greater than 10 and, 6) outcome measures included physical function (assessed or self-reported) and/or reported health-related quality of life (HRQoL). Seventeen abstracts were identified for further review. Both authors reviewed the full study reports and independently assessed them for eligibility based on the defined inclusion criteria. On further review, four studies were missing one or more inclusion criteria (e. g. one of the study group's mean age was < 65, depression score reported as HRQoL). If we did not reach the same decision after our independent review, we collectively reviewed the study, applied the criteria, and resolved through discussion. This occurred for one study, in which outcomes were reported in multiple publications, therefore only the original study¹⁷ investigating physical function and HRQoL was included for this review.

Results

Twelve independent studies (total 1149 subjects) met our search criteria. All but one study included the six-minute walk test (6MWT) in reporting of functional outcomes. Wall et al.¹⁸ compared their participant's function levels using the self-report Yale Physical Activity Survey (YPAS). Health-related quality of life was assessed using a specific heart failure

questionnaire (Minnesota Living with Heart Failure Questionnaire [MLWHFQ] or Chronic Heart Failure Questionnaire [CHFQ]) in all but one study in which Borland et al.¹⁹ used the Short Form-36 (SF-36).

Average participant age across studies was very similar at 70.1 years, with the exception of one study in which participant average age was 80.5 years.²⁰ Study sample sizes ranged from 19 to 200 participants. Almost one-half of the studies had a female participation rate of 42 percent or higher, and one study had an all-female sample. Minority participation information was included for less than 50 percent of the studies. Intervention times ranged from three to 12 months. Table 1 shows specific characteristics and outcomes related to physical function and HRQoL. Five studies^{17,19,21–23} reported significant differences in physical function and perceived HRQoL between intervention groups and standard care/control groups. Gary et al.²⁴ reported significant improvements in function but not HRQoL, and Yeh et al.²⁵ reported significant improvements in HRQoL but not function in their studies. Five studies^{18,20,26–28} showed no statistically significant differences between groups. All of the studies reported no participant adverse effects during the intervention.

There was a mix of intervention implementation methods, with four studies (33.3%) utilizing a group-based exercise/physical activity method, seven (58.3%) performing the exercise/physical activity intervention at an individual level, and one study using both group and individual methods (8.3%). Six studies incorporated both aerobic activity and resistance training,^{19–21,23,27,28} and three studies administered aerobic interventions.^{18,22,24} Participants in Yeh et al.²⁵ performed Tai Chi, which incorporates aerobic and anaerobic activity. Three studies^{21,22,24} included additional components of education or cognitive behavioral therapy with their exercise intervention. Two studies^{18,28} conducted a long-term intervention (12 months duration). All other studies had short intervention periods (between two and four months). Seven studies (58.3%) had short-term follow-up (three to six months), with five studies (41.6%) evaluating outcomes long-term (at 12 months).^{18,22,23,27,28}

Five studies contained a moderate to large sample size thus were able to identify smaller significant effects in the study population.^{20,22,23,27,28}

Literature Analysis

Safety Considerations for Physical Activity/Exercise

The reviewed studies show moderate results of physical activity/exercise on function and HRQoL. However, just as important, none of the studies suggested any harmful effects were experienced by participants. These results are encouraging as older adults have been excluded often from heart failure trials on the foundation they are more frail and thus more likely to suffer adverse events.²⁹ The combined result that these 12 randomized controlled studies shows that physical activity/exercise interventions can be safely performed by older adults with mild to moderate heart failure is promising. Our study findings are in line with a previous review of mostly older males that indicated physical activity and exercise training were safe practices for older adults with heart failure.³⁰ It is well known that exercise improves cardiovascular health— even in those with heart conditions^{31–33}—therefore

promotion programs of physical activity/exercise in heart failure patients should continue to be adopted by researchers and clinicians.

Intervention Components for Physical Activity/Exercise Effects on Function and HRQoL

Intervention type and dose—Intervention activities ranged from seated exercises, treadmill use, walking at home, to dancing, Tai-Chi, resistance training and high intensity training. In addition to physical training, three studies^{17,21,24} included education components in the intervention. The dose of physical activity/exercise training ranged widely across studies with session duration of 15 to 60 minutes, one to three sessions per week, with one study²⁷ administering only three initial sessions with infrequent follow-up sessions. Only three studies reported the intensity of training ranging from 40%¹⁷ to 70%^{27,28} of maximal heart rate. None of the studies described similar treatment group processes with the exception of the two studies by Gary et al.,^{17,24} in which both employed an individual home-based walking program. There was also a wide range of intervention periods across the studies, from three to 12 months. One-third of the studies were three month's duration, two studies spanned each four and six months, while three studies were nine to 12 months in duration. The variability of intervention components in studies reporting significant differences lends support to the use of a variety of programs to aid older adults with heart failure to engage in physical activity. The ability to tailor interventions to the needs of the patient is a critical element in successful programs targeting older adults.³⁴ Future studies need to replicate these diverse methods to add strength to current findings.

Intervention setting—A majority of interventions (five of seven) with positive function and/or HRQoL outcomes were delivered in a group setting.^{19,21–23,25} Of the five studies that reported no differences, two were group-based and three were individual-based interventions. While description of the intervention method was very good in most studies, only three studies provided adequate description of the group intervention setting,^{20,21,25} which makes it difficult to replicate in the future. Austin et al.²¹ attributes their community-hall group and significant other support as factors that aided participants to reach goals. Although Witham et al.²⁰ did not report significant results, their detailed description of the small group setting, activities, and spouse inclusion provides a template for future researchers interested in seated exercises for older adults. Of note is one individual-based intervention that reported significant results. Gary et al.¹⁷ described in detail the primary and alternate setting for their one-to-one individually tailored intervention. The authors identified assessment of individual preferences and assistance to form personal goals as important aspects of their study. The group setting may be an important component to address further for this population, however individually tailored interventions may be equally important.

Participant adherence—Participant adherence to protocols was measured in all of the studies, with wide variability in adherence across and within the individual programs. Previous studies show that adherence levels to a physical activity intervention may affect outcomes.^{35,36} In our analysis, one short term study (6 months) reported 94 percent attendance²¹ while another had much lower adherence (43 percent of participants attending 80 percent of the exercise program).²⁸ The level of contact from investigators may play a role in adherence, with studies incorporating frequent contact (at least weekly to start and

monthly if long-term) reporting higher participation rates than those studies providing few contact points. Austin et al.²¹ performed twice weekly group sessions for two months, and weekly group sessions for the next four months with a resulting 94 percent attendance during their six month program. Borland et al.¹⁹ reported 80 percent session attendance in their three month study that offered twice-weekly group-based training, and also found significant differences between groups. In comparison, researchers in Jolly et al.²⁷ visited participants only three times at home and performed three follow-up phone calls during their six month intervention. Participation rates dropped from an initial 81 percent to 54 percent at six months. Active supervision during the program may also influence outcomes. McKelvie et al.²⁸ reported significant differences at the end of three months where participants received weekly supervised training (in which participants trained for 2.3 ± 0.4 sessions per week) but no differences at 12 months where participants were without supervision for an extended period of time (training attendance dropped to 1.7 ± 0.4). These findings support outcomes reported by Davidson et al.²² in which participant supervision ended at three months and HRQoL declined from three months to 12 month follow-up.

However it may be more complex than contact or supervision only that is needed to produce positive outcomes as Wall et al.¹⁸ reported frequent contact and a 78.9 percent participation at 12 months, but reported no significant differences between intervention and control groups. The duration of the intervention may affect adherence. It has been shown that adherence in exercise interventions by adults and older adults drops with time.³⁵ Our findings from the reviewed studies are similar to other physical activity/exercise studies in healthy or sedentary older-aged adults of short and long duration, with and without regular supervision.^{36,37}

Discussion

Strengths of the Studies

Participant characteristics—All of the studies focused on older adults with a mean age across studies of 70 years. The attention to older adults with a health condition such as heart failure adds to the small but growing cache of information to support the development of appropriate interventions for this population. Additionally, all studies included older patients with New York Heart Association heart failure classification of II and III, with a few studies including class I. The widely-used classification system identifies the severity of heart failure (I-IV), and identifies the overall health of the patient related to their heart condition. All studies used exclusion criteria of “unstable heart condition” and therefore limited inclusion of NYHA class IV, with the exception of one patient in the study by Brubaker et al.²⁶ who was randomized to the control group. This is consistent with many current medical intervention studies, as class I heart failure patients typically do not have the associated symptoms which may contribute to lower physical activity, and class IV patients are not medically stable to participate in higher levels of physical activity.^{38,39} Comorbid conditions and medication characteristics were reported by most studies and were very similar. The very comparable characteristics of participants lend strength to generalizability, with the exception of minority groups. Minority representation was good in five studies with a range between 14 and 41 percent inclusion.

Research Design—All studies were randomized controlled trials, considered the gold standard for evaluating the efficacy of an intervention.⁴⁰ This reduces the risk of selection bias and ensures that both intervention and control groups have similar variance. A majority of studies included descriptions of the exercise/physical activity regimen and several detailed the intervention protocol, allowing for replicability of the study. Control group designs across studies were similar, and included usual care (primarily basic heart failure education), attention control (e. g. basic heart failure education plus nutrition education), and alternative treatment (e.g. weekly phone call follow-up).

Data Collection Measures—The use of valid and reliable data collection tools in the studies, with most studies using the same or very similar tools, allows for direct comparison of outcomes. For example, the six-minute walk distance test (6MWT)—used in 11 studies—has been validated across various older adult populations and specifically in older heart failure patients and has been used to predict future morbidity and mortality.⁴¹ Additionally, the MLWHFQ—used in nine studies—is a well-known and validated 21-item, disease-specific self-report questionnaire measuring physical, socioeconomic, and psychological impairment related to heart failure.⁴² The CHFQ (two studies) has also been validated in older adults and measures subjective health status in heart failure. It is a 16-item questionnaire that must be administered by a trained investigator.⁴³ Both instruments have been tested extensively in older adults and show strong correlations with NYHA status and were very responsive to heart failure patients' changing conditions.⁴⁴

Continuous health monitoring—All of the studies included prescreening (as eligibility criteria) and health assessment components at baseline and for the duration of the intervention for the treatment group. Measures were varied across studies, from electrocardiogram, blood pressure monitoring, and pulmonary function, to symptom assessment and reported exertion during exercise. Each study reported any loss of participation related to morbidity/mortality, but identified that none was a result of the intervention activity. All participants who began each exercise session were able to complete or stop on their own without the investigator halting the activity for a health reason. Several studies with unsupervised home exercise activities indicated investigators performed up to weekly follow-up phone calls to assess health condition. This manner of care for participants reduces the risk of adverse effects from an intervention but also can be perceived as support and encouragement to engage in the intervention. Knowing a trained investigator is monitoring one's health may result in higher engagement in the activity by the participant.⁴⁵

Clinically meaningful results—All of the studies reported a measure of physical function and perception of quality of life. These outcome measurements provide realistic and easily understandable results for the general heart failure population. In an exercise plan, goals and results should be communicated with the older adults in meaningful terms. Often highly technical results such as V02max, pulse pressure, and exertion levels, though not unimportant, are not easily translated to meaningful results for the participant. Simple, yet quality outcome measures such as distance walked/daily steps, strength, symptoms such as fatigue level, and ability to complete activities of daily living are easily understood by older adults. Additionally, with the changing lens of health care delivery to a patient-centered

focus, incorporating goals and values which are important to heart failure patients can help clinicians guide management of their care.

Limitations of the Studies

Absence of theory-based interventions—Only one study described a theoretical approach to their intervention. Gary et al.²⁴ describe the use of Cognitive Behavioral Therapy (CBT) as an integral part of their intervention to improve outcomes in their study population. Their results show that the combined intervention based on CBT and exercise resulted in significant changes in physical function, while exercise alone did not. However, there was no discussion regarding theory constructs that may have supported the improvement in function. It is well supported in the literature that increasing physical activity levels is a result of behavior change³⁵ thus, interventions to support this population should include a behavioral theory component. The use of components such as goal setting and social support for physical activity/exercise in the older adult population have been shown to promote feelings of exercise self-efficacy and competence.³⁷ Theory-based interventions that support behavior change may support long-term maintenance of physical activity in this population.

Underrepresentation of minority populations—Minority populations were not represented in seven (58.3%) of the studies as they either did not identify or did not include minority population information. Additionally, two of the larger studies (with N=100+) report less than 15 percent minority representation. Low representation makes the results from this analysis difficult to generalize to populations other than white. This leaves a significant gap in the evidence regarding physical activity/exercise effects in minority groups.

Recommendations

The small number of studies included in this review reported wide variability in intervention period, setting, and methods which makes it difficult to adequately identify specific components that may be effective in promoting physical activity in the older heart failure population. However, while the combined results from these studies show only moderate results on improvement of function and HRQoL through physical activity/exercise, there were no adverse participant outcomes, therefore they must be considered important factors for heart failure patients. Specific components such as group-based programs and frequent contact/supervision by researchers or health team members appear to promote positive outcomes.

The ability to maintain adequate physical function and independence in self-care abilities is a concern of older adults that has been identified in previous studies.^{46–48} Additionally, regardless of physical function level many older adults rate their health based on perceptions of their quality of life.⁴⁹ Studies assessing functional and/or quality of life outcomes not only address areas that are important to the older heart failure population, but also address key elements in the *Healthy People 2020* initiative, specifically the goals of reducing functional burden and increasing physical activity engagement by older adults.¹⁶

Clinicians and nurses play an important role in assisting older adults with heart failure in developing a physical activity/exercise program. They can use their technical knowledge of the heart failure condition, physical activity guidelines, measures, and outcomes to assist their patients in understanding and setting appropriate, realistic, and meaningful goals. Batt et al.¹⁰ recommend inactive older adults obtain an exercise prescription from their health care provider after physical assessment and begin physical activity at lower levels and increase duration and intensity to meet the U. S. Physical Activity Guidelines or a comparable activity equivalent according to their health condition. Participants in the reviewed studies showing significant results averaged 30 minutes of moderate exercise for two to three days a week, performing a variety of physical activities. This frequency is less than what is recommended for healthy older adults however may be adequate for this chronically ill population. It appears walking programs, dancing activities, use of cycle ergometry and resistance training are all appropriate activities to support function and quality of life outcomes. Pre-screening and health assessment and participant reporting of perceived exertion during the physical activity/exercise programs supports a safe setting for the intervention.

Areas for Future Research

Future research should continue testing differences between individual and group-based physical activity interventions on long-term outcomes. As five of the seven studies that reported significant differences in function or HRQoL performed group-based interventions, it may be that elements of the group process (e. g. feeling of community, interaction, verbal encouragement by similar others) were important influences on outcomes. This supports our earlier call for adoption of theory-based approaches to promote behavior change. Researchers should apply behavioral theory components that have been tested in previous physical activity interventions of older adults. Additionally, the group setting and/or inclusion of spouses or significant others may better support participant engagement and adherence to the program. Furthermore, older adults may need specialized instruction and continued support to maintain appropriate activity and exercise levels at home. Next, future research must place an emphasis on minority recruitment as it is well known that heart failure places a disproportionate burden on ethnic/racial minority populations, including African Americans and Latinos.⁵⁰ Diverse older adult participants may also provide a better understanding of culturally relevant physical activity intervention components that may be generalizable to broader settings. Future studies should also examine various methods of long-term participant contact and support, and report cost analyses of these, so that researchers may evaluate the most appropriate methods to maintain participant support for optimal outcomes. Finally, future research should incorporate patient-directed outcomes such as function and quality of life measures in their studies.

Conclusions

Adults 65 years and older with heart failure have significantly higher mortality rates⁵¹ and are at increased risk for decreased physical function and self-care abilities compared to their younger counterparts.⁵² However, higher levels of physical activity, even in older adults already suffering chronic heart failure, may improve physical function and fitness level and

thus reduce morbidity and mortality. A variety of physical activities from seated exercises to higher level treadmill exercise appear to be appropriate for this population. Both group and individual physical activity/exercise programs show success for patient engagement however continued supervision and encouragement may be required for long-term adherence. Further work is essential to identify successful strategies to support older adults with heart failure to increase physical activity thus supporting physical function levels and health related quality of life.

References

1. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: Increased vulnerability with age. *J Am Geriatr Soc.* 2003; 51(4):451–458. [PubMed: 12657063]
2. U. S. Centers for Disease Control and Prevention. Chronic disease prevention and health promotion. <http://www.cdc.gov/chronicdisease/resources/publications/AAG/aging.htm>. Updated 2011
3. Blecker S, Paul M, Taksler G, Ogedegbe G, Katz S. Heart failure-associated hospitalizations in the united states. *J Am Coll Cardiol.* 2013; 61(12):1259–1267. [PubMed: 23500328]
4. Berg J, Lindgren P, Kahan T, et al. Health-related quality of life and long-term morbidity and mortality in patients hospitalised with systolic heart failure. *JRSM Cardiovasc Dis.* 2014; 3:1–9.
5. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics--2014 update: A report from the American Heart Association. *Circulation.* 2014; 129(3):e28–e292. [PubMed: 24352519]
6. Heidenreich PA, Trogon JG, Khavjou OA, et al. Forecasting the future of cardiovascular disease in the United States: A policy statement from the American Heart Association. *Circulation.* 2011; 123(8):933–944. [PubMed: 21262990]
7. Kelley GA, Kelley KS, Hootman JM, Jones DL. Exercise and health-related quality of life in older community-dwelling adults A meta-analysis of randomized controlled trials. *J Appl Gerontol.* 2009; 28(3):369–394.
8. Gillison FB, Skevington SM, Sato A, Standage M, Evangelidou S. The effects of exercise interventions on quality of life in clinical and healthy populations; a meta-analysis. *Soc Sci Med.* 2009; 68(9):1700–1710. [PubMed: 19297065]
9. Chou C, Hwang C, Wu Y. Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: A meta-analysis. *Arch Phys Med Rehabil.* 2012; 93(2):237–244. [PubMed: 22289232]
10. Batt ME, Tanji J, Borjesson M. Exercise at 65 and beyond. *Sports Med.* 2013; 43(7):525–530. [PubMed: 23508579]
11. Dontje ML, van der Wal MH, Stolk RP, et al. Daily physical activity in stable heart failure patients. *J Cardiovasc Nurs.* 2014; 29(3):218–226. [PubMed: 23416939]
12. U.S. Preventive Services Task Force. The US preventative services task forces' guide to clinical preventive services. 2012. Retrieved from: <http://www.uspreventiveservicestaskforce.org/>
13. U. S. Centers for Disease Control and Prevention. Nutrition, physical activity and obesity data: Trends and maps. Retrieved from: http://nccd.cdc.gov/NPAO_DTM/IndicatorSummary.aspx?category=71&indicator=36. Updated 2011
14. Taylor RS, Sagar VA, Davies EJ, et al. Exercise-based rehabilitation for heart failure. *Cochrane Database Syst Rev.* 2014; 4:CD003331.
15. Mann N, Rosenzweig A. Can exercise teach us how to treat heart disease. *Circulation.* 2012; 126(22):2625–2635. [PubMed: 23184282]
16. U.S. Department of Health and Human Services. Healthy People. Washington, DC: 2020. Office of disease prevention and health promotion. Retrieved from: <http://www.healthypeople.gov/>
17. Gary RA, Sueta CA, Dougherty M, et al. Home-based exercise improves functional performance and quality of life in women with diastolic heart failure. *Heart Lung.* 2004; 33(4):210–218. [PubMed: 15252410]

18. Wall HK, Ballard J, Troped P, Njike VY, Katz DL. Impact of home-based, supervised exercise on congestive heart failure. *Int J Cardiol.* 2010; 145(2):267–270. [PubMed: 19854523]
19. Borland M, Rosenkvist A, Cider A. A group-based exercise program did not improve physical activity in patients with chronic heart failure and comorbidity: A randomized controlled trial. *J Rehabil Med.* 2014; 46(5):461–467. [PubMed: 24691771]
20. Witham MD, Gray JM, Argo IS, Johnston DW, Struthers AD, McMurdo ME. Effect of a seated exercise program to improve physical function and health status in frail patients > or = 70 years of age with heart failure. *Am J Cardiol.* 2005; 95(9):1120–1124. [PubMed: 15842989]
21. Austin J, Williams R, Ross L, Moseley L, Hutchison S. Randomised controlled trial of cardiac rehabilitation in elderly patients with heart failure. *Eur J Heart Fail.* 2005; 7(3):411–417. [PubMed: 15718182]
22. Davidson PM, Cockburn J, Newton PJ, et al. Can a heart failure-specific cardiac rehabilitation program decrease hospitalizations and improve outcomes in high-risk patients. *Eur J Cardiovasc Prev Rehabil.* 2010; 17(4):393–402. [PubMed: 20498608]
23. Nilsson BB, Westheim A, Risberg MA. Effects of group-based high-intensity aerobic interval training in patients with chronic heart failure. *Am J Cardiol.* 2008; 102(10):1361–1365. [PubMed: 18993156]
24. Gary RA, Dunbar SB, Higgins MK, Musselman DL, Smith AL. Combined exercise and cognitive behavioral therapy improves outcomes in patients with heart failure. *J Psychosom Res.* 2010; 69(2):119–131. [PubMed: 20624510]
25. Yeh GY, McCarthy EP, Wayne PM, et al. Tai chi exercise in patients with chronic heart failure: A randomized clinical trial. *Arch Intern Med.* 2011; 171(8):750–757. [PubMed: 21518942]
26. Brubaker PH, Moore JB, Stewart KP, Wesley DJ, Kitzman DW. Endurance exercise training in older patients with heart failure: Results from a randomized, controlled, single-blind trial. *J Am Geriatr Soc.* 2009; 57(11):1982–1989. [PubMed: 20121952]
27. Jolly K, Taylor RS, Lip GY, et al. A randomized trial of the addition of home-based exercise to specialist heart failure nurse care: The Birmingham rehabilitation uptake maximisation study for patients with congestive heart failure (BRUM-CHF) study. *Eur J Heart Fail.* 2009; 11(2):205–213. [PubMed: 19168520]
28. McKelvie RS, Teo KK, Roberts R, et al. Effects of exercise training in patients with heart failure: The exercise rehabilitation trial (EXERT). *Am Heart J.* 2002; 144(1):23–30. [PubMed: 12094184]
29. Lazzarini V, Mentz RJ, Fiuzat M, Metra M, O'Connor CM. Heart failure in elderly patients: Distinctive features and unresolved issues. *Eur J Heart Fail.* 2013; 15(7):717–723. [PubMed: 23429975]
30. Chen YM, Li Y. Safety and efficacy of exercise training in elderly heart failure patients: A systematic review and meta-analysis. *Int J Clin Pract.* 2013; 67(11):1192–1198. [PubMed: 24165432]
31. Aliabad HO, Vafaenasab M, Morowatisharifabad MA, Afshani SA, Firoozabadi MG, Forouzannia SK. Maintenance of physical activity and exercise capacity after rehabilitation in coronary heart disease: A randomized controlled trial. *Glob J Health Sci.* 2014; 6(6):198–208. [PubMed: 25363124]
32. Vigorito C, Giallauria F. Effects of exercise on cardiovascular performance in the elderly. *Front Physiol.* 2014; 5:51. [PubMed: 24600400]
33. From S, Liira H, Leppavuori J, Remes-Lyly T, Tikkanen H, Pitkala K. Effectiveness of exercise intervention and health promotion on cardiovascular risk factors in middle-aged men: A protocol of a randomized controlled trial. *BMC Public Health.* 2013; 13(1):125–130. [PubMed: 23398957]
34. Dondzila CJ, Swartz AM, Keenan KG, Harley AE, Azen R, Strath SJ. Translating exercise interventions to an in-home setting for seniors: Preliminary impact on physical activity and function. *Aging Clin Exp Res.* 2016:1–9. [PubMed: 26746234]
35. McAuley E, Jerome GJ, Elavsky S, Marquez DX, Ramsey SN. Predicting long-term maintenance of physical activity in older adults. *Prev Med.* 2003; 37(2):110–118. [PubMed: 12855210]
36. Jancey J, Lee A, Howat P, Clarke A, Wang K, Shilton T. Reducing attrition in physical activity programs for older adults. *J Aging Phys Act.* 2007; 15(2):152–165. [PubMed: 17556782]

37. Floegel TA, Giacobbi PR Jr, Dzierzewski JM, et al. Intervention markers of physical activity maintenance in older adults. *Am J Health Behav.* 2015; 39(4):487–499. [PubMed: 26018097]
38. Banks AZ, Mentz RJ, Stebbins A, et al. Response to exercise training and outcomes in patients with heart failure and diabetes mellitus: Insights from the HF-ACTION trial. *J Card Fail.* 2015; 12(7):1–7.
39. Pandey A, Parashar A, Kumbhani DJ, et al. Exercise training in patients with heart failure and preserved ejection fraction: Meta-analysis of randomized control trials. *Circulation: Heart Failure.* 2015; 8(1):33–40. [PubMed: 25399909]
40. Sidani, S. *Health intervention research: Understanding research design and methods.* Thousand Oaks, CA: Sage; 2015.
41. Demers C, McKelvie RS, Negassa A, Yusuf S. RESOLVD Pilot Study Investigators. Reliability, validity, and responsiveness of the six-minute walk test in patients with heart failure. *Am Heart J.* 2001; 142(4):698–703. [PubMed: 11579362]
42. Rector TS, Kubo SH, Cohn JN. Patients' self-assessment of their congestive heart failure: Content, reliability and validity of a new measure—the Minnesota living with heart failure questionnaire. *Heart Failure.* 1987; 3:198–209.
43. Guyatt GH, Nogradi S, Halcrow S, Singer J, Sullivan MJ, Fallen EL. Development and testing of a new measure of health status for clinical trials in heart failure. *J Gen Intern Med.* 1989; 4(2):101–107. [PubMed: 2709167]
44. Bennett SJ, Oldridge NB, Eckert GJ, et al. Comparison of quality of life measures in heart failure. *Nurs Res.* 2003; 52(4):207–216. [PubMed: 12867777]
45. Schutzer KA, Graves BS. Barriers and motivations to exercise in older adults. *Prev Med.* 2004; 39(5):1056–1061. [PubMed: 15475041]
46. Gustavsson M, Liedberg GM, Larsson Ranada A. Everyday doings in a nursing home -described by residents and staff. *Scand J Occup Ther.* 2015; 22(6):435–441. [PubMed: 26018609]
47. Norberg EB, Boman K, Lofgren B, Brannstrom M. Occupational performance and strategies for managing daily life among the elderly with heart failure. *Scand J Occup Ther.* 2014; 21(5):392–399. [PubMed: 24878004]
48. Janssen SL, Stube JE. Older adults' perceptions of physical activity: A qualitative study. *Occup Ther Int.* 2014; 21(2):53–62. [PubMed: 24302685]
49. Dunderdale K, Thompson DR, Miles JN, Beer SF, Furze G. Quality-of-life measurement in chronic heart failure: Do we take account of the patient perspective. *Eur J Heart Fail.* 2005; 7(4):572–582. [PubMed: 15921797]
50. Dickson VV, McCarthy MM, Howe A, Schipper J, Katz SM. Sociocultural influences on heart failure self-care among an ethnic minority black population. *J Cardiovasc Nurs.* 2013; 28(2):111–118. [PubMed: 22343210]
51. Karavidas A, Lazaros G, Tsiachris D, Pyrgakis V. Aging and the cardiovascular system. *Hellenic J Cardiol.* 2010; 51(5):421–427. [PubMed: 20876055]
52. Menezes AR, Lavie CJ, Milani RV, Arena RA, Church TS. Cardiac rehabilitation and exercise therapy in the elderly: Should we invest in the aged. *J Geriatr Cardiol.* 2012; 9(1):68–75. [PubMed: 22783325]

Physical activity/exercise randomized controlled trials assessing functional outcomes and health-related quality of life in older adults with heart failure

Table 1

| Study author | Sample & Setting | Intervention | Main findings | Limitations | Strengths |
|------------------------|--|--|--|--|--|
| Austin et al. (2004) | N = 185 Age: 71.8 ± 6.5 % Female: 44.5 % Minority: n.s. Clinic individual-based & Community center group-based | 2 months with cardiac rehabilitation program including 2x/week education sessions followed by 4 month community based exercise program (aerobic and resistance training) 1x/week for 60 minutes Control: standard care (8 weekly clinic-supervised monitoring of status) | significant improvement at 6 months in intervention group for 6MWT (p<.001) and in MLWHFQ scores (p<.01) compared to control | cardiac rehabilitation program not explained (unknown level/type of exercise) | high participant adherence rate (94%); significant other/partner encouraged to attend community program with participant |
| Borland et al. (2014) | N = 48 Age: 70.5 ± 8.0 % Female: 20.8 % Minority: n.s. Clinic group-based | 3 months with 60 minute twice-weekly, group-based aerobic exercise on cycle ergometry and resistance training Control: wait list; usual care | no difference in steps per day; significant improvement in intervention group at in 6MWT (p=.014), HRQoL [measured with SF-36 (p=.018)], and exercise tolerance (p=.008) compared to control | small percentage female subjects, unknown minority population | All participants attended 80% of sessions; detailed participant comorbidities |
| Brubaker et al. (2009) | N = 59 Age: 70.2 ± 5.1 % Female: 33.9 % Minority: 18.6 Clinic group-based | 4 months with 60 minute supervised clinic walking and cycle ergometry sessions 3 days/week Control: attention control (bi-weekly phone call) | no statistical difference between groups in 6MWT or MLWHFQ score at end of intervention | older study data (>10 yrs old at publication) prior to pharmacologic standards for HF patients | focus on HF patients with reduced ejection fraction; minority population included |
| Davidson et al. (2010) | N = 105 Age: 72 ± n.s. % Female: 38.1 % Minority: n.s. Clinic individual and group-based | 3 month multidisciplinary individualized exercise program with initial instruction in clinic followed by 1x/wk exercise at community gym near home; goal was 30 minutes moderate physical activity each session Control: usual care (1 information session w/ nurse & f/u with provider) | significant improvement in intervention group 6MWT compared to control (3 months p=.001; 12 months p<.001); significant improvement in intervention group in MLWHFQ at 3 months (p=.01), however at 12 months follow-up there was no significant difference between groups in MLWHFQ | unknown minority inclusion; 6MWT performed at each weekly visit (compensatory intervention) | multi-disciplinary approach; detailed participant comorbidities; individually tailored; reports 12 month readmission statistics (significantly lower in intervention group (p<.001)) |
| Gary et al. (2010) | N = 74 Age: 65.8 ± 13.5 % Female: 57.1 % Minority: 28.4 Individual home-based | 3 months with weekly home visits for individual exercise supervision and instruction; 3 groups: exercise therapy (EX), combined exercise and behavioral therapy (CBT/EX), and control (C); behavioral therapy encouraged to walk 3x/week; 30-45 minutes per session Control: usual follow-up care | at 6 month follow-up significant increase in 6MWT in CBT/EX group (p=.002); MLWHFQ improved most in CBT/EX but did not reach significance | small sample size for each group; one academic center; intervention dosage difference between EX & CBT/EX groups (EX 1 weekly visit, CBT/EX 2x/week visit) | included behavioral component; female and minority population well represented; included subjects with major depression |
| Gary et al. (2004) | N = 32 Age: 68 ± 11.0 % Female: 100 % Minority: 41 Individual home-based | 3 month home walking program at 40-60% intensity, 40 min/day, 3 days/week with weekly visits for education Control: heart disease and women's health education | significant increase in 6MWT distance by intervention group (p=0.002); no difference in perceived function; MLWHFQ scores significantly improved in intervention group (p=.019) | small sample size for each group | minority population represented; included comorbid conditions and subjects with depression |
| Jolly et al. (2009) | N = 169 Age: 68 ± 12.9 | 3 hospital-based classes followed by 6 month home-based walking and | at 6 and 12 months the intervention group scored higher on MLWHFQ but it | self-report on physical activity; adherence dropped | larger sample size; follow-up at 6 and 12 months; detailed |

| Study author | Sample & Setting | Intervention | Main findings | Limitations | Strengths |
|------------------------|---|--|--|---|---|
| McKelvie et al. (2002) | N = 181 Age: 65.9 ± 1.1 % Female: 19 % Minority: n.s Individual clinic- and home-based | resistance program 20–30 minutes at 70% intensity; encouraged to perform 5 times/week; Home visits at 4, 10, 20 weeks with phone f/u at 6, 15, 24 weeks Control: heart failure education | was non-significant; at 12 months the physical function but was nonsignificant | from initial 81% to 54% at 20 weeks | analysis of within-group differences |
| | N = 181 Age: 65.9 ± 1.1 % Female: 19 % Minority: n.s Individual clinic- and home-based | 3 months supervised training in clinic (treadmill, cycle and upper-body cycle, resistance training; 30 minute session at 60–70% HR) followed by 9 months unsupervised home-based cycle and resistance training Control: instruction to continue usual physical activity | significant increases at 3 months in arm and leg strength in intervention group (p=0.014 and p<0.001, respectively) compared to control; no significant difference between groups in 6MWT or MLWHFQ score at 6 or 12 months | underrepresented female population, unknown minority population; only 43% participants attended 80% sessions | equipment provided to all intervention participants for home use; measurements at 3 months and 12 months f/u; inclusion of medications |
| Nilsson et al. (2008) | N = 80 Age: 70.1 ± 7.9 % Female: 21.3 % Minority: n.s. Clinic group-based | 4 month program with aerobic dancing 50 min twice weekly and high intensity walking, sidestepping and leg lifts; 4 individual counseling sessions re: nutrition, physical activity, symptom reporting; 4 and 12 month f/u Control: usual care without exercise | significant improvement in intervention group at 6 months in 6MWT (p<.001) and MLWHFQ (p<.005) and at 12 months (6MWT p<.001 and MLWHFQ p=.003) compared to control | unknown minority population; no comorbid conditions cited; excluded frail; control group received intensive visits and education | Tested high-intensity interval training; included medication usage and adherence; investigators offered optional 2 additional sessions between 4–12 months; 12 month f/u |
| Wall et al. (2010) | N = 19 Age: 69 ± 4.25 % Female: 42 % Minority: 0 Individual home-based | 12 month home-based program using a treadmill at varied speeds for at least 15 minutes 3 times weekly; 3 visits at clinic, weekly home visit for 1 month, then monthly home visit for months 2–12 Control: chronic disease management program without exercise training | no differences in CHFQ results at any time point; Significant decrease in self-perceived fatigue by control group (p=.015) at 6 months, nonsignificant difference at 12 months | small sample size; no minority representation; limited analysis of YPAS for perceived activity level; limited comparability to similar studies for function | equipment provided to all intervention participants for home use; medication usage and adherence; long-term study with 78.9% participation at 12 months |
| Witham et al. (2005) | N = 82 Age: 80.5 ± 5.0 % Female: 45.2 % Minority: n.s. Clinic group-based and individual home-based | 3 months outpatient supervised seated exercise followed by 3 months at home exercise; 20 min. session for 2–3 times/week; weekly phone call during home-based exercise Control: usual heart failure care without exercise training | at 3 months preservation of FLP scores in intervention group with decline in control but did not reach significance; CHFQ scores did not differ between groups at any time point; no difference between groups in 6MWT at any time point | no discussion of clinical significance; unknown minority inclusion | 75% participant adherence to protocol (attending > 80% of sessions); included subjects with multiple comorbidities; older aged of study population; testing of seated-only exercises; supervised intervention 0–3 months with measurement at 6 months |
| Yeh et al. (2011) | N = 100 Age: 67.4 ± 12.0 % Female: 46 % Minority: 14 Community group-based | 3 month Tai Chi group-based program for 1 hour 2x/week; 6 month f/u Control: time-matched education | no significant differences between groups for 6MWT at study completion; significant improvement in MLWHFQ scores in intervention group (p=.02) at 3 months compared to education match; at 6 months follow-up, MLWHFQ differences were non-significant | significant (p=.01) change in use of statin medications in education group during intervention | multisite participation; 75% adherence to exercise protocol during 0–3 months; video of exercises for home use included; at 6 month f/u 68% reported performing exercises 2x/week |

N=number of participants randomized, Age=mean age ± s.d., n.s.=not stated, 6MWT=Six Minute Walk Test, SF-36=Short Form Health Survey Questionnaire, MLWHFQ=Minnesota Living With Heart Failure Questionnaire, CHFQ=Chronic Heart Failure Questionnaire, FLP=Functional Limitations Profile, YPAS=Yale Physical Activity Survey