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Research Article

The Effectiveness of Aerobic Training (Walking) on the Functional Capacity of Heart Failure (HF) Patients: A Systematic Review

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ABSTRACT

This study aims to determine the effectiveness of Aerobic Training (AT) (walking) in increasing the functional capacity of HF patients. This study is a systematic review collected from 5 databases, namely PubMed, scienceDirect, Scopus, Wiley and proQuest. Articles meet the criteria for English language, publication of the last 10 years (2011-2020), and interventions focused on Aerobic Training (walking) in HF patients. A total of 7 articles met the criteria for Heart Failure patients, especially those with ejection fraction <40% and the New York Heart Association class II and III. Aerobic exercise intervention (walking) resulted in an increase in peak VO_2 (mean differences: 1.7 ml/kg/min, 3.7 ml/kg/min, 2 ml/kg/min, and 1.1 ml/kg/min). In the 6-Minute walk there is an increase in the distance (average difference: 46.4 m, 98.3 m, 9 m, and 53.27 m). Duke Activity Status Index assessment, there is a significant change in p value 0.981. Also, in the Minnesota Living with Heart Failure questionnaire there was a clinical improvement (mean difference: 22.6 points, 19.7 points, and 2 points). The implementation of aerobic exercise (walking) with duration of 30-60 minutes for 3 times a week with low to moderate intensity training has been proven effective in increasing peak VO_2, 6 minute walks, Duke Activity Status Index, and improving quality of life in Heart Failure patients.

Keywords: Walking exercise, Heart Failure (HF), Functional capacity

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INTRODUCTION

The prevalence of Heart Failure (HF) will increase every year. It is estimated that it will increase by 46% from 2012 to 2030 by 8 million people aged ≥ 18 years (Go AS, *et al*., 2014). HF cases in the United States show an increase in prevalence from 5.7 million in 2012 to 6.2 million in 2016 (Virani SS, *et al*., 2020). In Asia, the prevalence of HF varies between 1.26% and 6.7%, and the mortality rate has been reported as 3.9%-6.7% (Mansouri A, *et al*., 2019). In Indonesia alone the prevalence of HF is reported to be 5% (Reyes EB, *et al*., 2016). Due to the high prevalence rate of HF, many previous studies were conducted to reduce readmission of HF patients but remain at high risk for hospitalization with 20% to 25% readmission within 30 days (Vargas J, *et al*., 2019). By reducing the re-admission of HF patients to hospitalization, an assessment of functional capacity is necessary.

Functional capacity is important in measuring the physical abilities of HF patients. Functional capacity is determined by the ability to perform physical activities that require a certain level of aerobic capacity or skeletal muscle strength and endurance (Jurgens CY, *et al*., 2015). The functional status and general health tools used are peak VO_2, Estimated Mets, Weber scale, 6-Minute walk, New York Heart Association (NYHA), Duke Activity Status Index (DASI), The Veterans Specific Activity Questionnaire (VSAQ), Kansas City Cardiomyopathy Questionnaire (KCCQ), and Minnesota Live with Heart Failure Questionnaire (MLHFQ) (Arena R, *et al*., 2007). This instrument has the advantage of being fast, cheap and safe (Arena R, *et al*., 2007). With the several advantages of this instrument, the modality of rehabilitation interventions in HF patients can be improved.

There are several modalities of rehabilitation interventions in HF patients to increase functional capacity. Aerobic Training (AT) is one of the core rehabilitation intervention modalities for patients with HF that has been shown to significantly improve exercise performance and functional capacity (Giallauria F, *et al*., 2018). Aerobic Training example: Walking is one of the most adopted intervention modalities in patients with HF and is recommended as initial activity (Giallauria F, *et al*., 2018). Walking is considered to be one of the most effective forms of physical activity, with little risk of injury among the low activity population, has been used as an intervention to reduce the burden of a number of chronic diseases including hypertension, cardiovascular risk, obesity, and osteoarthritis (Vetrovsky T, *et al*., 2017). Therefore, this review is expected to be an evidence-based reference for all health practitioners in providing AT recommendations, especially walking for patients with HF.

There needs to be a systematic review of AT (walking) interventions in HF patients. Recent meta-analysis studies suggest that resistance training in addition to standard HF drugs can provide clinically relevant improvements in exercise capacity and quality of life in Heart Failure with preserved Ejection Fraction (HFpEF) patients (Fukuta H, *et al*., 2016). However, further research is needed to establish the type, intensity, frequency, and duration in HFpEF patients (Fukuta H, *et al*., 2016). Likewise with other studies that explain that exercise provides a large increase in cardiopulmonary capacity because good functional capacity relieves symptoms and improves quality of life so it is attractive to the cardiac rehabilitation community (Giallauria F, *et al*., 2018). Further research should be designed to determine the best strategy in terms of type, duration, frequency and intensity of exercise programs (Giallauria F, *et al*., 2018). Therefore, the researcher conducted a systematic review of the literature in the form of a

detailed summary of the type, intensity, frequency, and duration of exercise in a systematic review of AT (walking) on the functional capacity of HF patients. So the purpose of writing in this study is to identify the results of systematic literature analysis regarding the effectiveness of AT (walking) to increase the functional capacity of HF patients.

METHODS

This systematic review uses the PRISMA Checklist 2009 guidelines (Moher D, *et al*., 2009).

Search strategy

Literature search was carried out in five data bases, namely PubMed, ScienceDirect, Scopus, Wiley, and ProQuest published from 2011 to 2020 and in English. The keywords use the PICO electronic method (Population, Intervention, Comparison and Outcome) (Aromataris E and Munn Z, 2020; Eriksen MB and Frandsen TF, 2018). The PICO in this article is P: "Heart Failure" or "Congestive heart failure"; I: "Walking" or "Walking exercise"; C: "Control" or "Usual care" and O: "Functional capacity" (*Figure 1*).

Inclusion studies

The selected studies were (1) HF patients aged>18 years; (2) focusing on AT (walking); (3) both control and usual care groups are described as maintaining the patient's usual/standard level of daily activity without a systematic exercise component including usual medical care, but may have received active interventions (eg: Education and psychological interventions); (4) functional capacity in the form of Peak VO_2, Estimated Metabolic Equivalents (METs), Weber Scale, 6-Minute Walk, NYHA, DASI, VSAQ, KCCQ, and MLHFQ assessments; and (5) Randomized Control Trial (RCT) research design.

Exclusion studies

The study was excluded if it met any of the following criteria: (1) patients with other cardiac diseases such as coronary artery disease, myocardial infarction, chest angina, atrial fibrillation, peripheral artery disease, stroke, vascular disease, musculoskeletal disorders and pulmonary disease (2) review papers; and (3) study group intervention which had no comparison (*Table 1*).

Risk of bias assessment

Article selection was assessed using 2 instruments, namely Critical Appraisal Skill Program (CASP) in 2018 and CEBM (Center for Evidence-Based Medicine, 2014). In addition, the quality of the articles was filtered and assessed effectively using the Cochrane Risk of Bias Tool recommended by the Cochrane Handbook for Systematic Review. This tool consists of six items, namely random allocation, allocation of sample concealment, blinding, incomplete results, selective result reporting and other sources of potential bias. Each item is rated "yes (+)" "no (-)" or "unclear (?)". According to the Cochrane Handbook and previous studies, test quality can be divided into 3 levels. Level A if the article fully meets all 6 criteria. Level B is defined when 1 or more criteria are partially met and are considered low risk of bias. Meanwhile, if 1 or more criteria are not met, it is called level C which is considered to have a high risk of bias (Higgins JP, *et al*., 2011) (*Table 2*).

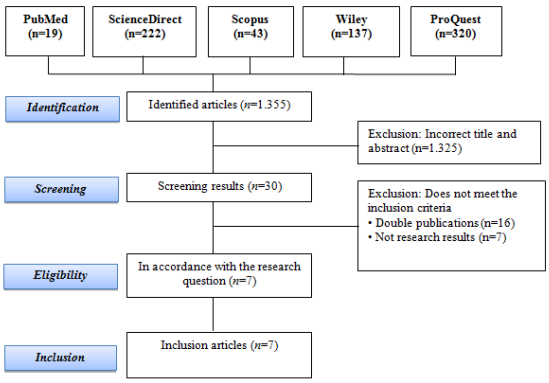

Figure 1: Article selection flow chart

Table 1: Outcomes of AT (walking) articles on functional capacity of HF patients

Researcher and year	Outcomes	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	P value	Pre-control	Post-control	P value
Gary RA, *et al*., 2011	6-Minute walk	364.3 ± 79.7	410.7 ± 91.5	0.006	306.6 ± 121.3	309.7 ± 135.4	0.855
	DASI	49.2 ± 9.0	49.2 ± 6.9	0.981	45.8 ± 11.1	41.9 ± 10.1	0.146
	MLHFQ	56.1 ± 24.4	33.5 ± 22.9	0.001	49.8 ± 26.0	46.5 ± 19.7	0.547
Awotidebe TO, *et al*., 2016	6-Minute walk	307.7 ± 22.5	406.0 ± 29.7	0.001*	309.2 ± 27.8	321.0 ± 25.7	0.001*
	Peak VO_2 (mL/kg/min)	8.6 ± 0.4	10.3 ± 0.5	0.001*	8.6 ± 0.5	8.9 ± 0.4	0.001*
Servantes DM, *et al*., 2012	Peak VO_2 (mL/kg/min)	11.6 ± 2.1	15.3 ± 2.9	<0.001*	11.8 ± 2.1	9.6 ± 1.9	<0.001*
	MLHFQ	40.4 ± 17.9	20.7 ± 16.3	<0.001*	46.5 ± 18.5	51.0 ± 16.8	<0.001*

Chien CL, *et al*., 2011	6-Minute walk (m)	424 ± 145	433 ± 145	Not written down	432 ± 81	429 ± 93	Not written down
	MLHFQ	11 ± 11	7 ± 9		16 ± 16	13 ± 13	
Lejczak A, *et al*., 2016	Peak VO_2 (mL/kg/min)	9.2	11.2	0.05	9	14.5	0.05
Safiyari-Hafizi H, *et al*., 2016	Peak VO_2 mL/kg/min	10.1 ± 3.1	11.2 ± 2.9	0.040*	10.1 ± 2.8	9.4 ± 2.4	0.040*
Teng HC, *et al*., 2018	6-Minute walk (m)	295.38 ± 80.46	348.65 ± 78.51	<0.001	265.03 ± 88.49	266.13 ± 81.61	<0.001

Note: *Significance value between intervention and control groups. AT: Aerobic Training; HF: Heart Failure; DASI: Duke Activity Status Index; MLHFQ: Minnesota Live with Heart Failure Questionnaire

Table 2: Risk of bias

Study and Country	Random sequence generation	Allocation concealment	Blinding of participants	Blinding of out-come assessment	Incomplete outcome data	Selective reporting	Levels
Gary RA, *et al*., 2011	+	+	?	-	+	+	B
Awotidebe TO, *et al*., 2016	+	+	+	+	+	+	A
Servantes DM, *et al*., 2012	+	+	+	+	+	+	A
Chien CL, *et al*., 2011	+	+	-	?	+	+	B
Safiyari-Hafizi H, *et al*., 2016	+	+	?	+	+	+	B
Lejczak A, *et al*., 2016	+	+	?	?	+	+	B
Teng HC, *et al*., 2018	+	+	-	-	+	+	C

Data extraction

Presentation of data from studies that have entered into the final results, will be extracted then made in a narrative form and presented in a data table consisting of researchers, countries, research objectives, characteristics of research samples, research interventions, research control, types of aspects measured, and results researchs.

RESULTS

From the initial literature search, 1,355 published articles were identified, after screening for unsuitable titles and abstracts, 1,325 articles were excluded. Among the remaining 30 trials, 23 studies were excluded for the following reasons: Double publication (n=16) and not study results (n=7). Thus, a total of 7 studies were included in the final analysis (Awotidebe TO, *et al*., 2016; Servantes DM, *et al*., 2012; Gary RA, *et al*., 2011; Chien CL, *et al*., 2011; Safiyari-Hafizi H, *et al*., 2016; Lejczak A, *et al*., 2016; Teng HC, *et al*., 2018)

Research design

The articles that have been summarized are 7 articles using the RCT research design, each of which was conducted in the USA, Nigeria, Brazil, Taiwan (n=2), Poland and Columbia.

Risk of bias

The overall risk of bias from the included studies was rated moderate because only 2 articles fully met all 6 criteria of the assessment recommended by the Cochrane Handbook for Systematic Review (Awotidebe TO, *et al*., 2016; Servantes DM, *et al*., 2012). There are 4 articles with partially fulfilled criteria, namely one or more criteria are met and are considered low risk of bias (Gary RA, *et al*., 2011; Chien CL, *et al*., 2011; Safiyari-Hafizi H, *et al*., 2016; Lejczak A, *et al*., 2016), and one article has a high risk of bias because one or more of the criteria are not met which is considered to have a high risk of bias (Teng HC, *et al*., 2018) (*Table 2*).

Characteristics of the research sample

Of the 7 articles that were included, the sample size in the study was 24 male and female samples aged 40-75 years (Gary RA, *et al*., 2011). There are 70 samples aged ≥ 50 years, mostly female (Awotidebe TO, *et al*., 2016). Meanwhile, there are 50 samples aged 30-70 years, the average is female (Servantes DM, *et al*., 2012). Next, 51 samples with a mean age of 58 years were male (Chien CL, *et al*., 2011). There were 24 samples with an average age of 30-63 years, all samples were male (Lejczak A, *et al*., 2016). Furthermore, 40 samples aged <75 years (Safiyari-Hafizi H, *et al*., 2016). The study amounted to 90 samples aged ≥ 20 years, mostly male (Teng HC, *et al*., 2018).

Type of exercise

Most of the types of exercises from the seven articles are AT (walking)+-Strength Training (ST) (Awotidebe TO, *et al*., 2016; Servantes DM, *et al*., 2012; Chien CL, *et al*., 2011; Safiyari-Hafizi H, *et al*., 2016). There is one study doing a combined type of AT (walking) exercise+resistance exercise (Gary RA, *et al*., 2011), types of Nordic walking exercises (Lejczak A, *et al*., 2016) and the last type of exercise with WEB intervention (Teng HC, *et al*., 2018).

Exercise duration

Exercise duration of 30-60 minutes was mostly done in research (Awotidebe TO, *et al*., 2016; Servantes DM, *et al*., 2012; Gary RA, *et al*., 2011; Chien CL, *et al*., 2011). The training duration of each interval varies and is adjusted individually depending on their functional capacity to ensure safety and program progress (Safiyari-Hafizi H, *et al*., 2016). Furthermore, the duration of the exercise starts with a 5-minute warm-up, 15-minute WEB, and 5-minute cooling (Teng HC, *et al*., 2018).

Exercise frequency

The frequency of exercise 3 times a week was the most used in the study (Awotidebe TO, *et al*., 2016; Gary RA, *et al*., 2011; Chien CL, *et al*., 2011).

Another study said that the frequency of exercise is adjusted regularly according to patient capacity and according to changes in heart rate response to exercise (Safiyari-Hafizi H, *et al*., 2016). Furthermore, the frequency of exercise is done 2 times a day in the morning and evening (Teng HC, *et al*., 2018).

Exercise intensity

Low-moderate intensity exercises are often performed in studies (Gary RA, *et al*., 2011; Chien CL, *et al*., 2011). Doing exercise intensity ranges from 60%-70% of the maximum heart (Awotidebe TO, *et al*., 2016). Furthermore, another study conducted exercise intensity which was determined by the heart rate associated with anaerobic threshold (VO_2 AT) (Servantes DM, *et al*., 2012). There is also high intensity exercise (80%-85% peak VO_2) followed by an active recovery period (40%-50% peak VO_2) (Safiyari-Hafizi H, *et al*., 2016).

Peak VO_2

A more significant increase in oxygen volume (VO_2) max 1.7 ml/kg/min with a significant p value of 0.001 (Awotidebe TO, *et al*., 2016). There was a significant increase in both interventions at peak values of VO_2 and VO_2 AT with the addition of 5.2 and 3.7 ml/kg/min and 5.3 and 3.5 ml/kg/min, respectively with p value<0.001 (Servantes DM, *et al*., 2012). The study states that the VO_2 value increases significantly with the addition of 2 ml / kg / min value with p value<0.005 (Lejczak A, *et al*., 2016). Also, the addition of the VO_2 value was significantly 1.1 ml/kg/min with a p value of 0.040 (Safiyari-Hafizi H, *et al*., 2016).

6-Minute walk

6-Minute walk increases an additional distance of 46.4 meters with a significance p value of 0.006 (Gary RA, *et al*., 2011). The research shows that the increase in the 6-minute walk distance is 98.3 meters with a significance p value of 0.001 (Awotidebe TO, *et al*., 2016). Other research says that the 6-minute walk increases the distance traveled by 9 meters and 1% predicted (Chien CL, *et al*., 2011). The additional distance in the 6-minute walk with a significance p value<0.005 (Safiyari-Hafizi H, *et al*., 2016). The study states that the additional 6-minute walk distance is significantly 56.27 meters with a p value of 0.001 (Teng HC, *et al*., 2018).

Duke Activity Status Index (DASI)

The intervention group for DASI, from pre intervention 49.2 ± 9.0 and post intervention 49.2 ± 6.9 with a significance value of p value 0.981(Gary RA, *et al*., 2011).

Minnesota Live with Heart Failure Questionnaire (MLHFQ)

Improved quality of life for MLHFQ was seen pre intervention 56.1 ± 24.4 and post intervention 33.5 ± 22.9 with a significance value of p value 0.001 (Gary RA, *et al*., 2011). In the study, it was seen that MLHFQ pre intervention 40.4 ± 17.9 and post intervention 20.7 ± 16.3 with a significance value of p value<0.001 (Servantes DM, *et al*., 2012). Meanwhile, for pre intervention MLHFQ 11 ± 11 and 7 ± 9 post intervention (Chien CL, *et al*., 2011). Furthermore, the study stated that improved Quality of Life (QoL) and few adverse symptoms during exercise were seen for MLHFQ with a significance value of p value<0.005 (Safiyari-Hafizi H, *et al*., 2016) (*Table 2*).

DISCUSSION

The average sample size is 24 to 50 samples. The power of an intervention will increase with a larger sample (White H, *et al*., 2014). A sample size that is too small would have insufficient power to detect true differences, so that significant differences between study groups may not be statistically significant (Malone HE, *et al*., 2016). So from the results of a literature review, a sample size of 24 to 50 samples shows the power of an intervention.

Performing AT interventions (walking)

The type of training that combines AT (walking) and Strength Training is the most widely used. This is consistent with research that the AT program and combined resistance training are effective in increasing VO_2 peak, muscle strength, 6-minute walk, and quality of life in HF patients (Wang Z, *et al*., 2019). Other studies have also shown that resistance training increases muscle strength, Health-Related Quality of Life (HRQOL) and peak VO_2 (even in small amounts) (Gomes-Neto M, *et al*., 2019). Therefore, joint training in the form of AT (walking) with Strength Training can maintain and increase muscle strength and functional ability.

The most widely used duration is 30-60 minutes. This is consistent with previous research saying that exercise usually involves walking for 30-60 minutes to achieve a peak VO_2 oxygen uptake of 40%-80% (Xie B, *et al*., 2017). uration of exercise for 30 minutes or 60 minutes will increase the elasticity of the arteries and produce minimal oxidant stress (O'Keefe JH, *et al*., 2014). If more than 60 minutes per session can cause increased oxidant stress in the blood vessels to become stiff, especially among men over 50 years of age (O'Keefe JH, *et al*., 2014). Therefore, walking is done for at least 30-60 minutes because it increases the elasticity of the arteries and results in minimal oxidant stress.

The frequency of exercise is carried out 3 times a week. This is consistent with other studies that count 1 to 2.4 hours of exercise for 2 to 3 times per week as a standard for optimal quantity and frequency of aerobic exercise to improve health (Patel H, *et al*., 2017). Other studies have also suggested that those who are moderately active (2 to 4 times per week) are the levels of physical activity that appear to provide the greatest benefit in terms of survival (Mons U, *et al*., 2014). Thus, walking exercises performed 3 times a week serve as the standard for optimal quantity and frequency of exercise to improve health and provide the greatest benefit in terms of survival.

The most widely used low-moderate intensity exercise in this study. This is in line with studies consistently showing that moderate-intensity physical activity is beneficial for long-term cardiovascular health (O'Keefe JH, *et al*., 2014). Likewise, a prospective observational study of older men and women (mean age 73 years) reported that moderate-intensity physical activity such as walking reduced the risk of heart rhythm disorders by about a third (O'Keefe JH, *et al*., 2014). Thus, moderate low intensity exercise can improve cardiovascular prognosis and reduce the risk of heart rhythm disturbances.

Results of the effectiveness AT interventions (walking)

In this study, there was a more significant improvement with increasing peak VO_2. This is in line with previous research that training-induced increases in peak VO_2 could have a beneficial effect on clinical outcomes (Giallauria F, *et al*., 2018). From a clinical point of view, regular exercise may be beneficial in HF patients even though it does not significantly increase VO_2 peaks but reduces/prevents decreases in VO_2 peaks exacerbated by sedentary lifestyle (Mandic S, *et al*., 2009). Thus, walking can increase the peak VO_2 which is sufficient to meet the body's metabolic needs in increasing the patient's functional capacity.

Likewise, with an increase in the 6-Minute walk distance. This is in line with research that states that the 6-minute walk as a measure of functional capacity has been used as a screening tool in HF (<300 meters) and can be a useful tool for assessing weakness which is a significant risk marker and potential contraindication to non-strategy pharmacological in HF (Crespo-Leiro MG, *et al*., 2018). Thus, the 6-minute walk serves as a useful screening tool to assess weakness in HF patients.

In addition to the 6-Minute walk there is also an increase in the DASI assessment. The tie is especially useful for those whose walking speed is affected by musculoskeletal problems but maintains a high level of regular physical activity (Potter E, *et al*., 2020). In particular, the reduction in DASI predicts short to medium term progression to real HF with a symptom state that should be considered HF (Potter E, *et al*., 2020). Thus, measurement of DASI could be of benefit to patients with HF in terms of response to increased functional capacity.

In this study, there was an improvement in quality of life and few adverse symptoms during exercise were seen in MLHFQ. This is consistent with previous studies that interventions such as exercise can improve quality of life and also reduce the incidence of death in patients with HF (Wu JR, *et al*., 2016). Previous studies have also shown that significant reductions in MLHFQ scores can be achieved well after exercise with a 5 point reduction considered clinically relevant which suggests that short-term cardiac rehabilitation is also beneficial and that some patients experience appreciable positive changes in physical and emotional quality of life (Beale L, *et al*., 2013). Therefore, AT (walking) can improve the quality of life.

This study has several limitations. This study only focuses on the RCT design so that the number of articles obtained is small (limited). Because the number of randomized controlled studies is small, publication bias is unavoidable and the results should be interpreted with caution. Patients in the study may have engaged in some covert physical activity that was not monitored during the study. Some of the participants who refused to attend the outcome assessment tended to have high levels of anxiety and depression and thus require additional strategies to reduce anxiety and depression in response to clinical research compliance. Further studies may be needed to carry out monitoring or surveillance of physical activity and explore the relationship between psychological status, physical function, and quality of life in HF patients.

CONCLUSION

AT intervention (walking) is a common activity, is always done in daily activities, and has long been recommended by researchers to increase the functional capacity of HF patients in research. The results of the effectiveness of AT interventions (walking) were that there was a more significant improvement in VO_2 peaks, an increase in the additional mileage on 6 minute walks, improved DASI assessments, and improved quality of life.

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