The effect of moderate intensity aerobic exercise on blood pressure in hypertension patients

El efecto del ejercicio aeróbico de intensidad moderada sobre la presión arterial en pacientes con hipertensión

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Abstract

Aerobic exercise is an exercise that uses large muscle groups to contract at a light to moderate intensity for long periods. Moderate-intensity aerobic exercise is more effective at managing blood pressure compared to heavy and light-intensity aerobics. Regular exercise can lead to decreased autonomic nervous system activity and decreased systemic vascular resistance, which is most likely involved in the exercise-induced reduction in blood pressure. This review aimed to determine the effect of moderate-intensity aerobic exercise on blood pressure in patients with hypertension. It was analyzed the related literature obtained from the search results in the database of medical journals, PubMed-MEDLINE, Science Direct, and Google Scholar. Twenty articles in English articles were included, published in 2011-2021. There was a difference in results of 17 articles that stated a significant decrease in blood pressure after doing moderate-intensity aerobic exercise duration of 30 minutes, 3 times a week for 8-12 weeks of treadmill exercise. Three other articles stated that they did not find a change in blood pressure after doing aerobic exercise duration of 30 minutes, 2 times a week for less than 8 weeks. It can be concluded that these results depend on the duration, frequency, and type of aerobic exercise performed.

Keywords: moderate-intensity aerobic exercise, blood pressure, hypertension

Resumen

El ejercicio aeróbico es un ejercicio que utiliza grandes grupos de músculos para contraerse a una intensidad de ligera a moderada durante largos períodos de tiempo. El ejercicio aeróbico de intensidad moderada es más efectivo para controlar la presión arterial en comparación con los ejercicios aeróbicos de intensidad alta y baja. El ejercicio regular puede provocar una disminución de la actividad del sistema nervioso autónomo y una disminución de la resistencia vascular sistémica, lo que probablemente esté involucrado en la reducción de la presión arterial inducida por el ejercicio. El propósito de la revisión fue determinar el efecto del ejercicio aeróbico de intensidad moderada sobre la presión arterial en pacientes con hipertensión. Se analizó la literatura relacionada obtenida de los resultados de búsqueda en la base de datos de revistas médicas, PubMed-MEDLINE, Science Direct y Google Scholar. Se incluyeron 20 artículos en inglés y publicados en 2011-2021. Hubo una diferencia en los resultados de 17 artículos que indicaron una disminución significativa en la presión arterial después de hacer ejercicio aeróbico de intensidad moderada con una duración de 30 minutos, 3 veces por semana durante 8 a 12 semanas de ejercicio en cinta rodante. Otros tres artículos afirmaron que no lograron un cambio en la presión arterial después de hacer ejercicio aeróbico de 30 minutos de duración, 2 veces por semana durante menos de 8 semanas. Se puede concluir que estos resultados dependen de la duración, frecuencia y tipo de ejercicio aeróbico realizado.

Palabras clave: ejercicio aeróbico de intensidad moderada, presión arterial, hipertensión

Introduction

Hypertension is one of the major risk factors for cardiovascular morbidity and morbidity since high blood pressure can cause damage to microvascular and macrovascular organs. According to its etiology, hypertension is classified into two; primary or essential hypertension and secondary or essential hypertension [1,2].

About 7.5 million deaths or 12.8% of all deaths worldwide, occur due to high blood pressure. It is predicted to increase to 1.56 billion adults with hypertension by 2025. The prevalence of hypertension varies between countries around the world. According to the World Health Organization (WHO), the African region has the highest prevalence of hypertension (27%), while the Americas region has the lowest prevalence of hypertension (18%). In 1975 the number of adults with hypertension increased from 594 million to 1.13 billion, in 2015 with a significant increase in low- and middle-income countries. This increase was mainly due to an increase in the risk factors for hypertension in this population[3,4]. Basic Health Research Results Report (Laporan Hasil Riset Kesehatan Dasar (Riskesdas)) by the Indonesian Ministry of Health in 2018 stated that based on the results of measuring blood pressure in the population aged 18 years in Indonesia, it was 34.11%. The prevalence of hypertension in South Kalimantan in the population aged 18 years is 44.13%. In contrast, the prevalence of hypertension based on a doctor's diagnosis or taking antihypertensive drugs is 10.81% and is the 5th highest province after North Sulawesi, East Kalimantan, Gorontalo, and In Yogyakarta[5].

Hypertension can lead to an increased risk of cardiovascular disease and is the number one major risk factor for death. However, hypertension is also one of the most significant modifiable risk factors in preventing cardiovascular disease. Although pharmacological interventions are often used to reduce blood pressure, lifestyle modification is the first-line therapy suggested by some regulatory agencies. Lifestyle modification often emphasizes improving diet and exercise habits. The American College of Sports Medicine (ACSM), the American Heart Association, and others have provided exercise recommendations for adults with hypertension. However, most of these recommendations focus on aerobic exercise[6].

Exercise has minimal side effects compared to drugs. Several studies have shown that blood pressure decreases, and some are persistent after aerobic exercise. In hypertensive patients, a study7 showed that aerobic exercise could significantly reduce blood pressure, both systolic and diastolic blood pressure. In addition, the reduction in blood pressure differed significantly between the studies for all exercise durations (less than 8 weeks, 8-12 weeks, and more than 12 weeks), and aerobic exercise lasting about 8 weeks had a better antihypertensive effect[6,7].

Based on the description above, with the differences in the results from previous studies, we performed a literature review related to the effect of moderate-intensity aerobic exercise on blood pressure in patients with hypertension.

Methods

The method used in this literature review uses a comprehensive strategy; searches were carried out on the following electronic databases: NCBI, Pubmed-MEDLINE, and Science Direct, Google Scholar and the official website. The studies used were in English and Indonesian, published from 2011-2021. The keywords used to obtain accurate information were aerobic exercise, blood pressure, hypertension, moderate-intensity aerobic exercise.

Results

This article review evaluates the effect of moderate-intensity aerobic exercise on blood pressure in hypertensive patients. It summarizes and compares articles related to comparing blood pressure values after doing moderate-intensity aerobic exercise on the duration, frequency, type of exercise, and its mechanism (Table 1).

Table 1. Literature related to the Effect of Moderate Intensity Aerobic Exercise on Blood Pressure

No.	Author and research title	Research sample	Research methods	Outcome
1.	Dimeo et al.[8] Aerobic exercise reduces blood pressure resistant hypertension	Have 50 samples aged 42-78 years. 14 people took 3 antihypertensive drugs and uncontrolled hypertension, 36 samples took 4 hypertension drugs. The intervention group was 24 samples and the control group was 26 samples	Randomized controlled trial	It was found that the intervention group experienced a significant decrease in ABP (ambulatory blood pressure) systolic and diastolic after 24 hours of exercise by 5.4±12.2 (P=0.03) and 2.8±5.9 mm Hg (P=0.01)
2.	Pagonas et al.[9] The impact of aerobic exercise on blood pressure variability	Have 72 samples aged 42-77 years with hypertension. Not currently taking hypertension medication or blood pressure of 140/90 mmHg. Divided into two groups. The intervention group and control group each consisted of 36 samples	Randomized controlled trial	There was a significant decrease in systolic and diastolic ABP during the day (P < 0.001 and P = 0.04. However, at night there was no significant change in systolic and diastolic (P = 0.21 and P = 0.69)
3.	Shaphe et al.[10] Effect of aerobic exercises on blood pressure in mild and moderate hypertensive middle-aged and older patients	Have 40 samples aged 35-51 years with prehypertension and stage 1 hypertension. The samples were divided into two groups. Group A for pre-hypertension and group B for stage 1 hypertension	Pretest and posttest design	It was found that systolic blood pressure decreased by 3 mmHg (P<=0.001) in group A and systolic blood pressure decreased by 21 mmHg (P<=0.001) in group B
4.	Gunjal et al. [11] Effect of aerobic interval training on blood pressure and myocardial function in hypertensive patients	Have 30 samples aged <65 years with stage 1 and stage 2 essential hypertension. Aerobic exercise was carried out in the laboratory 3 times a week for 12 weeks	Experimental pre and post-study	There was a decrease in systolic blood pressure of 12 mmHg (P<0.001) and diastolic blood pressure of 8 mmHg
5.	Navan et al.[12] The effect of aerobic exercises on cardiovascular risk-taking factors in hypertension men	Have 20 samples aged 40-60 years. Divided into two groups, intervention and control each contained 10 samples. The intervention group did aerobic exercise 3 times a week with 35 minutes per session for 8 weeks	Half experimental pretest and posttest	There was a decrease in systolic and diastolic blood pressure in the intervention group. Pretest systolic blood pressure 152.8 mmHg to 137 mmHg and pretest diastolic blood pressure 87.9 mmHg to 82.1 mmHg
6.	Maruf et al.[13] Effects of aerobic exercise and drug therapy on blood pressure and antihypertensive drugs: a randomized controlled trial	Have 63 samples aged 18-65 years with essential hypertension. The intervention group performed aerobic dancing and drug therapy and the control group was treated with hydrochlorothiazide + amiloride, hydrochloride, and amlodipine drug therapy	A randomized controlled trial	It was found that after controlling for several covariates, there was no significant change in systolic blood pressure (P=0.064) and diastolic blood pressure (P=0.106) between the two groups
7.	Bashiri[14] the effect of regular aerobic exercise and garlic supplementation on lipid profile and blood pressure in inactive subjects	Have 44 samples of adolescents aged 20-30 years. Divided into 4 groups, namely, the exercise + garlic group, the garlic group, the exercise and placebo group, and the placebo group.	Semi experimental	There was a significant decrease in systolic and diastolic blood pressure in the exercise and garlic groups. After 4 weeks of intervention, the exercise and garlic groups showed a significant reduction in systolic blood pressure (P = 0.01)
8.	Ammar[15] Effects of aerobic exercise on blood pressure and lipids in overweight hypertensive postmenopausal women	Have 45 samples of postmenopausal hypertensive women with overweight aged 49-60 years. Group A with hypertension medication for 3 months, group B with hypertension medication and aerobic exercise in the morning, and group C with hypertension medication and aerobic exercise in the afternoon	A randomized trial	There was a decrease in systolic and diastolic blood pressure in all groups. At the post-treatment there was a significant difference in the average value of systolic and diastolic blood pressure of the three groups (P=0.001)
9.	Swati et al.[16] Effects of aerobic versus resistance training on blood pressure in hypertensive patients	Have 30 samples aged <65 years with stage 1 and stage 2 hypertension. Group A (aerobic exercise) and group B (resistance exercise) each contained 12 samples.	Experimental study design	A more significant decrease in systolic blood pressure was found in group A at the end of the 6th week than in group B. The decrease was more significant in group A at the end of the 6th week compared to group B (P=≤0.025)
10.	Abdullah et al.[2] The effectiveness of aerobic exercises at different intensities of managing blood pressure in essential hypertensive information technology officers	Have 45 samples of men with essential hypertension. Age 35-45 years with BMI less than 30 Kg/m2 and blood pressure between 130/85 mmHg and 159/99 mmHg. Divided into 3 groups A, B, C with 15 people in each group. Aerobic exercise is brisk walking using a treadmill for 45 minutes/day 4 times a week for 4 weeks	Non-probability convenience sampling	Group A obtained systolic pressure of 140.0 mmHg to 133.6 mmHg and diastolic pressure of 90.0 mmHg to 84.1 mmHg. Group B systolic pressure was 140.1 mmHg at 127.7 mmHg and diastolic pressure was 89.53 mmHg at 81.27 mmHg. Group C systolic pressure was 140.2 mmHg to 134.5 mmHg and diastolic pressure was 89.67 mmHg at 86.67 mmHg
11.	Masroor et al.[17] Heart rate variability following combined aerobic and resistance training in sedentary hypertensive women: a randomized control trial	Have 38 samples of women aged 30-50 years with stage 1 and stage 2 hypertension. The combined aerobic and resistance training (CART) group performed 5 times a week for 4 weeks and the control group who followed conventional treatment without exercise intervention	A single-blinded study with a two-arm comparative pretest-posttest design	There was a significant decrease in systolic blood pressure from 141 mmHg to 122 mmHg and diastolic from 84 mmHg to 77 mmHg in the CART group. In the control group, there was no difference in systolic blood pressure at pretest and posttest, which was 149 mmHg and diastolic blood pressure from 85 mmHg to 86 mmHg

12.	Ramos et al. [18] Moderate aerobic training decreases blood pressure but no other cardiovascular risk factors in hypertensive overweight/obese elderly patients	Have 24 samples of elderly aged 60 years, hypertension, samples consuming beta-blockers. The sample was divided into 2 groups. The intervention group and control group consisted of 10 women and 2 men, respectively	Random sample	Measurements were taken before and after 12 weeks of treatment. The intervention group experienced a decrease in diastolic blood pressure of -10.1 ± 3.3 mmHg and there was no change in systolic blood pressure. The control group had no significant changes in systolic and diastolic blood pressure
13.	Belozo et al.[19] Effects of ninety minutes per week of continuous aerobic exercise on blood pressure in hypertensive obese humans	Have 7 samples (4 women and 3 men), 45 years old, BMI 33,44 kg/m2. Exercises were performed 3 times a week every 48 hours for 8 weeks with 24 sessions. Each training session consists of a 30-minute walk	Pretest and posttest design	There was a significant increase in heart rate between systolic pressure (R=0.5675) and diastolic pressure (R=0.7083) from the previous value. There was no difference (P<0.2949 for systolic pressure) and (P<0.2621 for diastolic pressure)
14.	Baghaiee et al.[20] Effects of a 12-week aerobic exercise on markers of hypertension in men	Have 40 samples were 37 years old with primary hypertension. The intervention group was 20 samples and the control group was 20 samples. The intervention group did 12 weeks of aerobic exercise	Semi experimental	There was a decrease in systolic and diastolic blood pressure in the intervention group at week 12 (P=0.031 and 0.023). The control group increased at week 12 (P=0.032 and 0.048)
15.	Hong et al. [21] Effect of aerobic exercise on blood pressure and arterial compliance in patients with essential hypertension	Have 14 samples aged 45-55 years with essential hypertension. The intervention group and control group each containing 7 samples	Experimental	There was a significant decrease in the intervention group. Systolic and diastolic blood pressure (P<0.05). The control group also experienced a decrease in both systolic and diastolic blood pressure, but there was a statistically significant difference
16.	Schroeder et al.[3] Comparative effectiveness of aerobic, resistance, and combined training on cardiovascular disease risk factors: A randomized controlled trial	Have 69 samples aged 45-74 years, hypertension without taking antihypertensive drugs, obese or overweight, did not participate in aerobic exercise or resistance during the last 3 months. The group was divided into a control group, an aerobic exercise group, a resistance training group, and a combination of aerobic and resistance training	Pretest and posttest design	Obtained after 8 weeks of exercise, the combination group decreased peripheral and central diastolic blood pressure by -4 mmHg and -4 mmHg. However, the aerobic and combination groups showed a decrease in resting heart rate of -2 bpm which was significantly different from the control group (p<0.02)
17.	Perdomo et al.[22] Acute effects of aerobic exercise duration on blood pressure, pulse wave velocity, and cerebral blood flow velocity in middleaged adults	Have 15 samples aged 35-59 years. Conducted in 3 acute experimental sessions: 10 minutes, 30 minutes, and sitting control (SIT). Blood pressure checks were carried out 30 and 60 minutes after each session. At the initial visit, participants were familiarized with the treadmill and underwent workload estimation	Randomized crossover study	It was found that diastolic blood pressure at 30 minutes post-session did not experience a difference in the 10-minute session, but there was an increase in the 60-minute post-session 10-minute session, while at 30 minutes post-session it decreased in the 30-minute session and decreased at 60 minutes. post-session session 30 minutes
18.	Honda et al.[23] Effect of moderate-intensity seated exercise on the management of metabolic outcomes in hypertensive individuals with or without exercise habits	Have 42 samples aged 50-75 years with hypertension. Divided into 3 groups. Moderate-intensity aerobic exercise 30 minutes/day for 2 days/week or no exercise (None). 30 minutes/day of moderate intensity aerobic exercise for 2 days/week at home (Home). 30 minutes/day of moderate-intensity aerobic exercise 2 days/week in a hospital gym (Gym)	A prospective study	The systolic blood pressure was recorded (p < 0.05) and the Nongroup had a higher systolic blood pressure than the gym group (p < 0.01)
19.	Liang et al.[24] Promotion of aerobic exercise-induced angiogenesis is associated with a decline in blood pressure in hypertension	Have 141 samples aged 19-40 years. The sample was divided into an intervention group of 75 samples and a control group of 66 samples. Aerobic exercise was performed 5 times a week for 12 weeks using a moderate-intensity cycle ergometer	Randomized controlled trial	There was a significant decrease in the intervention group (P=, 0.001). In the control group obtained (P=0.25)
20.	Barros et al.[25] The effects of acute aerobic exercise on blood pressure, arterial function, and heart rate variability in men living with HIV	Have 25 samples. 12 samples of men with HIV aged 48 years and 13 men without HIV/AIDS as a control group aged 41 years	Pretest and posttest design	There was no difference between sessions for systolic blood pressure, except for controls which showed lower values 2 hours after exercise and non-exercise sessions (P=0.03). In the control group, diastolic blood pressure was lower after 20 minutes (P<0.01), 30 minutes (P=0.01), and 70 minutes (P<0.01)

Based on the 20 articles reviewed the results indicate that 17 articles show a decrease in blood pressure and three articles show no change. These results are dependent on the duration, frequency, and type of aerobic exercise.

In the studies of Dimeo et al., Shaphe et al., Gunjal et al., Ammar et al., Hong et al., and Liang et al., it is showed that there was a significant decrease in systolic and diastolic blood pressure after moderate-intensity aerobic exercise such as a treadmill performed 3 to 5 times a week with a duration of each exercise of 30 to 60 minutes. Many factors can affect blood pressure such as age, diet, excessive alcohol consumption, lack of exercise, obesity, sleep apnea, and stress[1,2,8,10,11,15,21,24]. Aerobic exercise causes significant reductions in blood pressure in prehypertension and essential hypertension by decreasing arterial stiffness in individuals[16]. The rate of exercise-induced reduction in blood pressure varies widely from study to study, ranging from 5 to 15 mmHg[8,21].

Light, moderate, and vigorous-intensity aerobic exercise effectively manages blood pressure. However, moderate-intensity aerobic exercise was more effective for managing blood pressure than both high-intensity and light aerobic exercise[2,17]. In addition, studies have shown that 30 minutes of intense exercise more than 3 times a week can help treat systemic hypertension[19]. One of the mechanisms in the reduction in systolic blood pressure during exercise is associated with an increase in functional sympatholysis. Sympathetic vasoconstriction during exercise is attenuated in contracting muscles by vascular endothelial-derived factors such as nitric oxide (NO). However, vascular endothelial function declines with age leading to decreased functional sympatholysis in older individuals with a sedentary lifestyle[24].

Bashiri's research explains that the mechanism of lowering blood pressure from regular exercise such as a treadmill is due to a decrease in autonomic nervous system activity and a decrease in systemic vascular resistance. In addition, a decrease in the sympathetic nervous system will also affect the kidneys, which is the most powerful factor in long-term blood pressure regulation. The renin-angiotensin system regulates blood pressure through a direct effect on the smooth muscles of arteriolar blood vessels, resulting in vasoconstriction and can also cause an increase in blood volume through the process of increasing water intake and sodium and water retention in the distal renal tubules[14].

The studies of Swati et al.[16] and Masroor et al.[17] showed a decrease in systolic and diastolic blood pressure after doing aerobic exercise and resistance training performed 3 times a week with an exercise duration of 4 to 6 weeks. The effects of aerobic and resistance exercise on blood pressure are different because they have different mechanical characteristics. If aerobic exercise is done with large muscle groups contracting, then resistance training, also called weight training or strength training, is characterized by the execution of exercises in which the muscles of certain body segments resist forces opposing the movement. Short-duration aerobic exercise on resting blood pressure and heart rate in pre-hypertension and stage 1 hypertension-induced greater improvements in cardiorespiratory fitness and cardio-metabolic variables[3,17]. the study of Schroeder et al. showed no change in blood pressure after doing aerobic exercise and resistance training or a combination with the duration of each exercise was 60 minutes for 9 weeks because most exercise interventions resulted in a reduction in blood pressure for at least 12 weeks[3].

Perdomo et al. study showed a decrease in systolic and diastolic blood pressure after doing moderate-intensity aerobic exercise using a treadmill and 30 minutes of workload. This indicates that intermittent 10 minutes of exercise is not as effective as 30 minutes of continuous exercise in improving cardiorespiratory fitness. The shorter duration of shear stress-induced nitric oxide release for 10 min of exercise may not be sufficient to counteract the sympathetically induced vasoconstriction and possibly due to the difference in timing of exercise initiation[22].

Meanwhile, in a study conducted by Ramos et al.[18,] the decrease only occurred in diastolic blood pressure. A study conducted for 12 weeks of moderate-intensity aerobic exercise reduced diastolic blood pressure in elderly subjects with overweight/obese hypertension without additional effects on body composition and biochemical parameters. Obesity can cause increased sodium retention, the activity of the cardiac sympathetic system, and the renin-angiotensin-aldosterone system, which can increase blood pressure values. Important biochemical and body composition changes will occur with a combination of exercise and nutritional intervention, while exercise alone can limit improvement.

As for the research of Navan et al.[12], Baghaiee et al.[20], and Honda et al.[23] showed a decrease in systolic and diastolic blood pressure after doing aerobic exercise. Untrained individuals have lower physiological responses to the same intensity of exercise, such as energy expenditure and fat oxidation, than trained individuals. Its development is caused by many factors, but the most important are impaired endothelial and renin-angiotensin function and hyperactivity in the sympathetic nervous system. Decrease in blood pressure arising from aerobic exercise to reduce the sympathetic force and increase the parasympathetic force, to reduce the production of catecholamines in exercise results[12].

Pagonas et al. showed no change in blood pressure variability after doing aerobic exercise. Aerobic exercise effectively lowers blood pressure but is not effective in reducing blood pressure variability[9]. Meanwhile, Maruf et al., Belozo et al., and Barros et al. showed that there was no change in systolic and diastolic blood pressure after moderate-intensity aerobic exercise. Individuals who exercised alone did not have significant changes in blood pressure compared to taking antihypertensive drugs in combination with exercise. Significant reductions in blood

pressure over a shorter period are associated with the involvement of antihypertensive drug therapy that can accelerate blood pressure reduction. However, neither group completed the 12-week intervention period, thus affecting the overall outcome[13,19,25].

The mechanism of the effect of aerobic exercise is the same as that of beta-blockers reducing blood pressure by attenuating the sympathetic nerves activity and reducing the heart rate[8]. During exercise, vascular smooth muscle (myogenic tone) and muscle afferent fibers reset blood pressure to higher levels. When exercise is stopped, decreased sympathetic activity resets the baroreflex to a lower level[24]. Aerobic exercise restores decreased peripheral vascular resistance and vascular elasticity. Thus, changes in the elasticity of blood vessels after aerobic exercise amplify the increase in vascular pressure and expansion of blood vessels due to the higher blood flow rate during aerobic exercise[25-28].

According to the ACSM (American College of Sports Medicine) guidelines, aerobic exercise depends on the duration, intensity, and frequency of the work interval and the length of the recovery interval. The recommended duration is at least 30 minutes of moderate-intensity physical activity 5 days a week and 20 minutes of vigorous activity 3 days a week.

Conclusions

Based on this literature review, it was found that aerobic exercise carried out with the right duration can have a positive effect, namely a duration of more than 30 minutes with a frequency of 3 times per week for 8-12 weeks with an intensity range of 50-70%, namely moderate intensity like a treadmill. Then the use of antihypertensive drugs will affect the value of blood pressure. Obesity can also cause increased sodium retention, the activity of the cardiac sympathetic system, and renin-angiotensin-aldosterone, which can increase blood pressure values.

Further research is needed on the effect of moderate-intensity aerobic exercise on blood pressure because there are differences between the results of the articles used in this literature review to be able to strengthen the hypotheses proposed by each researcher.

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