

Effect of Exercise Duration Toward Heart Rate Recovery in Elderly

Arie Ramdhiani Mahassa¹, Mohammad Rizki Akbar², Sri Yusnita Irda Sari³

Abstract

Background: Age-related change in autonomic nerves covers parasympathetic function decrease that hampers heart rate (HR) control. The effective attempt to improve autonomic nervous function for elderly is routine exercise, however exercise duration among elderly is not always standardized. This study is aimed to compare the effect of different exercise duration to post-exercise Heart Rate Recovery (HRR) between two elderly groups with the same frequency, intensity, type criteria of routine exercise.

Methods: Method was cross-sectional study which compared exercise duration of standardized group (3x90 minutes/week) and unstandardized group (3x30 minutes/week). Group 1 was elders with standardized duration from Healthy Heart Club and Group 2 was elders who take unstandardized duration from Elderly Home in Bandung city. Each group consisted of 43 elders and data were collected in July-August 2019. After one hour of medium intensity exercise, all respondents were examined for resting HR (HRrest), maximum HR (HRmax), one minute post-exercise HR, and four minutes post-exercise HR. HRR was obtained by subtracting HRmax by one minute post-exercise HR and normal if > 12 bpm. Analysis data was done by SPSS with Mann-Whitney U Test, Fisher Chi Square and Logistic regression.

Results: Most of respondents were 60-69 years old and female. Respondents in unstandardized group were more low education, hypertension and smoking. The HRrest of both groups was categorized as normal but increased greater (30x/min) in standardized group. The result showed a significant difference in comparison of median HRR ($p=0.001$) and number of normal and abnormal HRR ($p=0.001$) between both groups. Gender, smoking and standardized duration of exercise associated with abnormality of HRR, elders who take unstandardized duration have 12.7 times risk to get abnormal HRR.

Conclusion: Routine exercise for elderly is recommended in standardized duration with minimal 150 minutes per week in order to increase post-exercise HRR.

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Keywords: Elderly, duration exercise, heart rate recovery (HRR).

¹ Faculty of Medicine,
Universitas Padjadjaran,

² Department of Cardiology
and Vascular Medicine, Faculty
of-Medicine, Universitas
Padjadjaran,

³ Department of Public
Health, Faculty of Medicine,
Universitas Padjadjaran

Correspondence:

Arie Ramdhiani Mahassa,
Jl. Penghulu No.16, Bidaracina,
Jatinegara, Jakarta Timur
13330
Telp.: +62 81 280414594
E-mail: aramdiani98@gmail.
com / mahassa_arie@yahoo.
com

Introduction

Aging is a physiological process that is normally experienced by every individual.¹ Based on data in 2017 from Indonesian Statistics Bureau, it was estimated about 23.66 million senior citizens and was predicted to keep increasing every year.² Aging process is followed by the physiological decrease of body active system function,¹ including the decrease of autonomic nervous function that covers parasympathetic function decrease that might obstructing heart rate control.^{3,4}

Based on the study conducted by de Lima et al., the effective attempt to improve elders' autonomic nervous function is a routine exercise.⁵ The effectiveness of an exercise can be viewed from various hemodynamic parameters such as blood pressure, heart rate, cardiac output, and other parameters. However, heart rate is the most common parameter to use.⁶

Heart Rate Recovery (HRR) refers to the decrease of heart rate after exercise cessation and the combination of withdrawal effect of sympathetic nerves and reactivation of parasympathetic nerves of the autonomic nervous system.⁷ Post-exercise HRR is a pivotal predictor of death, particularly those caused by cardiovascular disease.^{8,9} Data from Basic Health Research in 2013 shows that the highest prevalence of cardiovascular disease in Indonesia was coronary heart disease (CHD), this occurred mostly on the age group of 65-74 years old (3.6%).¹⁰

The study conducted by Elshzly et al. found that post-anterior myocardial infarction patient experiences significant statistical improvement in HRR -1 and HRR -2 ($p < 0.001$) after completing cardiac rehabilitation program.¹¹ Jales et al. also proved the improvement of average HRR on elderly patients with hypertension after undergoing endurance training.¹² Significant average HRR was also proven by the previous study conducted by Noah Greenspan on elderly patients with chronic obstructive pulmonary disease (COPD) after undergoing routine exercises.¹³

Various guidelines on routine exercise for elders have been widely proposed. It is suggested for elders to perform a routine aerobic exercise such as gymnastic¹⁴ for 3-5 times/ week with a duration of 150 minutes/ week with medium intensity¹⁵ constantly for 8-12 weeks at minimum.¹⁶ Although, the impact of the difference

in duration in exercise to post-exercise HRR in elderly have not been widely observed, even with the same frequency, intensity, and type (FIT). The aim of this study was to compare the effect of different duration of exercise to post-exercise HRR in elderly with the same FIT criteria in routine exercise.

Methods

Study Design and Populations

The present study employed an observational method with cross-sectional approach that conducted in July-August 2019. The population of the study were elders in group 1 who take exercise for 3x90mnt/ week (standardized exercise duration) in Healthy Heart Club *Universitas Padjajaran* and those in group 2 (unstandardized exercise duration) who take exercise for 3x30mnt/week in Elderly Home named *Balai Perlindungan Sosial Tresna Werdha* (BPSTW) Pakutandang in Bandung city. The inclusion criteria covered elders aged ≥ 60 years old, group 1 who has been member of the club for \geq two months, and group 2 who has been the residents of BPSTW Pakutandang for \geq two months. The respondents with irregular heart rates were excluded. The minimum number of samples for each group was 38 elders, determined using two independent groups mean comparison formula. Finally, 43 samples were selected for each group using purposive sampling technique.

Heart Rate Measurements

Four parameters of heart rate were measured manually using stopwatch and recorder. The parameter consisted of resting heart rate, maximum heart rate, one-minute post-exercise heart rate, and four-minute post-exercise heart rate. The heart rate was measured for 15 seconds and was multiplied by 4.¹⁷ The followings were the steps of heart rate measurement: (1). Measuring resting heart rate; (2). 60 minutes of exercise in medium intensity; (3). Measuring maximum heart rate;¹⁷ (4). Measuring the 1st minute- heart rate; (5). Measuring the 4th minute- heart rate.

The result of heart rate was then interpreted as 1st minute- HRR after subtracting 1-minute post-exercise

heart rate from maximum heart rate.⁸ Heart rate recovery was considered normal when the result is >12 beats per minute (bpm).¹⁸ Besides, history of diabetes, hypertension, kidney disease, smoking habit, and coronary artery disease were also utilized as descriptive data. Level of education was categorized as low if the respondent only got elementary and junior high school level.

Statistical Analysis

In analysis, categorical variables were presented as percentages and numerical variables were presented as median. The comparison for categorical variables was tested using the Fisher Chi-square test. The comparison between 2 numerical variables was tested using the Mann Whitney-U test. P value ≤ 0.05 was considered statistically significant. Multivariate analysis was done using logistic regression using enter method to find the most risk factors associated with abnormality of HRR. All statistical analysis were performed using SPSS 22.0.

Results

Table 1 provided the data on baseline clinical characteristics of each group, consisting of age, gender,

education, history of diabetes, hypertension, kidney disease, smoking habit, and coronary artery disease. The data showed that the majority of the respondents in both groups were 60-69 years old and female. More than half of respondents in group 1 were graduated from senior high school, while the majority of respondents in group 2 were graduated from elementary school level (p=0.003). The number of respondents in group 2 with history of smoking habit (25.6%), hypertension (53.5%), and coronary artery disease (11.6%) were greater compared to the respondents in group 1. There is a significant difference from respondents with history of smoking habit (p=0.002) and hypertension (p=0.002) between 2 groups.

Table 2 showed comparison of respondent’s heart rate in both groups. Four parameters of heart rate were measured manually in each group. The median of resting heart rate in group 1 (78 bpm) and group 2 (72 bpm) was categorized as normal,¹⁹ however, group 2 exhibited lower heart rate. Following the median of maximum heart rate that was measured immediately after exercise,¹⁷ the increase of heart rate in group 1 (108 bpm – 78 bpm = 30 bpm) was faster than group 2 (90 bpm – 72 bpm = 18 bpm). The median of four-minute post-exercise heart rate showed that group 1 has

Table 1. Data on Respondent’s Baseline Characteristics

Variable	Group 1 n (%)	Group 2 n (%)	P value
Age			
60-69	25 (58.1%)	28 (65.1%)	0.746
70-79	12 (27.9%)	9 (20.9%)	
80+	6 (14%)	6 (14%)	
Gender			
Male	5 (11.6%)	19 (44.2%)	0.001
Female	38 (88.4%)	24 (55.8%)	
Education			
No formal education	0	9 (20.9%)	0.003
Elementary School	5 (11.6%)	11 (25.6%)	
Junior High	10 (23.3%)	8 (18.6%)	
Senior High	20 (46.5%)	11 (25.6%)	
Diploma	2 (4.7%)	0 (0.0%)	
Undergraduate	6 (14%)	4 (9.3%)	
Diabetes Mellitus	5 (11.6%)	5 (11.6%)	
Hypertension	9 (20.9%)	23 (53.5%)	0.002
Kidney disease	1 (2.3%)	1 (2.3%)	0.753
Coronary Artery Disease	3 (7.0%)	5 (11.6%)	0.356
Smoking	1 (2.3%)	11 (25.6%)	0.002

Table 2. Respondent's Heart Rate

Variable	Group 1 n = 43 (bpm)	Group 2 n=43 (bpm)	P value
Resting Heart Rate			0.677
Median	78	72	
Min – Max	60 - 96	60 -114	
Maximum Heart Rate			0.729
Median	108	90	
Min – Max	90 - 180	66 - 126	
1st-minute Heart Rate			0.212
Median	84	84	
Min – Max	60 - 108	60 - 108	
4th-minute Heart Rate			0.763
Median	78	78	
Min - Max	48 - 102	54 - 102	
1st minute HRR			0.001
Median	24	6	
HRR			0.001
Normal	37	12	
Abnormal	6	31	

Min. = Minimal; Max = Maximal; HRR = Heart Rate Recovery; normal HRR > 12bpm

returned to the resting heart rate, while group 2 was still higher than their resting heart rate. There was a significant difference in the median of HRR ($p=0.001$) since the median of 1st-minute HRR of group 1 was 24 bpm, whereas that of group 2 was 6 bpm. Group 1 had more respondents with normal HRR than group 2 group does ($p=0.001$).

Table 3 illustrated factors associated to abnormality of HRR, gender, smoking habit and duration of exercises significantly associated with abnormality of HRR. Further analysis using multivariate logistic regression in table 4 showed that unstandardized duration of exercise can lead 12 times more risk to have abnormality of HRR among elderly.

Discussion

This present study shows that the median of HRR of group 1 was 24 bpm. According to Cole et al., abnormal HRR refers to a decrease of <12 bpm from maximum heart rate at the first minute¹⁸ and ≤ 42 bpm at the second minute.²⁰ Thus, group 1's HRR is two times faster than Cole et al. 's definition of abnormal HRR.¹⁸ This proves that elders in group 1 have good physiological response of autonomic nerves to heart rate, this supported by

de Lima et al. who stated that routine exercise is an effective attempt to improve elders autonomic nervous function.⁵ Elders in group 1 perform the exercise at least three times a week, with 90 minutes per session for more than eight weeks (2 months). The exercise carried out by group 1 has met the recommended routine exercise for elders, i.e., aerobic exercise with medium intensity for 3-5 times/week and 150 minutes/week constantly for at least 8-12 weeks.^{16,15}

Group 2's HRR was 6 bpm, which is only half of abnormal HRR definition. This illustrated that group 2's autonomic nerves physiological response has decreased. The finding on group 2 is in line with theory stated by Wichi et al., that autonomic nervous function decreases along with aging.³ Autonomic change due to aging involves the decrease of parasympathetic function, obstructing the control toward heart rate.⁴

To date, there has been no study on four-minute post-exercise HRR that returns to pre-exercise resting heart rate. However, the present study shows that group 1's median of four-minute post-exercise heart rate returned exactly like their resting heart rate (78 bpm). While group 2's median of four-Minute post-exercise heart rate (78 bpm) is still higher than their resting heart rate (72 bpm). This might be associated

Table 3. Factors Associated with Abnormality of Elderly Heart Rate Recovery

Characteristics	Heart Rate Recovery		Chi Square	P value
	Abnormal	Normal		
Gender				
Female	21	41	7.503	0.008
Male	16	8		
Education				
Low	21	22	1.172	0.384
High	16	27		
Diabetes Mellitus				
Yes	4	6	0.042	0.838
No	33	43		
Hypertension				
Yes	15	17	0.305	0.581
No	22	32		
Kidney Disease				
Yes	0	2	1.528	0.216
No	37	47		
Coronary Artery Disease				
Yes	2	6	1.155	0.282
No	35	43		
Smoking				
Yes	10	2	9.137	0.003
No	27	47		
Routine Exercise				
Unstandardized	31	12	31.869	0.001
Standardized	6	37		

Table 4. Final Model on Factors Associated to Abnormality of Elderly Heart Rate Recovery

Characteristics	β	SE	P value	OR	CI
Gender	-.070	.754	0.926	.932	0.213 – 4.088
Smoking	1.211	1.074	0.259	3.358	0.409 – 27.576
Unstandardized Exercise	2.549	.578	0.001	12.793	4.117 – 39.753
Constanta	-3.032				

*Based on logistic regression. Model accuracy of 83.3%. β , regression coefficient; SE, standard error of β ; OR, odds ratio (exponential of β); CI, confidence interval of OR with 5% of error.

with physiological response of autonomic nerve to heart rate, which is affected by routine exercise.

The number of respondents in group 2 group with history of hypertension and smoking was greater than respondents in group 1. This data supports the study conducted by Cole et al. who found that individual with abnormal HRR tends to have history of hypertension, diabetes, smoking, and coronary artery disease, compared to an individual with normal HRR.²¹

Based on previous research done by Yu Y et al, lower HRR were found in hypertensive patients with uncontrolled blood pressure compared to patients with controlled blood pressure.²² Subsequently, the history of hypertension in group 2 which is two times larger affects the result of their HRR. Another study also stated that antihypertension drugs like beta blocker can impede HRR,^{23,24} given that beta blocker is known to have a significant impact to HRR due to its effect

on chronotropism. Both of the effect from history of uncontrolled hypertension and antihypertension drugs (beta blocker) toward the HRR of respondents in this research were not clearly explored, due to some limitations, data about the drug consumed by the respondents were not collected. Since the information regarding the use of beta blockers might serve as a confounding factor to HRR especially in elderly populations in whom a lot of them are consuming beta blockers secondary to the cardiovascular disorders. Therefore, this issue is recommended to be considered for the next research.

Besides, the majority of respondents in group 2 were only elementary school graduates ($p=0.003$). This educational background may affect their knowledge of basic exercise the elders should do. Based on the study conducted by Shishehbor et al, an abnormal post-exercise HRR was more common among adults who did not graduate from high school compared with those who attended at least some college.²⁵ Moreover, in this study gender, smoking and duration of exercise proven to have association with abnormality of HRR. Unstandardized duration of exercise which only 3 x 30 minutes in group 2 corroborate to 12 times higher risk to get HRR abnormality. This result confirm that routine exercise is not only about proper frequency, intensity and type of exercise but it is also important to take appropriate duration of exercise particularly for elderly.

The present study has some limitations during the study. During the data collection, the measurement of the respondent's heart rate was done manually without special tool which might affect the data accuracy.

Conclusion

The present study shows difference in post-exercise HRR between elderly who took standardized exercise and those who took unstandardized exercise. Elders who take longer exercise duration, the physiological response of autonomic nerve to heart rate would be better, resulting in faster HRR and can be categorized as normal. Abnormality of HRR may be affected by their history of hypertension and smoking habit. The study shows that longer exercise duration significantly affects HRR even though they have same frequency, intensity, and type of exercise. Based on this finding, it is suggested for elders to perform exercise with proper duration in

order to prevent lowering of parasympathetic nerves function.

Ethical Clearance

This study had approved by Research Ethics Committee, Universitas Padjadjaran no.774/UN6. KEP/EC/2019.

Publication approval

The publication of this article has been approved by every party.

Conflict of Interest

None.

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List of Abbreviations

bpm: beats per minute
 BPSTW: Balai Perlindungan Sosial Tresna Werdha
 CHD: coronary heart disease
 COPD: chronic obstructive pulmonary disease
 HR: heart rate
 Hrmax: maximum heart rate
 HRR: heart rate recovery
 Hrrest: resting heart rate
 KJS: Klub Jantung Sehat
 Unpad: Universitas Padjadjaran

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