Original Article

The impacts of combination of physical exercise programs on the functional capacity of patients with heart failure

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ABSTRACT

This study aims to increase cardiac functional capacity using a physical exercise programs to patients with heart failure. 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, stationary bike workout, and group 5 was the control group. The study was conducted for 12 weeks. There was one treatment that had the most significant impact compared to the other treatments, which was combination treatment of tai chi, treadmill training, and stationary bike workout, with a value of p = .000. Based on the results of data analysis, All treatments had a significant impact on cardiac functional capacity of patients with heart failure and the impact of physical exercise combination 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 as Tai-Chi, treadmills, and stationary bike exercise.

Keywords: Physical exercise program; Tai chi; Treadmill; Stationary bike; Functional capacity; Heart failure.

Cite this article as:
Permadi, A.W., Hartono, S., Wahjuni, E.S., & Lestari, N.K.D. (2020). The impacts of combination of physical exercise programs on the functional capacity of patients with heart failure. *Journal of Human Sport and Exercise*, *in press*. doi:https://doi.org/10.14198/jhse.2021.163.07

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Submitted for publication January 11, 2020
Accepted for publication March 10, 2020
Published *in press* April 24, 2020
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2021.163.07

INTRODUCTION

Heart failure has been one of the deadliest diseases impacting millions of people worldwide (Palmer, Bowles, Paton, Jepson, & Lane, 2018), (Lee, Won, & Son, 2019). In Indonesia, heart failure contributes to more than 30% of population deaths in 2011(Sumartono, Sirait, Holy, & Thabrany, 2011). Heart failure is one of the main causes of disability with regard to self-limitation to physical activity (Mohammed & Shabana, 2018), (Goleman, Daniel; Boyatzis, Richard; Mckee, 2019). 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) (Perez-Terzic, 2012), (Fernhall, Borghi-Silva, & Babu, 2015).

Doctors, paramedics or nurses and researchers have been made innovations related to the treatment and maintenance of heart failure patients but these still become obstacles in overcoming the problem of cardiovascular disease because which exercise are less effective. One important factor in the recovery of heart failure is to increase the fitness of cardiac functional capacity, namely VO_{2Max} or peak VO_2, blood pressure, and pulse (Kelly et al., 2016), (Fleg, 2017). This was evidenced in a heart training test that was measured using 6-minute walk test during physical activity training (Bellet, Adams, & Morris, 2012), (Kubo et al., 2018). One way to decrease the risk of heart failure is to do a structured and routine exercise by a physiotherapist (Kunstler et al., 2018). Exercise that is often applied by cardio physiotherapists is aerobic exercise in accordance with physiological bodily activities to improve cardiac functional capacity (Noites et al., 2017). The results proved that aerobic exercise in the form of a treadmill had a significant impact on aerobic fitness capacity, such as VO_{2max} and pulse, and could predict mortality among male outpatients with heart disease (Mählmann et al., 2017), (Grazzi et al., 2018). The results of other studies proved that the only impact of stationary workout on the respiratory response and VO_{2max} 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 (Jehn et al., 2011). 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 (Lu & Kuo, 2012), (Hu et al., 2016). The results of Previous studies have also found showed that compared with a physiotherapy intervention, Tai Chi could significantly reduce the incidence rates of falls with heart failure patients and improving balance in the elderly (Lian et al., 2017).

The results of a review of research journal articles found aerobic exercise program was a safe recommendation on the treatment of cardiovascular disease for patients with heart failure and management of heart failure (Ha, Hare, Cameron, & Toukhsati, 2018), (Gök, Zoghi, Sinan, Kılıç, & Tokgözoğlu, 2019). On the other hand, there are still many medical treatments, especially for cardiovascular patients, which are less effective to take (Sinan et al., 2019). 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 (Maessen et al., 2016), (Travensolo, Goessler, Poton, Pinto, & Polito, 2018).

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 (Caiati, Lepera, Carretta, Santoro, & Favale, 2013), (Wewege, Thom, Rye, & Parmenter, 2018). 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 VO_{2Max} (Zheng, Lal, Meier, Sibbritt, & Zaslawski, 2014), (Papathanasiou et al., 2017). 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.

MATERIAL AND METHODOLOGY

Participants

In this study, fifty patients (men = 32 and women = 18) were divided into five groups. Group 1 was given the treatment of Tai-Chi exercise (Yang style), group 2 was treated with treadmill exercise (Bruce protocol), group 3 was given stationary bicycle training (YCMA), group 4 (combination of tai chi, treadmill training, stationary bike workout) and group 5 was set as the control group. All were given exercises twice a week for 12 weeks, located specifically at the Integrated Heart Service, Denpasar, Bali, who were divided into five groups in which each group consisted of 10 people. The patients were in the age range of 45 to 60 years with the provisions of the New York Heart Association (NYHA) class I and II. 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.

Measures

In the initial stage, respondents were tested to obtain the results of cardiac functional capacity, such as blood pressure, pulse, and VO_{2Max}. 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 (Travensolo et al., 2018). In the second stage, 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, patients were retested for evaluating the capacity of heart function (VO_{2Max}, Blood pressure and heart rate) which was then tested for 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 (Babu, Desai, Maiya, Guddattu, & Padmakumar, 2016), (Palmer et al., 2018). 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 $p < .05$.

RESULTS

Positive changes occurring in research subjects who had blood pressure after treatment in Table 1 can be seen in the decrease in the number of study subjects with blood pressure with "mild hypertension" and the reduction in research subjects whose blood pressure is "normal" to "optimal". This proves that all treatments except the control group had a good effect on blood pressure. There is a good change in pulse rate which shows the number of research subjects with 'very good' pulse increased. This proves that all treatments had a positive effect on the pulse of the research subjects. Significant impact on VO_{2Max} after treatment can be seen from the decreasing number of research subjects in the "poor" and "fair" categories and the increasing number of research subjects in the "good" category. Some subjects even reached the "excellent" category. The results of this analysis prove that all treatments had a very good effect on VO_{2Max} of subjects, except those the control group.

Table 1. Heart function capacity frequency test in all groups.

Cardiac Functional Capacity Category	Pre	Percentage (%)	Post	Percentage (%)
Blood pressure				
Optimal			20	50.0
Normal	8	16.0	14	38.0
Mild Hypertension	42	84.0	16	12.0
Moderate hypertension				
Severe hypertension				
Isolated Systolic Hypertension				
Pulse				
Very good	6	12.0	27	54.0
Well	43	86.0	12	44.0
Moderate	1	2.0	1	2.0
Less				
VO_{2Max}				
Very Poor				
Poor	28	56.0	5	10.0
Fair	22	44.0	12	24.0
Good			30	60.0
Excellent			3	6.0
Superior				

The results of the cardiac functional capacity category before and after treatment in Table 2 shows the mean difference of all groups that had a p value less than .05 ($p < .05$). This showed that in all groups, there were significant changes before and after treatment. Thus, averagely, all treatments had a good impact on blood pressure, pulse, and VO_{2Max} of patients with heart failure.

In Table 3, it is explained that the tai chi treatment group showed the lowest blood pressure with a value of 119.76, followed by group of combination of tai chi, treadmill training, and stationary bike workout, with a value of 112.30. Blood pressure was the highest in the control group with a value of 143.65. Meanwhile, the pulse variable in the group of combination of tai chi, treadmill training, and stationary bike workout had the lowest value of 75.20 and the highest pulse variable was in the control group with a value of 84.90. In the VO_{2Max} variable, the control group showed the lowest VO_{2Max} with a value of 30.20 and the group of

combination of tai chi, treadmill training, and stationary bike workout showed the highest VO_{2Max} with a value of 41.50.

Table 2. Comparison test of cardiac functional capacity categories before and after treatments in all groups.

Cardiac Functional Capacity Category	All Groups		t	p
	Mean	Standard Deviation		
Pre-Treatment Blood Pressure and Post-treatment Blood Pressure	13.1	11.2	7.9	.000
Pre-treatment pulse and post-treatment pulse	4.2	2.6	7.4	.000
VO_{2Max} Pre-VO_{2Max} Post	-5.7	5.7	-8.5	.000

Annotation:

1. *p value < .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.*

Table 3. Duncan Post Hoc ANOVA of optimization of cardiac functional capacity based on treatments.

Groups After Treatment	Variable(s)		
	Blood Pressure	Pulse	VO_{2Max}
ANOVA	.000	.000	.000
Tai chi	119.76^{a}	77.80^{b}	39.70^{bc}
Treadmill training	139.33^{c}	82.20^{c}	36.70^{b}
Stationary bike workout	131.84^{b}	80.70^{c}	39.00^{bc}
Tai chi, treadmill training, stationary bike workout	120.30^{a}	75.20^{a}	41.50^{c}
Control	143.65^{d}	84.90^{d}	30.20^{a}

Annotation:

1. *p value < .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 was p = .000 (p < .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

Theoretically, tai chi, treadmill training, and stationary bike workout are included in the category of aerobic exercise of heart failure patients (Achttien et al., 2015), (Ciani et al., 2018). 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 VO_{2Max} (Noël et al., 2010). The study was in line with the latest findings on 21 patients (41 male patients and 19 female patients) aged 40 to 60 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 VO_{2Max} metabolism thereafter (Bittencourt et al., 2014). Thus, the results of comparison of pulse and VO_{2Max} values showed a significant value (p < .001).

Significant differences in the relationship between pulse and VO_{2Max} resulted in the assumption that combination of treadmill training and stationary bike workout provided an optimal increase in cardiac functional capacity. The literature on two aerobic exercise intervention indicated that exercise conducted of a longer duration (> 12 weeks) elicit beneficial changes for individuals with Pulse and blood pressure. Several studies have been conducted related to the three exercises (Tai-Chi, treadmill and stationary bike) but only one or two comparisons of exercises were given, 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 (Achttien et al., 2015).

The effect of treadmill exercise on patients with heart failure is advantageous for health professionals in need of a simple indicator for functional capacity(VO_{2Max}, blood pressure and pulse) monitoring outcomes and being widely studied in several developing countries (Noël et al., 2010). Previous research proved the impact of treadmill training was to evaluate the blood pressure of male and female patients over the age of 40 with heart failure. Their study was conducted on 300 patients (percentage of male patients by 63%) without a history of diabetes mellitus (DM) and musculoskeletal disease who did treadmill exercises for 1 years (Krishnaswami et al., 2017). Another relevant study was carried out by giving treadmill exercise treatments for 3 months to 30 patients with heart failure. The result was an increase in VO_{2max} and a decrease in blood pressure significantly by 78% and followed by a stable optimal pulse rate of 80%, with the limitation that the patient had no history of other chronic diseases (Bona et al., 2017). 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 (Grazzi et al., 2018).

The findings about stationary bike workout, especially in its relationship with patients with heart failure, were still lacking in 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 the impact of stationary bike training had an optimal impact on blood pressure, pulse, and VO_{2Max}. 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 ($p \leq .027$) in peak oxygen or VO_{2Max} uptake, followed by significant changes over time ($p < .001$) in all groups (Garzon, Gayda, Nigam, Comtois, & Juneau, 2017), (Rodríguez-Santamarta, Sayago, & López, 2017). This proved that gradually, stationary bike workout had become a viable alternative for optimizing VO_{2Max}, 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 fibres so that physiologically, there will be an increase in cardiac fitness (Dionne, Leone, Andrich, Pérusse, & Comtois, 2017). However, in this 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 VO_{2Max}.

The literature that is developing at this time shows that tai chi exercise can significantly influence blood pressure, pulse, and VO_{2max} (Araújo-Gomes, Valente-Santos, Vale, Drigo, & Borba-Pinheiro, 2019). This is evidenced by several research findings in which 150 patients with an average age range of 45 to 65 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 10 to 18 weeks, and

the results obtained were significant differences 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 (Hu et al., 2016). 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 (Wong, Chow, & Chung, 2016). 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 research 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 (Ren et al., 2017), (Rodríguez-Santamarta et al., 2017), (Grazzi et al., 2018). 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 (Wu, Wang, Burgess, & Wu, 2013), (Forestieri et al., 2016). 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.

Among all treatments given to patients in this study, it was found that all treatments had an increase impact on cardiac functional capacity, such as blood pressure, pulse, and VO_{2Max}. However, after Duncan post hoc ANOVA, it can be proven that after treatment, the combination of tai chi, treadmill training, and stationary bike workout provided the most significant impact compared to other treatments, showing a value of $p = .000$ or p less than .05 ($p < .05$). This proved that the combination of tai chi, treadmill training, and stationary bike workout brought a significantly different impact compared to other treatments.

CONCLUSIONS

From the study conducted for 12 weeks, it can be concluded that all treatments had a significant impact on cardiac functional capacity of patients with heart failure. It is found that the impact of physical exercise combination 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 as Tai-Chi, treadmills, and stationary bike exercise.

AUTHOR CONTRIBUTIONS

Agung Wahyu Permadi concepted the research, designed experiments, provided the methods, and authored the manuscript. Soetanto Hartono designed experiments and co-wrote the paper. Endang Sri Wahjuni and Ni Kadek Dwipayani Lestari analysed the obtained data and co-wrote the manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

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

REFERENCES

Achttien, R. J., Staal, J. B., van der Voort, S., Kemps, H. M., Koers, H., Jongert, M. W. A., & Hendriks, E. J. M. (2015). Exercise-based cardiac rehabilitation in patients with chronic heart failure: A dutch practice guideline. Netherlands Heart Journal, 23(1), 6–17. https://doi.org/10.1007/s12471-014-0612-2

Araújo-Gomes, R. C., Valente-Santos, M., Vale, R. G. D. S., Drigo, A. J., & Borba-Pinheiro, C. J. (2019). Effects of resistance training, tai chi chuan and mat pilates on multiple health variables in postmenopausal women. Journal of Human Sport and Exercise, 14(1), 122–139. https://doi.org/10.14198/jhse.2019.141.10

Babu, A. S., Desai, C. V., Maiya, A. G., Guddattu, V., & Padmakumar, R. (2016). Changes in derived measures from six-minute walk distance following home-based exercise training in congestive heart failure: A preliminary report. Indian Heart Journal, 68(4), 527–528. https://doi.org/10.1016/j.ihj.2016.05.010

Bellet, R. N., Adams, L., & Morris, N. R. (2012). The 6-minute walk test in outpatient cardiac rehabilitation: Validity, reliability and responsiveness-a systematic review. Physiotherapy (United Kingdom), 98(4), 277–286. https://doi.org/10.1016/j.physio.2011.11.003

Bittencourt, M. S., Christman, M. P., Hulten, E., Divakaran, S., Skali, H., Kwong, R. Y., … Blankstein, R. (2014). Comparison of the use of downstream tests after exercise treadmill testing by cardiologists versus noncardiologists. American Journal of Cardiology, 114(2), 305–311. https://doi.org/10.1016/j.amjcard.2014.04.040

Bona, R. L., Bonezi, A., da Silva, P. F., Biancardi, C. M., de Souza Castro, F. A., & Clausel, N. O. (2017). Effect of walking speed in heart failure patients and heart transplant patients. Clinical Biomechanics, 42, 85–91. https://doi.org/10.1016/j.clinbiomech.2017.01.008

Caiati, C., Lepera, M. E., Carretta, D., Santoro, D., & Favale, S. (2013). Head-to-head comparison of peak upright bicycle and post-treadmill echocardiography in detecting coronary artery disease: A randomized, single-blind crossover study. Journal of the American Society of Echocardiography, 26(12), 1434–1443. https://doi.org/10.1016/j.echo.2013.08.007

Ciani, O., Piepoli, M., Smart, N., Uddin, J., Walker, S., Warren, F. C., … Taylor, R. S. (2018). Validation of Exercise Capacity as a Surrogate Endpoint in Exercise-Based Rehabilitation for Heart Failure: A Meta-Analysis of Randomized Controlled Trials. JACC: Heart Failure, 6(7), 596–604. https://doi.org/10.1016/j.jchf.2018.03.017

Dionne, A., Leone, M., Andrich, D. E., Pérusse, L., & Comtois, A. S. (2017). Acute breathing patterns in healthy and heart disease participants during cycling at different levels of immersion. Respiratory Physiology and Neurobiology, 235, 1–7. https://doi.org/10.1016/j.resp.2016.09.011

Fernhall, B., Borghi-Silva, A., & Babu, A. S. (2015). The Future of Physical Activity Research: Funding, Opportunities and Challenges. Progress in Cardiovascular Diseases, 57(4), 299–305. https://doi.org/10.1016/j.pcad.2014.09.003

Fleg, J. L. (2017). Exercise Therapy for Older Heart Failure Patients. Heart Failure Clinics, 13(3), 607–617. https://doi.org/10.1016/j.hfc.2017.02.012

Forestieri, P., Guizilini, S., Peres, M., Bublitz, C., Bolzan, D. W., Rocco, I. S., … Gomes, W. J. (2016). A cycle ergometer exercise program improves exercise capacity and inspiratory muscle function in

hospitalized patients awaiting heart transplantation: A pilot study. Brazilian Journal of Cardiovascular Surgery, 31(5), 389–395. https://doi.org/10.5935/1678-9741.20160078

Garzon, M., Gayda, M., Nigam, A., Comtois, A. S., & Juneau, M. (2017). Immersible ergocycle prescription as a function of relative exercise intensity. Journal of Sport and Health Science, 6(2), 219–224. https://doi.org/10.1016/j.jshs.2015.12.004

Gök, G., Zoghi, M., Sinan, Ü. Y., Kılıç, S., & Tokgözoğlu, L. (2019). Demographics of patients with heart failure who were over 80 years old and were admitted to the cardiology clinics in Turkey. Anatolian Journal of Cardiology, 21(4), 196–205. https://doi.org/10.14744/AnatolJCardiol.2018.94556

Goleman, daniel; boyatzis, Richard; Mckee, A. (2019). ACSM's Guidlines for Exercise Testing and Prescription. In Journal of Chemical Information and Modeling (Vol. 53).

Grazzi, G., Mazzoni, G., Myers, J., Codecà, L., Pasanisi, G., Mandini, S., … Chiaranda, G. (2018). Determining the best percent-predicted equation for estimated $VO_{2\ peak}$ by a 1-km moderate perceptually-regulated treadmill walk to predict mortality in outpatients with cardiovascular disease. Journal of Science and Medicine in Sport, 21(3), 307–311. https://doi.org/10.1016/j.jsams.2017.06.003

Ha, F. J., Hare, D. L., Cameron, J. D., & Toukhsati, S. R. (2018). Heart Failure and Exercise: A Narrative Review of the Role of Self-Efficacy. Heart Lung and Circulation, 27(1), 22–27. https://doi.org/10.1016/j.hlc.2017.08.012

Hu, Y. N., Chung, Y. J., Yu, H. K., Chen, Y. C., Tsai, C. T., & Hu, G. C. (2016). Effect of Tai Chi Exercise on Fall Prevention in Older Adults: Systematic Review and Meta-analysis of Randomized Controlled Trials. International Journal of Gerontology, 10(3), 131–136. https://doi.org/10.1016/j.ijge.2016.06.002

Jehn, M., Halle, M., Schuster, T., Hanssen, H., Koehler, F., & Schmidt-Trucksäss, A. (2011). Multivariable analysis of heart rate recovery after cycle ergometry in heart failure: Exercise in heart failure. Heart and Lung: Journal of Acute and Critical Care, 40(6). https://doi.org/10.1016/j.hrtlng.2011.01.005

Kelly, J. P., Hammill, B. G., Doll, J. A., Felker, G. M., Heidenreich, P. A., Bhatt, D. L., … Hernandez, A. F. (2016). The Potential Impact of Expanding Cardiac Rehabilitation in Heart Failure. Journal of the American College of Cardiology, 68(9), 977–978. https://doi.org/10.1016/j.jacc.2016.05.081

Krishnaswami, A., Ho, W. K. W., Kwan, W. P., Tsou, C., Rana, J. S., Solomon, M. D., … Praserthdam, A. W. (2017). A pilot study to assess the utility of five established variables to standardize exercise treadmill test reporting. International Journal of Cardiology, 231, 271–276. https://doi.org/10.1016/j.ijcard.2016.12.020

Kubo, H., Nozoe, M., Yamamoto, M., Kamo, A., Noguchi, M., Kanai, M., … Shimada, S. (2018). Safety and Feasibility of the 6-Minute Walk Test in Patients with Acute Stroke. Journal of Stroke and Cerebrovascular Diseases, 27(6), 1632–1638. https://doi.org/10.1016/j.jstrokecerebrovasdis.2018.01.017

Kunstler, B. E., Cook, J. L., Freene, N., Finch, C. F., Kemp, J. L., O'Halloran, P. D., & Gaida, J. E. (2018). Physiotherapists use a small number of behaviour change techniques when promoting physical activity: A systematic review comparing experimental and observational studies. Journal of Science and Medicine in Sport, 21(6), 609–615. https://doi.org/10.1016/j.jsams.2017.10.027

Lee, J. K., Won, M. H., & Son, Y. J. (2019). Combined influence of depression and physical frailty on cognitive impairment in patients with heart failure. International Journal of Environmental Research and Public Health, 16(1), 1–10. https://doi.org/10.3390/ijerph16010066

Lian, Z., Yang, L., Bian, Y., Zeng, L., Li, M., Sun, Y., & Li, W. (2017). Effects of Tai chi on adults with essential hypertension in China: A systematic review and meta-analysis. European Journal of Integrative Medicine, 12(January), 153–162. https://doi.org/10.1016/j.eujim.2017.05.007

Lu, W. A., & Kuo, C. D. (2012). Effect of 3-month Tai Chi Chuan on heart rate variability, blood lipid and cytokine profiles in middle-aged and elderly individuals. International Journal of Gerontology, 6(4), 267–272. https://doi.org/10.1016/j.ijge.2012.01.025

Maessen, M. F. H., Verbeek, A. L. M., Bakker, E. A., Thompson, P. D., Hopman, M. T. E., & Eijsvogels, T. M. H. (2016). Lifelong Exercise Patterns and Cardiovascular Health. Mayo Clinic Proceedings, 91(6), 745–754. https://doi.org/10.1016/j.mayocp.2016.02.028

Mählmann, L., Gerber, M., Furlano, R. I., Legeret, C., Kalak, N., Holsboer-Trachsler, E., & Brand, S. (2017). Aerobic exercise training in children and adolescents with inflammatory bowel disease: Influence on psychological functioning, sleep and physical performance – An exploratory trial. Mental Health and Physical Activity, 13, 30–39. https://doi.org/10.1016/j.mhpa.2017.09.002

Mohammed, H. G., & Shabana, A. M. (2018). Effect of cardiac rehabilitation on cardiovascular risk factors in chronic heart failure patients. Egyptian Heart Journal, 70(2), 77–82. https://doi.org/10.1016/j.ehj.2018.02.004

Noël, M., Jobin, J., Marcoux, A., Poirier, P., Dagenais, G., & Bogaty, P. (2010). Comparison of Myocardial Ischemia on the Ergocycle Versus the Treadmill in Patients With Coronary Heart Disease. American Journal of Cardiology, 105(5), 633–639. https://doi.org/10.1016/j.amjcard.2009.10.057

Noites, A., Freitas, C. P., Pinto, J., Melo, C., Vieira, Á., Albuquerque, A., … Bastos, J. M. (2017). Effects of a Phase IV Home-Based Cardiac Rehabilitation Program on Cardiorespiratory Fitness and Physical Activity. Heart Lung and Circulation, 26(5), 455–462. https://doi.org/10.1016/j.hlc.2016.08.004

Palmer, K., Bowles, K. A., Paton, M., Jepson, M., & Lane, R. (2018). Chronic Heart Failure and Exercise Rehabilitation: A Systematic Review and Meta-Analysis. Archives of Physical Medicine and Rehabilitation, 18, 1–6. https://doi.org/10.1016/j.apmr.2018.03.015

Papathanasiou, J., Boyadjiev, N., Dimitrova, D., Kasnakova, P., Tsakris, Z., Tsekoura, D., … Masiero, S. (2017). The effect of group-based cardiac rehabilitation models on the quality of life and exercise capacity of patients with chronic heart failure. Hellenic Journal of Cardiology, 58(6), 432–435. https://doi.org/10.1016/j.hjc.2017.04.003

Perez-Terzic, C. M. (2012). Exercise in cardiovascular diseases. PM and R, 4(11), 867–873. https://doi.org/10.1016/j.pmrj.2012.10.003

Ren, X., Li, Y., Yang, X., Li, J., Li, H., Yuan, Z., … Gao, Y. (2017). The effects of Tai Chi training in patients with heart failure: A systematic review and meta-analysis. Frontiers in Physiology, 8(DEC), 1–13. https://doi.org/10.3389/fphys.2017.00989

Rodríguez-Santamarta, M., Sayago, I., & López, J. (2017). High effectiveness of repeated levosimendan cycles in a patient with advanced heart failure. Medicina Clinica, 149(5), 226. https://doi.org/10.1016/j.medcli.2017.04.035

Sinan, Ü. Y., Ekmekçi, A., Özbay, B., Akçay, F. A., Bekar, L., Koza, Y., … Zoghi, M. (2019). The real-life data of hospitalized patients with heart failure: On behalf of the journey HF-TR study investigators. Anatolian Journal of Cardiology, 21(1), 25–30. https://doi.org/10.14744/AnatolJCardiol.2018.50880

Sumartono, W., Sirait, A. M., Holy, M., & Thabrany, H. (2011). Smoking and socio-demographic determinant of cardiovascular diseases among males 45+ years in Indonesia. International Journal of Environmental Research and Public Health, 8(2), 528–539. https://doi.org/10.3390/ijerph8020528

Travensolo, C., Goessler, K., Poton, R., Pinto, R. R., & Polito, M. D. (2018). Measurement of physical performance by field tests in programs of cardiac rehabilitation: a systematic review and meta-analysis. Revista Portuguesa de Cardiologia, 37(6), 525–537. https://doi.org/10.1016/j.repc.2017.07.008

Wewege, M., Thom, J., Rye, K.-A., & Parmenter, B. (2018). Aerobic, resistance or combined training: A systematic review and meta-analysis of exercise to reduce cardiovascular risk in adults with

metabolic syndrome. Atherosclerosis, 0(274), 162–171. https://doi.org/10.1016/j.atherosclerosis.2018.05.002

Wong, C. H. L., Chow, J. T. M., & Chung, V. C. H. (2016). Should Tai Chi be part of cardiac rehabilitation programme for patients with chronic heart failure? Advances in Integrative Medicine, 3(2), 62–63. https://doi.org/10.1016/j.aimed.2016.10.002

Wu, Y., Wang, Y., Burgess, E. O., & Wu, J. (2013). The effects of Tai Chi exercise on cognitive function in older adults: A meta-analysis. Journal of Sport and Health Science, 2(4), 193–203. https://doi.org/10.1016/j.jshs.2013.09.001

Zheng, S., Lal, S., Meier, P., Sibbritt, D., & Zaslawski, C. (2014). Protocol: The Effect of 12 Weeks of Tai Chi Practice on Anxiety in Healthy but Stressed People Compared to Exercise and Wait-list Comparison Groups: A Randomized Controlled Trial. JAMS Journal of Acupuncture and Meridian Studies, 7(3), 159–165. https://doi.org/10.1016/j.jams.2014.01.003