Aerobic Weight and Non-Weight Bearing Exercise Effects on Myocardium: An in vivo Study on Elderly *Mus Musculus*

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Abstract

Background: Due to the process of aging, the function of human organs and muscles decreases. Exercise is a solution to improve organ and muscle function. But it all must be in proportion. So far, aerobic exercise is an exercise solution for the elderly, but which aerobic exercise has not been widely studied.

Purpose: To test aerobic weight bearing exercise and aerobic non weight bearing exercise as a sports solution for old age.

Methods: The experimental laboratory used a completely randomized post-test design using 26 elderly females' mice samples with three actions, namely 9 mice that were not exercised, 9 mice with aerobic weight bearing exercise and 8 mice with aerobic non weight bearing exercise. this process is carried out for 6 weeks with a frequency of exercise 5 times a week, and processed statistically using the statistical product and service solution (SPSS) program.

Results: Aerobic weight-bearing exercise and aerobic non-weight-bearing exercise resulted in an enlargement of the myocardium but there was significant difference between groups due to the One Way ANOVA test, with p-value < 0,05.

Conclusion: weight bearing exercise induce hipertrophic effects and significant differences between aerobic weight bearing exercise and aerobic non weight bearing exercise between the two groups.

Keywords: aerobic weight bearing exercise, aerobic non weight bearing exercise, elderly, myocardium

Introduction

The heart is one of the most vital organs in the human body systems. On the other hand, as humans age, they are going to advance the final stage of the human cycle, the elderly. Elderly is a period in which humans have reached maturity in size and organ function, whose functions have also shown a decline over time, as well as a process of slowly disappearing the ability of tissues to repair in order to maintain their normal functional structure.[1] Accordingly, the heart as a part of the cardiovascular system is also going to show a decline in function as they are aging.

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The aging process will cause anatomical, physiological, and biochemical changes which might significantly affect the function and ability of the body as a whole, including muscle mass decrease, changes in muscle blood distribution, muscle cell pH alteration, muscle stiffening, and muscle strength weakening.[1]

In addition, the female physical strength equal to two-thirds of that male possessed. Poitrast reported that at the age of twenty, women had 65% lifting strength compared to men while her pushing and pulling strength was approximately 75% of the man.[2] Moreover, optimal muscle strength is at the age of 20-39 years and will decrease by 20% at the age of 60 years. Hence, it could be understood that women's physical endurance tends to be relatively lower than men's and might be considered as a more vulnerable group.

Exercise is one of the solutions to improve organ and muscle functions. So far, aerobic exercise is an exercise solution for the elderly. Aerobic exercise might improve body composition, such as body fat, bone health, muscle mass, muscle endurance, muscle strength, and muscle flexibility so that the elderly are expected to be healthier and fitter and lower the risk of falling. The benefits of aerobic exercise for the elderly include prolonging life expectancy, nourishing the cardiorespiratory and musculoskeletal organs, promoting being more independent, preventing obesity, reducing anxiety and depression, and gaining higher self-confidence. Aerobic exercise for health maintenance is suggested to be done in the morning, without exceeding the 60 - 70% maximum heart rate.[1]

Aerobic exercise comprises activities that make an individual bear his body weight (weight-bearing), such as walking, or activities that do not directly support his body weight (non-weight bearing), such as cycling and swimming. The usefulness of an exercise program for the elderly also relies on the program being conducted. Therefore, it is recommended that the exercise program should fulfill principles of *Frequency, Intensity, Time, Type (FITT)*.[3]

According to Aziz et. al. (2021) study, the heart rate of athletes was significantly higher when they predominantly performed anaerobic compared to aerobic exercise.[5] This might be explained as the oxygen demand of the aerobic exercise-performing population is considerably high and constant. An increase in preload and volume becomes the major stimulus for ventricular adaptation in the form of hypertrophy and dilatation of the ventricular wall, thereby increasing the effectiveness of heart-pumping function, which in turn would reduce the heart rate in predominantly aerobic athletes. This finding might support the idea that aerobic is better than anaerobic exercise, especially for elderly population. Furthermore, Rahima et. al. (2015) added that there might also be changes in the levels of Brain Natriuretic Peptide (BNP) in the heart muscle which affected changes in the histological size of the heart muscle.[5] However, the study concerning which type of aerobic exercise is better for elderly still becomes a research topic that should be explored. Therefore, this study aimed to investigate the effect of weight-bearing and non-weight bearing aerobic exercise on myocardiac histological properties in animal model of elderly *Mus musculus.*

Materials and Methods

A laboratory experimental study employing a randomized posttest design was conducted in Animal Study Laboratory, Faculty of Veterinary Medicine, Universitas Airlangga, Indonesia, from January to February 2021. All experimental procedure has been reviewed and approved by Medical Research Ethics Committee, Faculty of Medicine, Universitas Airlangga (No.77/EC/KEPK/FKUA/2021)

A total of twenty-seven female mice (Mus Musculus) aged 7–8-month-old with good physical fitness were obtained from Animal Study Laboratory, Faculty of Veterinary Medicine, Universitas Airlangga. Mice were randomly assigned to three study groups evenly, generating three observed groups (control [K0], aerobic weight bearing [K1], and aerobic non weight bearing group [K2]). Mice were placed at cages measuring 60x20x40 cm made from plastic covered with gauze equipped with a place to eat and drink bottles. Each cage was occupied by each group consisting of nine mice. Mice were placed at room temperature and the lighting was regulated by a 12-hours light-dark cycle. The feeding was done at 09.00 – 10.00 a.m. ad libitum. Formerly, all mice were acclimatized in their cages for two weeks and were habituated with treadmill and swimming activity during their second week's acclimatization, 5 minutes/day.

K1 group were treated with zero-degree-inclination treadmill exercise, conveyed at 21 cm/s in velocity. Each exercise session took 30 minutes and was given 5 times/week for six weeks (Souza et. al., 2007). K2 group received 30 minutes of swimming exercise for each session, given 5 times/week for six weeks (Darsana et al, 2019).

On the last day of sample observation, the myocardiac tissue of each animal model was obtained by surgical process done under ketamine HCl anesthesia. However, one of the studied mus musculus from the K2 group should be excluded since there was significant technical damage in its myocardiac specimen. Therefore, the final myocardium specimens that met eligibility criteria were twenty-six specimens. All specimens were prepared for histopathological examination on Hematoxylin Eosin Staining and were analyzed microscopically through 400x magnifications. The myocardiac thickening was also examined by using the ImageJ v1.33 software downloaded from the NIH website (http://rsb.info.nih.gov/ij).

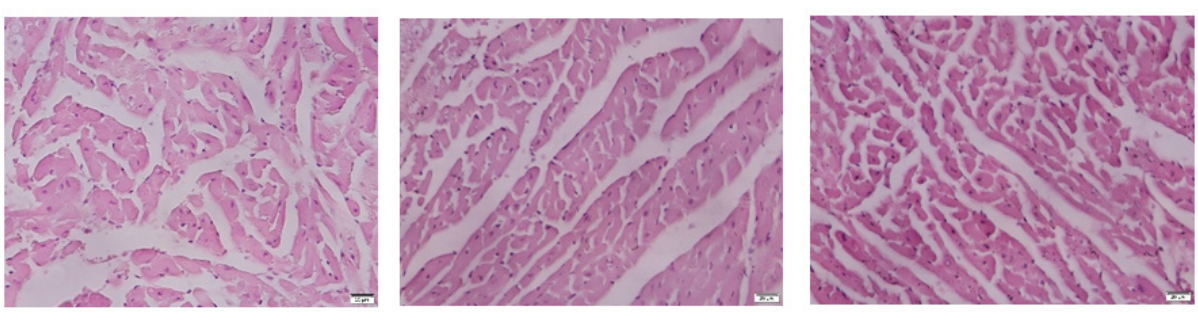
Obtained the data were then processed and analyzed statistically using SPSS v16 for Windows. The normality test was carried out using the Kolmogorov-Smirnov test following by the homogeneity test to determine the similarity between the treatment groups. The test used to compare the average comparison values of the research studied was carried out using the One-Way ANOVA test. This finding was considered significant at $p<0.05$.

Results and Discussion

Out of twenty-six eligible specimens from three studied group, the baseline characteristics of myocardium thickness were summarized in the Table 1. Additionally, the representative of histopathological finding of each group were depicted in Figure 1.

Table 1: Baseline characteristics of myocardium thickness of each investigated group

Group	n	Myocardium thickness (μm)	Minimum Thickness (μm)	Maximum Thickness (μm)
K_0	9	15.952,72 $\pm$ 9571,67	1.643,25	35.734,75
K_1	9	10.049, 59 $\pm$ 7.255,05	839,23	28.571,05
K_2	8	8.227,61 $\pm$ 7.988,26	213,81	31.301,56



a b c

Figure 1: Histopathological appearances of K0 (a); K1 (b); K2 (c)

After analyzing the comparative studies, this study found that the thickness of the myocardium of K1 was significantly lower than that of K0, as was K2. However, the thickness of the K1 myocardium was significantly higher than that of K2. Comparative studies of the thickness of the myocardium in each group can be seen in Table 2 below.

Tabel 2: Comparative study of myocardium thickness of each group (ANOVA-one way test)

Group	n	ANOVA-one way test
K_0	9	
K_1	9	0,004*
K_2	8	

* significant at p<0.050

Evidence of significant thickness of the myocardium seen in the aerobic weight bearing exercise group may result in mild enlargement of the ventricular myocardium. This is in line with research by Soya et. al. (2007) who reported that treadmill aerobic exercise causes myocardial hypertrophy.[6] This is also supported by another study which showed mild ventricular hypertrophy after being given treatment in the form of running for 6 weeks, compared to the group without intervention.[7]

Similarly, the findings of a significant thickness of myocardium were seen in the aerobic non weight bearing exercise group of the study reported by Medeiros et. al. (2004) who observed that aerobic non weight bearing exercise can cause myocardial adaptation in the form of various changes, including enlargement and renewal of the myocardium.[8] In addition, these findings are in line with another study in adult mice treated with swimming for 4 weeks which reported that the treated mice only experienced an increase in ventricular mass, ventricular mass-weight ratio, and an increase in heart wall thickness compared to adult mice. those who do not exercise.[9]

This study also showed that both aerobic weight-bearing exercise and aerobic non weight bearing exercise groups caused a hypertrophic effect. However, when viewed from the descriptive mean test, the results without exercise have the highest value compared to the average of aerobic weight bearing exercise and aerobic non weight bearing exercise. Possibly this was due to the low number of mice in the aerobic non weight bearing exercise treatment, as well as the high oxygen consumption in the mice that rested too much. However, there has been no further research that discusses the difference between aerobic weight bearing exercise and aerobic non weight bearing exercise but based on previous research that discusses the effects of exercise can cause hypertrophy.

Conclusion

This animal model study suggests that the effect of aerobic weight bearing exercise and aerobic non weight bearing exercise on elderly mice myocardium differ significantly. However, more research concerning this topic still needed to add more information in this field.

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References

1. Pribadi A. Pelatihan Aerobik untuk kebugaran paru jantung bagi lansia. Jorpres (Jurnal Olahraga Prestasi). 2015; 11(2).
2. Utami, SR. Hubungan Antara Status Gizi Dan Tingkat Kebugaran Jasmani Dengan Produktivitas Kerja Pada Tenaga Kerja Wanita Unit Spinning 1 Bagian Winding PT. Apac Inti Corpora Bawen [Doctoral Dissertation]. [Surakarta]: Universitas Negeri Semarang. 2013.
3. Kurnianto D. Menjaga Kesehatan Di Usia Lanjut. Jorpres (Jurnal Olahraga Prestasi). 2015; 11(2).
4. Aziz H., Nurhayati T., Sylviana N. Perbedaan Denyut Jantung Dan Tekanan Darah Pada Atlet Predominan Aerobik Dan Anaerobik Koni Jawa Barat Tahun 2016. Jurnal Ilmu Faal Olahraga Indonesia. 2021; 3(2).
5. Rahima, R., Flora, R., & Theodorus, T. Indikator Beban Berlebih Pada Otot Jantung Tikus Wistar Yang Diberi Perlakuan Latihan Fisik Akut. Biomedical Journal of Indonesia. 2015; 1(1): 35-39.
6. Soya H, Mukai A, Deocaris CC, Ohiwa N, Chang H, Nishijima T, Fujikawa T, Togashi K, Saito T. Threshold-like pattern of neuronal activation in the hypothalamus during treadmill running: establishment of a minimum running stress (MRS) rat model. Neurosci Res. 2007 Aug;58(4):341-8.
7. Puhl SL, Müller A, Wagner M, Devaux Y, Böhm M, Wagner DR, Maack C. Exercise attenuates inflammation and limits scar thinning after myocardial infarction in mice. Am J Physiol Heart Circ Physiol. 2015 Jul 15;309(2):H345-59.
8. Medeiros A, Oliveira EM, Gianolla R, Casarini DE, Negrão CE, Brum PC. Swimming training increases cardiac vagal activity and induces cardiac hypertrophy in rats. Braz J Med Biol Res. 2004 Dec;37(12):1909-17.
9. Derumeaux G, Ichinose F, Raher MJ, Morgan JG, Coman T, Lee C, Cuesta JM, Thibault H, Bloch KD, Picard MH, Scherrer-Crosbie M. Myocardial alterations in senescent mice and effect of exercise training: a strain rate imaging study. Circ Cardiovasc Imaging. 2008 Nov;1(3):227-34.