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The Effect of Additional *Aerobic Exercise* to Functional Therapy on Resting Heart Rate in Chronic Phase Post Stroke Patients

Fanny Thresia Yunus[1], Hari Peni Julianti[1], Erna Setiawati[1]

[1] Department of Physical Medicine and Rehabilitation, Diponegoro University, Semarang, Indonesia

ABSTRACT

Introduction: Regular aerobic exercise has a direct effect on resting heart rate, both acute and chronic effects. One of the chronic effects decrease resting heart rate which is beneficial for heart health. The objective of this study was to prove the effect of adding aerobic exercise to functional therapy on resting heart in post-stroke patients with chronic phase.

Methods: The study used a randomized controlled trial with pre and post-test control group design. The treatment group (n = 10) received additional aerobic exercise and the control group only received functional therapy (n = 10). Assessment of resting heart rate measurements was carried out before and after exercise.

Results: There was a significant difference (p=<0.001) in the mean resting heart rate in the treatment group before intervention 89.00 ± 9.13 and after intervention 76.10 ± 10.16. There was a significant difference (p=0.017) in the mean resting heart rate in the control group before intervention 88.60 ± 7.75 and after intervention 84.40 ± 6.98. There was a significant difference in the resting heart rate delta value between the treatment group (-12.90 ± 6.56) compared to the control group (-4.20 ± 4.37).

Discussion: The value of resting heart rate pre and post-test in the treatment group showed a more significant difference than the control group. Aerobic exercise can inhibit the activation of the sympathetic nervous system and increase the activation of the parasympathetic nervous system due to the effects of cardiovascular adaptation.

Conclusion: The intervention of adding aerobic exercise can reduce resting heart rate in post-stroke patients with chronic phase.

Keywords: Aerobic exercise, functional therapy

ABSTRAK

Pendahuluan: *Aerobic exercise* teratur berpengaruh terhadap denyut jantung istirahat baik efek akut dan kronis. Salah satu efek kronis menurunkan denyut jantung istirahat yang bermanfaat bagi kesehatan jantung. Tujuan untuk membuktikan pengaruh penambahan *aerobic exercise* pada terapi fungsional terhadap denyut jantung istirahat pada pasien paska stroke fase kronik.

Metode: Penelitian menggunakan uji coba terkontrol acak pre dan post-test control group design. Kelompok perlakuan (n = 10) yang mendapat penambahan aerobic exercise dan kelompok kontrol hanya mendapat terapi fungsional (n = 10). Penilaian pengukuran denyut jantung istirahat dilakukan sebelum dan sesudah latihan.

Hasil: Terdapat perbedaan bermakna (p=<0,001) rerata denyut jantung istirahat pada kelompok perlakuan sebelum intervensi 89,00 ± 9,13 dan setelah intervensi 76,10 ± 10,16. Terdapat perbedaan bermakna (p=0,017) rerata denyut jantung istirahat pada kelompok kontrol sebelum intervensi 88,60 ± 7,75 dan setelah intervensi 84,40 ± 6,98. Terdapat perbedaan yang bermakna pada nilai delta denyut jantung istirahat antara kelompok perlakuan (-12,90 ± 6,56) dibandingkan kelompok kontrol (-4,20 ± 4,37)

Diskusi: Nilai *resting heart rate pre* dan *post-test* pada kelompok perlakuan menunjukkan perbedaan yang lebih signifikan dibanding kelompok kontrol. Aerobic exercise dapat menghambat aktivasi sistem saraf simpatik dan peningkatan aktivasi sistem saraf parasimpatis karena efek adaptasi kardiovaskular.

Simpulan: Intervensi penambahan aerobic exercise dapat menurunkan denyut jantung istirahat pada pasien paska stroke fase kronik.

Kata kunci: *Aerobic exercise*, terapi fungsional

Correspondent Detail:

Hari Peni Julianti

Department of Physical Medicine and Rehabilitation
Faculty of Medicine Diponegoro University, Semarang, Indonesia
Email: hari_peni@yahoo.com

INTRODUCTION

Stroke is a life-threatening medical condition caused by both focal or global impaired brain function which progresses rapidly, lasts more than 24 hours or results in death, without vascular disorders present.[1,2]

An increase in the resting heart rate (RHR), which controls the autonomic nervous system's activities, the effects of circulating hormones, and cardiopulmonary fitness, has also been linked to an increased risk of CVD and metabolic syndrome, according to a recent prospective study.[3–5] As it can shorten the diastolic phase of

the cardiac cycle, increase cardiac workload as a result of lower coronary flow, and encourage the development of atherosclerotic plaque, an increase in RHR can be detrimental to the heart.[6]

Interventions on cardiorespiratory fitness in the chronic phase are carried out by providing regular strengthening and aerobic exercise programs. The purpose of this cardiovascular fitness exercise is to increase functional output and to make it easier for patients to carry out their activities. The exercise must be adjusted to the patient's comorbidities and functional limitations, including walking, treadmill, stationary cycle, combined arm-leg exercise program, ergometry, arm ergometry, or seated stepper.[6]

Aerobic exercise has cardiorespiratory effect as it can enhance oxygen uptake, increase blood capacity to transport oxygen, and reduce resting heart rate during activities. Aerobic exercise can also increase the number of capillaries, reduce lipid levels and increase fat-burning enzymes.[7–9] Additionally, aerobic exercise can decrease sympathetic nervous system activation while increasing parasympathetic nervous system activity, which results in a reduction in RHR. Improved fitness, one of the main outcomes of exercise, may lead to a decrease in RHR.[10–12]

The acute effect of exercise is an increase in resting heart rate. This increasing resting heart rate is caused by exercise, the need for blood to transport O_2 to active body tissues will increase. In addition, acute effects, exercise also cause the effect is in the form of a decrease in the frequency resting heart rate.[6,7]

The heart rate or pulse is controlled by the autonomic nervous system. The response of an increase nerve impulses from the brainstem to the sympathetic nerves will cause a decrease in diameter blood vessels and an increase in heart rate. Heart rate is regulated by sympathetic and parasympathetic nerve activity and also by epinephrine and norepinephrine. [8,9]

Functional therapy given to stroke patients with chronic phase is intended to train patients to be able to return to their daily activities independently. Functional therapy is a form of exercise associated with daily activities. Functional therapy will help stroke survivors regain the muscle coordination needed to perform activities of daily living. Functional therapy has been shown to improve the independent performance of stroke patients when performing activities of daily living. This functional therapy uses functional movements compared to basic movements.[7,13]

This study differ from previous studies, including the addition of functional therapy interventions to aerobic exercise. The purpose of this study was to determine the effect of adding aerobic exercise to functional therapy in post-stroke patients with chronic phase.

METHODS

This study was a randomized controlled trial pre and post-test control group design by comparing the effects of adding aerobic exercise to functional therapy in post stroke patients with chronic phase located on ground floor of medical rehabilitation Installation at General Hospital Ungaran on September until November 2021. The total sample was 20 people who were recruited using consecutive sampling technique and then simple randomization was divided the subjects into 2 groups. Inclusion

criteria including patients after stroke in the chronic ischemic phase in the period between 6 months to 18 months, patient age 40 to 60 years old, stroke with lesions in one hemisphere with manifestations of hemiparesis, body mass index between 18.5 to 29.9 kg/m2, extremity muscle strength with MMT value > 3, can understand instructions (MOCA-Ina score > 26), walk independently with or without assistive device.

Exclusion criteria were patients with neurological disorders due to impairments in the brain that inhibit the exercise process, such as apraxia, aphasia, severe spasticity (MAS > 3), and ataxia, there are contraindications of aerobic exercise, having a condition or disease that affects resting heart rate based on a doctor's diagnosis in the patient's medical record and clinical condition of the patient, such as Alzheimer's, multiple sclerosis, Parkinson's, depression, cancer and autoimmune diseases . Drop out criteria was patients did not come to the exercise as scheduled for three non-consecutive sessions or two consecutive sessions, did not come at the beginning and end of the study, the participant refuses to continue the exercise.

The research group was divided into 2, the treatment group and the control group. The control group received functional therapy with a frequency of 3 times a week for 4 weeks. The treatment group received functional therapy plus high-intensity aerobic exercise using a static bicycle with a frequency of 3 times a week for 4 weeks. Pre-treatment evaluation was carried out before the first session, by measuring resting heart rate using a digital sphygmomanometer. Post-treatment evaluation is carried out within a maximum time of 2 hours after the last session (12^{th} session), by measuring resting heart rate using a digital sphygmomanometer.

Hypothesis testing for comorbid confounding variables and gender on changes in resting heart rate will be randomized to the treatment group and the control group. If randomization is not successful, data analysis will be carried out using the Chi Square test. Hypothesis testing for the confounding variable of age on resting heart rate will be randomized to the treatment group and the control group. If randomization is not successful, data analysis will be carried out using an unpaired t test if the data is normally distributed, whereas if the data is not normally distributed, then the Mann Whitney test is performed.

All data were processed with the help of a computer using SPSS® software. The significance in this study was obtained if the p value <0.05 with 95% confidence interval was obtained.

Before conducting the research, ethical clearance was requested from the Ethics Commission of the Faculty of Medicine, Diponegoro University and Ungaran Hospital. The Obtained ethical clearance from the Faculty of Medicine, Diponegoro University with the number 51/EC/KEPK/FK-UNDIP/IV/2020 and ethical clearance from the Ungaran Hospital with the number 445/647.1/IX/2020. Participants' willingness to be included in the study was done in writing (informed consent). Previously given an explanation of the objectives, benefits and effects that can occur as a result of research. Participants' data will be kept confidential and will not be published except with the participant's permission. All costs associated with the research are the responsibility of the researcher.

RESULTS

The research was conducted at the Medical Rehabilitation Installation at the Ungaran Hospital from August 2020 to September 2020. The total number of subjects in this study were 20 patients after chronic phase stroke (onset between 6 months - 18 months), divided into the control with a frequency of three times a week for four weeks (12th sessions). The parameter evaluated in this study was the change in resting heart. All study subjects from both groups were able to complete the training session until the end of the treatment period up to 12 sessions within a period of 4 weeks. There were no significant side effects in this study, either in the treatment group or the control group. Demographic and clinical characteristics of research subjects in both groups are shown in group and the treatment group with 10 subjects in each group. The control group received functional therapy with a frequency of three times a week for four weeks. The treatment group received functional therapy plus aerobic exercise using a static bicycle.

Table 1. Characteristics of the Participants (n= 20)

	Group		P
	Control	Treatment	
Gender			
Male	6 (60%)	6 (60%)	1.000¥
Female	4 (40%)	4 (40%)	
Age	54.20 ± 3.58	55.00 ± 3.37	0.613§
Hemiparesis			
Dextra	4 (40%)	6 (60%)	0.371¥
Sinistra	6 (60%)	4 (40%)	
IMT*	26,20 ± 1,73	25,79 ± 1,69	0,599§
Physical activity			
Sedentery	10 (100%)	10 (100%)	-
Onset	12.90 ± 4.20	14.10 ± 4.07	0.525§
Comorbid			
Hypertension	7 (70%)	9 (90%)	0.582¥
DM*	5 (50%)	3 (30%)	0.650¥
Dislipidemia	2 (20%)	2 (20%)	1.000¥

*BMI: Body mass index; DM: Diabetes mellitus significance ($p < 0.05$); ¥Chi square, § Independent T

From table of the results of the homogeneity test of demographic characteristics consisting of gender, age, side of paresis, Body Mass Index, level of physical activity, stroke onset and comorbidity, did not find a significant difference between the control group and the treatment group, with *p* value > 0.05. This means that there is homogeneity of demographic characteristics in both groups.

The number of male and female subjects was the same in both groups, Hemiparesis sinistra was more in subjects in the control group (60%) while hemiparesis dextra was more in subjects in the treatment group (60%). Hypertension comorbidities were more in the treatment group (90%) while diabetes mellitus comorbidities were more in the control group (50%), and dyslipidemia comorbidities were converging in both groups (20%).

The mean age in the treatment group was 55.00 ± 3.37, while in the control group it was 54.20 ± 3.58, there was no significant difference between the two groups. The mean stroke onset until the treatment was given was longer in the treatment (14.10 ± 4.07 months) than the control group (12.90 ± 4.20 months) but did not get a significant difference. The mean body mass index was higher in the control group (26.20 ± 1.73) compared to the treatment group (25.79 ± 1.69), but no significant difference was found means. The previous level of activity in the two groups also did not show any difference.

Table 2. Difference HR Rest Pre, Post and Delta

HR Rest	Group		p
	Treatment	Control	
Pre	89,00 ± 9,13	88,60 ± 7,75	0,917§
Post	76,10 ± 10,16	84,40 ± 6,98	0,067‡
p	<0,001¶*	0,017†*	
Delta	-12,90 ± 6,56	-4,20 ± 4,37	0,003§*

*Significance (p<0,05);§ Independent T;‡ Mann Whitney; ¶ Paired t.

Resting heart rate measurement results from the measurement of resting pulse, the results obtained in Table 2.

DISCUSSION

Statistically, there was no significant differences in the participants' characteristics including gender, age, side of paresis, Body Mass Index, level of physical activity, stroke onset and comorbidity (Table 1) between treatment group and control group (p value > 0.05). The conclusion from the data in Table 1 is that the characteristics of the research subjects in the two groups are homogeneous. Subjects in this study were 20 patients who were suffered chronic phase stroke aged 54-58 years. In this study, participants consist of 20 chronic phase stroke patients. They were divided into 2 groups, control group and treatment group. Control group consists of 10 patients received functional therapy (ADL training) and the other

group which consists of 10 patients received functional therapy and aerobic exercise (ergo cycle). The findings of this study demonstrate that addition of aerobic exercise reduced heart rate, which corroborates the results of Jung kang S, *et al* study suggested that subjects in the exercise group performed aerobic exercise at 60–80% of maximum heart rate for 40 min 5 times a week for 12 weeks and this results that aerobic exercise had beneficial effects on resting heart rate, reduce resting heart rate of patients with metabolic syndrome.[14] Rahnama et al. study which gave the exercise training (Walking for 25 to 45 minutes, 2 sessions per week) to 29 subjects with postmenopausal women with breast cancer and the results showed that exercise training decrease resting heart rate.[15] In the comparison of the results of the pre and post-test, both groups had a significantly decreased resting heart rate of patients with chronic phase stroke furthermore the post-test results in the treatment group had resting heart rate more significant than those of the control group. Both groups demonstrated a significant *p* value for the decrease in resting heart rate, however the intervention group was more significant than the control group. The adding aerobic exercise in treatment group can inhibit the activation of the sympathetic nervous system and increase the activation of the parasympathetic nervous system due to the effects of cardiovascular adaptation.

This is because the treatment group received functional therapy interventions and the addition of aerobic exercise compared to the control group which only received functional therapy in chronic stroke patients. Aerobic exercise plays a central role in the primary prevention and treatment of CVD. Moreover, prospective studies have suggested RHR is an independent predictive factor of CVD, and elevated RHR has been shown to increase the risk of metabolic syndrome onset.[16] Thus, measures for controlling RHR, which is related to the prognosis of CVD, have become important. A study by Lakka et al. verified that having higher fitness lowered the risk of metabolic syndrome development. This indicates that improved fitness, which is a benefit of exercise, is also important in metabolic syndrome. Therefore, it appears that aerobic exercise increases cardiopulmonary fitness and muscle fitness contributing to the lowering of CVD risk in patients with metabolic syndrome.[17] In other words, it seems that aerobic exercise is crucial in lowering resting heart rate. Lower RHR is beneficial for the patients as elevated RHR is associated with higher levels of oxidative stress and endothelial dysfunction that leads to a higher rate of atherosclerosis. Elevated RHR is usually related to sympathetic over-activity, which reflects increased stress or anxiety, vascular stiffness, cardiac remodeling, atherosclerosis, metabolic changes (insulin resistance, dyslipidemia, and obesity) and additionally has pro-arrhythmic effect.[18]

This result was in accordance with Systematic review by Reimers et al. that reported that regular exercise reduces RHR especially endurance training and yoga.[19] Frequent exercise may contribute to a reduction in all-cause and correlated with a study by Bahrainy et al. that suggests an increase in resting parasympathetic tone or a decrease in response to beta-adrenergic stimulation do not contribute to the decrease in RHR after regular exercise or physical activity in humans.[20] A plausible explanation might be due to a decrease in the intrinsic heart rate through mechanisms which have not yet been fully understood. Lower RHR may also be caused by

an increased parasympathetic output in yoga.[21] Although this study uses an aerobic exercise intervention such as ergo cycle, it still has the same mechanism in reducing resting heart rate with physical exercise.

This study is consistent with previous studies showing that physical exercise such as aerobic exercise can reduce resting heart rate. So many studies have been done about exercise or sport that can lower resting heart rate. This can be shown in a systematic review study by Reimers et al. which showed that the effects of various types of sports decreased RHR.[19]

This study has several limitations. The long-term effect of increasing aerobic exercise was not measured in this study. The number of research subjects is still limited, so the results of the study have not been able to describe the results in a large population. Outcomes in the form of functional assessment have not been measured in this study.

CONCLUSION

From several studies there are several factors resting pulse rate disturbances such as ender, age, body position, and physical activity. In this study that adding aerobic exercise to functional therapy is further decreasing the resting heart rate in chronic phase post-stroke patients compared to functional therapy alone. Increase in exercise intensity will increase the pulse rate, so otherwise there will be a decrease if reduced exercise. This effect is acute effects of physical exercise on frequency pulse. Effects of chronic exercise on pulse rate is resting pulse rate decrease when doing aerobic physical exercise regularly and continuously.

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