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The Combination of Physical Exercise Programs in Patients with Heart Failure

Agung Wahyu Permadi[1,2]*, Soetanto Hartono[3], Endang Sri Wahjuni[4], Ni Kadek Dwipayani Lestari[5]

[1] Graduate Student, Doctoral Program in Sport Science, Universitas Negeri Surabaya, Indonesia.
[2] Physiotherapy Department, Faculty of Health, Sciences and Technology, Universitas Dhyana Pura, Badung, Bali, Indonesia.
[3] Professor, Head of Doctoral Program in Sport Sciences, Universitas Negeri Surabaya, Indonesia.
[4] Department of Sport Sciences, Universitas Negeri Surabaya, Indonesia.
[5] Biology Department, Faculty of Health, Sciences and Technology, Universitas Dhyana Pura, Badung, Bali, Indonesia.

ABSTRACT

This study aims to optimize cardiac functional capacity using a combination of physical exercise programs to reduce the death rate of patients with heart failure. The study was conducted at the outpatient clinic of the Integrated Heart Service, Sanglah General Hospital, for 12 weeks. Research subjects were 50 people divided into five groups. Group 1 was given the treatment of tai chi exercise, group 2 was treated with treadmill training, group 3 was given a treatment of stationary bike workout, group 4 was given a combination treatment of tai chi, treadmill training, and stationary bike workout, and group 5 was the control group. All treatments had a significant impact on cardiac functional capacity of patients with heart failure with a p value less than 0.05 ($p < 0.05$). However, there was one treatment that had the most significant impact compared to the other treatments, which was the combined treatment of tai chi, treadmill training, and stationary bike workout, with a value of $p = 0{,}000$. Based on the results of data analysis, it can be concluded that all aerobic physical exercise treatments impacted cardiac functional capacity and the impact of combination treatment of tai chi, treadmill training, and stationary bike workout was significantly more optimal in patients with heart failure than treatments without combination of physical exercise.

Key Words: *Physical exercise program, Tai chi, Treadmill, Stationary bike, Functional capacity.*

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INTRODUCTION

Cardiovascular disease causes more people to die each year than any other cause [1, 2]. Heart failure in Indonesia itself is ranked first as the main cause of death (12.9%), followed by stroke in all age ranges with a diagnosis of chronic or non-communicable diseases [3]. Heart failure is one of the main causes of disability with regard to self-limitation to physical activity [4, 5]. Deaths due to heart failure can be reduced through promotive approach (by improving quality of life), preventive approach (by preventing chronic illness), curative approach (by managing chronic diseases), and rehabilitative approach (by maintaining health) [6, 7]. Many studies have investigated the effect of physical exercise on health [8]. Nowadays, health care is very important among all people [9] and maintaining a quality of life and also doing regular exercise are the hallmarks of a fit person [10]. One important factor in the recovery of

Corresponding author: Agung Wahyu Permadi
Address: Graduate Student, Doctoral Program in Sport Science, Universitas Negeri Surabaya, Indonesia.
E-mail: ✉ agungwahyu@undhirabali.ac.id
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heart failure is to increase the fitness of cardiac functional capacity, namely VO2Max or peak VO2, blood pressure, and pulse [11, 12]. This was evidenced in a heart training test that was measured using 6-minute walk test during physical activity training [13, 14]. Physiotherapists specialized in cardiovascular disease have various effective training methods to deal with cases of heart failure that affect functional and body movements [15]. Exercise that is often applied by cardio physiotherapists is aerobic exercise in accordance with physiological bodily activities to improve cardiac functional capacity [16]. The results proved that aerobic exercise in the form of a treadmill had a significant impact on aerobic fitness capacity, such as VO2max and pulse, and could predict mortality among male outpatients with heart disease [17, 18]. The results of other studies proved that the only impact of stationary workout on the respiratory response and VO2max was the reduction in the urge to breathe in patients with heart disease, so stationary bike is a safe exercise modality for heart failure patients [19]. Previous studies have also found that physical exercise treatments using traditional therapies such as tai chi are known as a beneficial alternative approach to physical fitness [20, 21]. This exercise has been proven effective in helping to reduce stress, improve balance and movement of the body, strengthen functional capacity, and increase self-confidence [22].

Various efforts have been made by practitioners and academics both from professional doctors, paramedics or nurses, and researchers who have competencies to create innovations related to the management and maintenance of cardiovascular health, especially for heart failure, but these still become obstacles in overcoming the problem of cardiovascular disease [23, 24]. On the other hand, there are still many medical treatments, especially for cardiovascular patients, which are less effective to take [25]. The results of a review of research journal articles on exercise in patients with heart failure found strong evidence that a structured exercise program was a safe recommendation for patients with heart failure and had extraordinary beneficial effects, not only on the prevention of cardiovascular disease, but also on management of heart failure [26, 27].

From several cardiac rehabilitation exercise programs after hospitalization that refer to aerobic physical exercise, to date, there have been no studies that combine tai chi, treadmill training, or stationary bike workout [28, 29]. The three exercise methods are considered to be very effective and optimal for evaluating and measuring the impact of functional capacity, such as blood pressure, pulse, and VO2Max [30, 31]. So, starting from the problem, this study tries to focus on finding which group is the most optimal by comparing the combination of exercise programs with exercise programs without a combination.

METHOD

Participants

In this study, the respondents were patients or clients who were diagnosed with heart failure at the outpatient clinic at Sanglah General Hospital, located specifically at the Integrated Heart Service, Denpasar, Bali. The study involved 50 respondents, consisting of 32 male respondents and 18 female respondents, who were divided into five groups in which each group consisted of 10 people. The groups consisted of Group 1 who were given tai chi treatment, Group 2 who were treated with treadmill training, Group 3 who were given stationary bike workout, Group 4 who were given a combination of Yang-style tai chi, (low-level Bruce protocol) treadmill training, stationary bike (YCMA), and group 5 which was the control group. All treatment exercises were given with a frequency of 2 times a week for 12 weeks.

Measures

In the initial stage, the respondents were tested to obtain the results of cardiac functional capacity, such as blood pressure, pulse, and VO2Max. The method used to measure cardiac functional capacity was the 6-minute walking test (6MWT). This walking test evaluated thoroughly and integrated with all systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism [27]. In the second stage, the respondents were given training for 24 meetings according to their respective groups, namely Group 1 (tai chi), group 2 (treadmill training), Group 3 (stationary bike workout), Group 4 (combination of tai chi, treadmill training, stationary bike workout), and Group 5, which was the control group. The last stage was the stage where the respondents were examined again to obtain the results of evaluation of cardiac functional capacity, which was then tested by data analysis.

Procedures

The sample criteria in this study were outpatients in the age range of 50 to 60 years with heart failure who were diagnosed by vascular heart specialists based on the classification of New York Heart Association (NYHA) class I and class II [32]. The respondents who can be recommended to be given cardiac rehabilitation training with a combination of aerobic exercise in the form of tai chi, treadmill training, and stationary bike workout were patients who had no history of chronic comorbidities, such as musculoskeletal disease, diabetes mellitus (DM), post stroke, impaired kidney function (kidney failure), and chronic lung disease [1]. All respondents were provided with education about the risks and benefits of the exercise and they gave consent before participating. This study has been tested through a review of proposals involving human subjects and has been approved by the Research Ethics

Committee of the Udayana University Medical School or Sanglah Hospital.

Statistical Analyses

The data description employed the Statistical Product and Service Solution (SPSS) program for Windows. Paired t-test (t-test) was used to determine the difference in influence between all groups before treatments were given and after treatments were given. Duncan post hoc ANOVA, in this case, was employed to find out which variable or group had the greatest impact on the treatment groups. All data were reported as mean ± standard deviation (SD), with 95% confidence interval if appropriate. Statistical significance was accepted as $p<0.05$.

RESULTS

The results of the cardiac functional capacity category before and after the treatment in Table 1 shows the mean difference of all groups that had a p value less than 0.05 ($p <0.05$). This showed that in all groups, there were significant changes before and after the treatment. Thus, averagely, all treatments had a good impact on blood pressure, pulse, and VO2Max of patients with heart failure.

Table 1*:* Comparison Test of Cardiac Functional Capacity Categories before and after the Treatments in All Groups

Cardiac Functional Capacity Category	All Groups		t	p
	Mean	Standard Deviation		
Pre-Treatment Blood Pressure and Post-treatment Blood Pressure	11.3	10.1	7.8	0.000
Pre-treatment pulse and post-treatment pulse	3.3	2.8	8.4	0.000
VO2Max Pre-VO2Max Post	-5.1	3.7	-9.5	0.000

In Table 2, it is explained that the tai chi treatment group showed the lowest blood pressure with a value of 114.76, followed by group of combination of tai chi, treadmill training, and stationary bike workout, with a value of 115.30. Blood pressure was the highest in the control group with a value of 138.65. Meanwhile, the pulse variable in the group of combination of tai chi, treadmill training, and stationary bike workout had the lowest value of 70.20 and the highest pulse variable was in the control group with a value of 79.90. In the VO2Max variable, the control group showed the lowest VO2Max with a value of 25.20 and the group of combination of tai chi, treadmill training, and stationary bike workout showed the highest VO2Max with a value of 36.50.

Table 2*:* Duncan Post Hoc ANOVA of Optimization of Cardiac Functional Capacity Based on Treatments

Groups After Treatment	Variable(s)		
	Blood Pressure	Pulse	VO2Max
ANOVA	0.000	0.000	0.000
Tai chi	114.76^{a}	72.80^{b}	34.70^{bc}
Treadmill training	134.33^{c}	77.20^{c}	31.70^{b}
Stationary bike workout	126.84^{b}	75.70^{c}	34.00^{bc}
Tai chi, treadmill training, stationary bike workout	115.30^{a}	70.20^{a}	36.50^{c}
Control	138.65^{d}	79.90^{d}	25.20^{a}

Annotation:

1. p value <0.05 is called significantly different or significant
2. Numbers followed by the same notation belong to the same group
3. The notation “a” shows the lowest mean
4. The notations “c” and “d” indicate the highest mean

The average results in all groups showed that the group of combination of tai chi, treadmill training, and stationary bike workout had p = 0,000 (p <0.05). This has proven that the group of combination of tai chi, treadmill training, and stationary bike workout had a more significant or significantly different impact than the other treatment groups on cardiac functional capacity.

DISCUSSIONS

The effect of combined training on cardiovascular variables in humans is not far-fetched [33]. The literature that is developing at this time shows that tai chi exercise can significantly influence blood pressure, pulse, and VO2max [34]. This is evidenced by several research findings in which 242 patients with an average age range of 61 to 74 years were diagnosed with chronic heart failure due to left ventricular systolic dysfunction (45% ejection fraction) according to the New York Heart Association (NYHA) class I and II, then these patients did tai chi exercises for 50-60 minutes per session with a frequency of 2-3 times a week with a duration of 12 to 16 weeks, and the results obtained were significantly different in exercise capacity measured by the 6-minute walking test (6MWT). However, several studies have found that in a meta-analysis, clinical evidence about the impact of tai chi with a combination of high-intensity exercise on heart failure was inconclusive [21]. This was because the group-based tai chi effect test on older adults for six months showed unclear health status results of heart failure and showed a much lower blood pressure and body mass index than the test on conventional treatment group [35]. Thus, there was an assumption that there was a limitation of research that

tai chi exercise that was not combined with other physical exercises were still not able to optimize blood pressure significantly.

The effect of treadmill exercise on patients with heart failure is being widely studied in several developing countries [36]. Previous research proved that the impact of treadmill training was to evaluate the blood pressure of male and female patients over the age of 50 with heart failure. Their study was conducted on 715 patients (percentage of male patients by 57%) without a history of hypertension who did treadmill exercises for 2 years [37]. Another relevant study was carried out by giving treadmill exercise treatments for 3 months to 21 patients with heart failure. It resulted in an increase in VO2max and a decrease in blood pressure significantly by 66% and followed by a stable optimal pulse rate of 75%, with the limitation that the patient had no history of other chronic diseases [38]. This was related to the direct response to the muscle and cardiac output needs of the blood that contains oxygen and releases carbon dioxide in order to maintain the homeostasis of the body. However, some experts said that the combination of treadmill with other aerobic physical exercises had a more optimal impact than one exercise did because there was a presumption that the combination of treadmill training with other exercises caused a lot of increase in lung volume so that the quality of gas exchange was higher [18].

The findings about stationary bike workout, especially in its relation with patients with heart failure, were still lacking the interest of researchers. This is caused by the suboptimal impact of this exercise. We conducted a study involving stationary bike workout and obtained results that had scientific implications for cardiac functional capacity. Our results proved that stationary bike training had an optimal impact on blood pressure, pulse, and VO2Max. These results were in line with other studies that showed that 3-month stationary bike workout done by 59 patients (38 male patients and 21 female patients) with heart failure provided significant changes over time ($P \leq 0.027$) in peak oxygen or VO2Max uptake, followed by significant changes over time ($P < 0.001$) in all groups [39, 40]. This proved that gradually, stationary bike workout had become a viable alternative for optimizing VO2Max, pulse, and blood pressure in abnormalities of cardiac function. This was because stationary bike workout was able to provide improvement in contraction of the lower limb muscles that convey information on mechanical deformation that is transmitted to the afferent nerve fibers so that physiologically, there will be an increase in cardiac fitness [41]. However, in the study, it was suggested that additional combination of other aerobic exercise should be given so that the impact was more optimal and better for blood pressure, pulse, and VO2Max.

Among all treatments given to patients in this study, it was found that all treatments had an optimal impact on cardiac functional capacity, such as blood pressure, pulse, and VO2Max. However, after Duncan post hoc ANOVA, it can be proven that after the treatment, the combination of tai chi, treadmill training, and stationary bike workout provided the most optimal impact compared to other treatments, showing a value of $p = 0.000$ or p less than 0.05 ($p < 0.05$). This proved that the combination of tai chi, treadmill training, and stationary bike workout brought a significantly different or significant impact compared to other treatments even though tai chi and combined-exercise group belonged to the same group in the blood pressure category.

Theoretically, tai chi, treadmill training, and stationary bike workout are included in the category of aerobic exercise that is used to optimize the overall cardiac functional capacity of heart failure patients [42, 43]. Several studies have been conducted related to the three exercises, but only one or two comparisons of exercises were given. There was evidence of scientific literature explaining the comparison between treadmill training and stationary bike workout in which both exercises had a good impact on blood pressure and VO2Max [36]. The study was in line with the latest findings on 21 patients (11 male patients and 9 female patients) aged 50 to 65 years in which each patient completed treadmill training and stationary bike workout tests simultaneously or in combination and showed a response of heart rate and VO2Max metabolism thereafter [44]. Thus, the results of comparison of pulse and VO2Max values showed a significant value ($p < 0.001$). Significant differences in the relationship between pulse and VO2Max resulted in the assumption that combination of treadmill training and stationary bike workout provided an optimal increase in cardiac functional capacity, but it was explained that most participants were unable to achieve strong intensity of exercise while exercising so that a combination of two or additional practices is needed for further research [42].

The combination of tai chi, treadmill training, and stationary bike workout resulted in the optimization of cardiac functional capacity, showing benefits for patients with heart failure who were over 50 years old [18, 40, 45]. The combination of these three exercises was a low-risk exercise and had been proven to be effectively safe in elderly individuals who were patients with heart failure. There were no side effects related to the combination of the three exercises that had been reported by patients with heart failure with the classification of NYHA I and II. The most common side effect of these three exercises was muscle pain, but the pain was not specific and was usually mild and lasted only a few days [46, 47]. Research on the combination of tai chi, treadmill training, and stationary bike workout like this had never been conducted so that the

results of this study can only be compared with the results of previous studies that used various methods of giving one or two comparisons of training only. Data from various studies that had been conducted still cause controversy while similar studies have never been published in Asia, especially in Indonesia.

CONCLUSION

From this 12-week study, it can be concluded that aerobic physical exercises of tai chi, treadmill training, and stationary bike workout could optimize cardiac functional capacity of patients with heart failure. The impact of physical exercise combination of tai chi, treadmill training, and stationary bike workout was significantly more optimal than physical exercise without combination of tai chi, treadmill training, and stationary bike workout.

Conflict of interest

The authors declare that there is no conflict of interest related to this study.

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