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The effect of exercise on the reduction of blood pressure among elderly with hypertension: a systematic literature review

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ABSTRACT

Elderly is a person who enters a period of achievement level of maturity that has shown deterioration, aged 60 years and older. This group which is categorized as elderly is experiencing an aging process which is marked by a decline in the body systems. Cardiovascular disease is responsible for more mortality, especially in people over 60 years of age with a history of hypertension. This study used a literature review method. A systematic search strategy was carried out by accessing the NCBI Pubmed, Elsevier, and PedRo databases online using the keywords "exercise", "hypertension" and "elderly". Based on the result of the search for articles that have been carried out, there were 90 articles. Nine articles that fit the inclusion and exclusion criteria were analyzed and all of them showed impact of exercise on reduction of blood pressure. Aerobic exercise, resistance exercise, breathing exercise and exercise in water affect the reduction of blood pressure in hypertensive elderly. Further studies are needed to determine the effectiveness of these exercises in reducing blood pressure in elderly people with hypertension.

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1. INTRODUCTION

Elderly is a person who enters a period of achievement level of maturity that has shown deterioration, aged 60 years and older [1]. This group which is categorized as elderly is experiencing an aging process which is marked by a decline in the body systems. The age limit for the elderly according to the World Health Organization (WHO) includes: i) middle age is the age group 45 to 59 years; ii) elderly between 60 and 74 years; iii) late elderly between 75 to 90 years and very old above the age of 90 years [2], [3]. Meanwhile, geriatrics is elderly people who suffer from illness more than two diseases, which can be caused by biopsychosocial factors, so it requires an assessment with a holistic viewpoint. Biopsychosocial viewpoint including musculoskeletal, neuromuscular, cardiovascular, respiration and integument aspects [4].

Based on data from the United Nations (UN) on World Population Aging, it is estimated that in 2015 there were 901 million elderly people in the world. This number is projected to continue to increase to reach two billion people in 2050 [2], [5]. Indonesia is also experiencing an aging population. The number of Indonesia's elderly population in 2019 is projected to increase to 27.5 million or 10.3%, 2020 (27.08 million), 2025 (33.69 million), 2030 (40.95 million), 2035 (48.19 million) and 57.0 million people or 17.9% in 2045 [2], [5]. Cardiovascular disease is the leading cause of morbidity and mortality worldwide. The World Health Organization (WHO) estimates that deaths from this disease are up to three

times higher in low- and middle-income countries than in high-income countries. Cardiovascular disease is responsible for more mortality, especially in people over 60 years of age with a history of hypertension [6].

The Institute for Health Metrics and Evaluation stated about the risk factors for premature death and disability in the world based on the disability adjusted life years (DAILYs) figures for all age groups. Based on these data, there are three highest risk factors for men are smoking, an increase in systolic blood pressure, and an increase in sugar levels, while the risk factors for women are an increase in systolic blood pressure, an increase in blood sugar levels and a high body mass index (BMI) [7]. Another study showed that 37% of premature deaths in low-middle-income countries were due to cardiovascular disease such as ischemic heart disease and stroke. About 90% of deaths from non-communicable diseases are caused by ischemic heart disease and stroke. This disease is closely related to risk factors for smoking, consumption of opium and high blood pressure [8].

According to WHO data in 2015, there are around 1.13 billion people in the world suffering from hypertension, each one of three people in the world is diagnosed with hypertension. It is estimated that in 2025 there will be an increase in the hypertension rate by 1.5 billion people who are affected by hypertension and there will be an increase every year around 10.44 million people die from hypertension and complications. In 2018, Indonesia experienced an increase in hypertension rate, which increased from 25.8% to 34.1% [9].

Pharmacotherapy is one of the most effective treatments with minimal side effects, but increases the cost of health care. Several studies and international guidelines currently recommend non-pharmacological methods for the treatment of hypertension [10], [11]. Non-pharmacological method include controlling a healthy diet through increasing potassium as well as calcium intake, smoking cessation, increasing physical activity and reducing anxiety and fear [8], [11]–[13]. A meta-analysis research conducted by Wen and Wang recommend that some form of physical activity can be an additional therapy in the management of cardiovascular disease, especially in hypertensive condition. The recommended exercise program for blood pressure management in the elderly is dynamic resistance aerobic exercise [14]. Recent study has shown that isometric resistance training (IRT) can lead to a greater reduction in blood pressure than with aerobic exercise and dynamic resistance [12]. Several studies suggest aerobic and resistance exercise for the prevention and treatment of hypertension [15]–[17]. Moderate intensity aerobic exercise such as walking, jogging, cycling, yoga and swimming for 30 minutes for 5-7 days per week can reduce blood pressure [13].

Several studies have shown an effect of acute hypotension after physical exercise and the mechanism of change so that currently there is no effective and consistent argument about the effect of changes in various components of training load (intensity, duration, rest interval, type of exercise, and exercise method) [18]. A study explain that the form of physical activity or exercise recommended as a lifestyle therapy for hypertensive patients is arranged individually to meet the component principles of frequency, intensity, time, and type (FITT) [19]. The aim of this systematic review was to examine the effect of certain types of exercise on reducing blood pressure in the elderly with hypertension.

2. RESEARCH METHOD

This study employed a literature review method. This study used secondary data obtained from the results of previous studies related to the elderly, physical activity, blood pressure, and hypertension. This study used preferred reporting items for systematic reviews and meta-analysis (PRISMA) method which was carried out systematically by following the study protocols. The data is obtained through online search of international scientific journals. A systematic search strategy was carried out by accessing the NCBI Pubmed, Elsevier, and PedRo databases online. A systematic search for journals in the database was carried out using the keywords "exercise", "hypertension" and "elderly".

The study design for this systematic review was limited on published experimental study. It aimed to determine the effect of exercises on elderly with hypertension who met the inclusion and exclusion criteria. The inclusion criteria were: i) research respondent are elderly (age>60 years) with hypertension; ii) experimental study with the provision of physical activity or exercise without being combined with pharmacological therapy; and iii) articles were limited by journal publication years from 2015-2020. The exclusion criteria were a history of comorbidities and a study with more than one intervention. Article was examined using the critical appraisal instrument. It was summarized in a table consisting of title, year, author name, sample, study design and study result.

3. RESULTS AND DISCUSSION

Initial database search yielded 90 articles, PubMed (84) dan Pedro (6). Following duplicate removal (15 articles) and initial screening by title or abstract, a full text review was performed on 15 articles, which six articles did not meet the inclusion criteria. The final analysis was conducted for nine studies. Diagram of

systematic review proces is shown in the PRISMA flow chart as presented Figure 1. The articles were summarized in the data extraction as shown in Table 1.

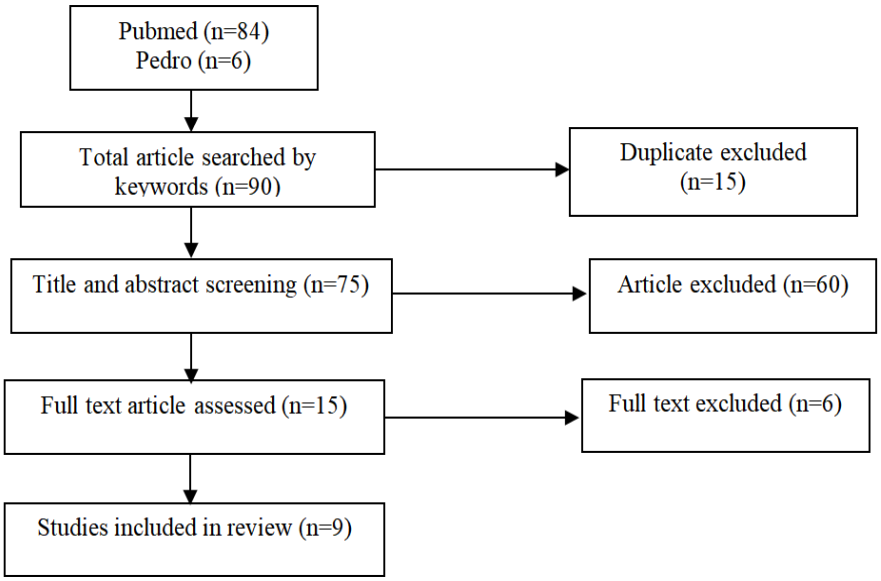

Figure 1. PRISMA flow diagram of systematic review process

Table 1. Summary of research articles on the effect of exercise on hypertension.

Author	Year	Purpose of study	Method	Subject	Result
[20]	2019	To determine the effect of a combination of endurance exercise and strengthening exercise on lowering blood pressure	Randomized control trial	54 hypertensive elderly	Decrease in systolic blood pressure in the endurance training group ($p<0.005$) and the combination of endurance and strength training ($p<0.01$)
[21]	2018	To determine the effect of yoga breathing exercise on lowering blood pressure	Randomized control clinical trial	83 hypertensive elderly	Decrease in blood pressure ≥5 mmHg ($p<0.01$)
[22]	2017	To determine the effect of water based ergonomic and land based ergometric exercise on reducing blood pressure	Experimental	45 hypertensive elderly women	Water based exercise was effective in reducing blood pressure ($p<0.05$)
[23]	2017	To determine the effect of slow-loaded breathing exercise on reducing blood pressure	Randomized control trial	20 hypertensive elderly	Slow-loaded breathing exercise has an effect on reducing resting blood pressure ($p=0.004$) and decreasing blood pressure response during exercise ($p=0.002$)
[24]	2018	To determine effect of brisk walking training on reducing blood pressure	Randomized control trial	46 hypertensive elderly	Brisk walking training can lower blood pressure during exercise ($p=0.035$)
[25]	2016	To determine the effect of a combination of resistance exercise and aerobic exercise on lowering blood pressure	Randomized control trial	20 hypertensive elderly women	The combination of resistance and aerobic exercise can lower blood pressure
[26]	2019	To determine the effectiveness of heated water-based exercise in reducing blood pressure	Randomized control trial	15 hypertensive elderly	Heated water-based exercise is effective at lowering blood pressure
[27]	2020	To determine the effectiveness of physical activity in elderly at risk of hypertension	Experimental	106 hypertensive elderly	Heart rate was significantly associated with physical activity and blood pressure decreased with physical activity
[28]	2015	To determine the effectiveness of abdominal breathing exercises in reducing blood pressure	Quasi experimental	30 hypertensive elderly	A significant relationship between abdominal breathing exercises and a decrease in blood pressure

3.1. Impact of endurance and strengthening exercise on blood pressure

Ruangthai dan Phoemsapthawee [20] conducted a study to determine the effect of a combination of endurance exercise and strengthening exercise on 54 hypertensive elderly respondents. The study was conducted by dividing the subjects into three groups, the endurance training group, strengthening group and a combination of endurance and srengthening. The result showed a decrease in systolic blood pressure of 10.6 mmHg (7.9%) in the endurance training group ($p<0.005$) and 8.2% in the combination group of endurance and strength training ($p<0.01$).

Mechanisms underlying the antihypertensive effect of endurance training and the combination of endurance and strength training are associated with increased secretion of endothelial vasodilator substances. Endurance training and combination of endurance and strength training may increase nitric oxide (NO) secretion, which results in increased vasorelaxation of endothelium in subject with hypertension. Exercise-induced endothelial adaptation and increased endothelial relaxation are primarily mediated by a significant increase in NO production and or decreased NO breakdown by reactive oxygen species (ROS) [29], [30]. Overall, the results of this study indicate that the effect of aerobic exercise in the endurance training group and the combination of endurance and strength training resulted in an increase of plasma NOx concentrations which resulted in a decrease in blood pressure[20].

3.2. Impact of water-based exercise on blood pressure

Bocalini *et al*. [22] conducted a study to determine the effect of water-ergometry and land-ergometry on reducing blood pressure in 45 hypertensive elderly. The results showed that the decrease in blood pressure in the underwater exercise group was greater than that in the land exercise group. Subjects in water-based exercise experienced a decrease in blood pressure by 10% ($p<0.05$) in the uncontrolled hypertension group and 26% ($p<0.05$) in the controlled hypertension group. Subjects who exercised on land experienced a decrease in blood pressure by 4% ($p<0.05$) in the uncontrolled hypertension group and 18% ($p<0.05$) in the controlled hypertension group [22]. A similar study was conducted by Ngomane *et al.* on 15 hypertensive elderly people by providing interventions in the form of moderate intensity exercise in water and walking exercises on a treadmill. The results showed a decrease in resting systolic blood pressure by 3.1 mmHg ($p<0.01$) 45 minutes after exercise in water and systolic and diastolic blood pressure 24 hours after exercise ($p<0.05$) which was lower than the exercise group on the treadmill [26].

The mechanisms associated with a decrease in post-exercise blood pressure are associated with decreased sympathetic activity, changes in renin and angiotensin release as a result of decreased catecholamine synthesis, peripheral vascular resistance and the synthesis of vasopressin and endothelin [22], [26], [31]. Mechanism which exercise increases vagus activity is still not clear. Potential mediators associated with this mechanism are angiotensin II and nitric oxide (NO), both of which play a role in the mechanism of decreasing blood pressure after exercise. Angiotensin II, which is known to inhibit cardiac vagal tone, is suppressed during exercise and after exercise [22]. Other factors such as decreased volemia, renin, angiotensin II and adosterone levels and increased atrial natriuretic peptide were also associated with decreased blood pressure during exercise in water [32], [33]. These factors make the decrease in blood pressure more significant after performed water exercises in the elderly with hypertension [22], [26].

The temperature of the water used for exercise also plays a role in the mechanism of lowering blood pressure. Significant changes in hemodynamics were found in several immersion conditions with different water temperatures. Decreases in blood pressure and heart rate occur when hydrostatic pressure increases venous return blood flow and blood volume, causing decreased peripheral resistance and changes in autonomic response. This also affects the decrease in heart rate by the baroreceptor feedback mechanism. The Aquatic Exercise Association recommends the optimal temperature used for exercise in water, at an ambient temperature of 30 ± 1 °C [34], [35].

3.3. Impact of breathing exercise on blood pressure

A study conducted by Jones *et al.* determined the effect of slow-loaded breathing training on 20 hypertensive elderly. The study was conducted using a randomized control trial method by dividing 20 respondents aged 60-74 years into two groups, a control group and a treatment group. The treatment group received intervention in the form of slow breathing exercises against the inspiratory resistance of 18 cmH_2O for eight weeks. The results showed that there was a decrease in resting systolic blood pressure by 10.6 mmHg (95% CI, -16 to -5 mmHg, p=0.004) and there was no change in the control group. Another result showed that there was an increase in systolic blood pressure during activity decreased by 12.6 mmHg (95% CI, -6.9 to -18.2 mmHg, p=0.002) [23]. Another study that is in line with previous study is the study of Misra *et al*. [21]. The results from this study showed that there was an effect of yoga breathing exercise with duration of 15 minutes five times per week for one month on lowering blood pressure. This exercise has the effect of reducing systolic blood pressure by ≥5 mmHg [21].

Relaxation techniques and breathing exercises are effective in lowering blood pressure. Types of exercise such as yoga, deep breathing exercises and progressive muscle relaxation can reduce blood pressure in hypertension conditions [36]–[39]. The increase in blood pressure fluctuation that occur during slow breathing exercise increases baroreceptor activity, if this occurs continuously over a period of eight weeks would result in central modification of the autonomic control of blood pressure. Although baroreceptors are generally thought to be associated only with short-term blood pressure regulation, it has been found that they are also an important part of an integrated control system involving the renin-angiotension and Na excretion systems in the kidneys. This relates to changes in renin as a result of certain exercises [23], [40], [41]. Deep and slow breathing exercises, especially with longer exhalations, can decrease sympathetic nerve activity, causing arteriolar dilatation. This mechanism is initiated by activation of the pulmonary mechanoreceptors that respond to the increase in tidal volume that accompanies slow breathing. This mechanism works in conjunction with cardiac mechanoreceptors to inhibit sympathetic outflow [36], [41].

3.4. Impact of aerobic exercise on blood pressure

Study on 46 hypertensive elderly to determine the effect of brisk walking exercise on reducing blood pressure. The results showed that resting systolic blood pressure decreased by 8.3 mmHg (p=0.035), during low-intensity exercise decreased by 15.6 mmHg (p=0.001) and during high-intensity exercise decreased by 22.6 mmHg (p=0.001) after 12 weeks of exercise [24]. Son *et al*. [25] conducted a study on postmenopausal women with hypertension to determine the effect of a combination of resistance exercise and aerobic exercise on reducing blood pressure. The results showed a decrease in systolic blood pressure by 12 mmHg and diastolic blood pressure by 9 mmHg after a combination of resistance and aerobic exercise. Other studies have shown that brisk walking exercise can reduce systolic blood pressure in a sedentary population group. Effective steps range from 4,000 to <8,000 steps per day and brisk walking (100-150 steps/minute) has the ideal effect of decreasing systolic blood pressure [43] [42].

Aerobic exercise affects the secretion of vasodilating substances such as NO, prostacyclin 2 (PG12), endorphin and endothelium-derived hyperpolarization factors which can shed the factors that cause arterial [43]-[46]. Aerobic forms of exercise such as brisk walking can decrease vagus sympathetic activity, which can reduce peripheral resistance. Regular physical activity can lower norepinephrine level and affect the decrease in resting blood pressure. Regular physical activity also affects the release of vasodilator substances such as endorphins and reduces insulin resistance [24], [41]. A decrease in blood pressure and arterial stiffness after 12 weeks of exercise occurred as an effect of decreased sympathetic activity and stimulated an increase in parasympathetic [25]. To maintain blood pressure during exercise, the heart must pump out more blood. Exercise with a higher intensity puts greater stress on the cardiovascular system and increases cardiac output. This causes an adaptive change in the structure of the heart known as ventricular hypertrophy. Exercise that is done for certain duration also affects the work of the sympathetic nervous system. Excitability of the sympathetic nervous system increases adaptively due to exercise [38], [47]. This study aimed to collect evidence on to the impact of certain exercises on reducing blood pressure in the elderly with hypertension. Notable limitations from the study where we only selected English based articles; this means that our scope of review is limited.

4. CONCLUSION

Our findings showed that aerobic exercise, resistance exercise, breathing exercise and exercise in water can reduce blood pressure in the hypertensive elderly. We recommended exercise as a part of non-pharmacological treatment of hypertension in elderly. Further studies are needed to determine the most effective type of exercise to reduce blood pressure in hypertensive elderly.

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