PHYSICAL ACTIVITY TO LOWER BLOOD PRESSURE IN HYPERTENSIVE ELDERLY: AN INTEGRATIVE REVIEW

Demitrius Liklao Sikone [1], Erfina [2], Saskiah Putri Dyiniati [3]

[1]Student of the Master of Nursing Science Program at Hasanuddin University, Indonesia
[2]Lecturer of the Master of Nursing Science Program at Hasanuddin University, Indonesia
[3]Student of the Master of Nursing Science Program at Hasanuddin University, Indonesia

**Correspondence Author: riussikone@gmail.com*

Abstract

Background: Hypertension is a hazardous cardiovascular disease with a high risk of causing fatal conditions such as stroke, dementia, and various heart diseases. The prevalence of hypertension doubled from 650 million to 13 billion between 1990 and 2019, necessitating effective management strategies. **Objective:** This integrative review aims to systematically evaluate the impact of the frequency, intensity, type, and duration of physical activity on blood pressure among elderly individuals with hypertension. **Methods:** This review involves a literature search in five databases (PubMed, Proquest, Cinahl, Scopus, and Garuda) using keywords related to hypertension and physical activity. The inclusion criteria are quantitative English or Indonesian studies published in the last five years, with participants aged 60 and above. Data extraction and quality assessment were performed using the 9-item Critical Appraisal Skills Program (CASP) checklist. **Results:** Findings indicate that low to moderate-intensity aerobic exercises such as stationary cycling and continuous or intermittent walking significantly reduce systolic and diastolic blood pressure in elderly individuals with hypertension. High-intensity interval training (HIIT) and resistance training also show notable post-exercise hypotensive effects. **Conclusion:** Physical activity is crucial for managing and lowering blood pressure in elderly individuals with hypertension. Aerobic exercises such as walking and cycling effectively reduce blood pressure and improve cardiovascular health. Resistance training and high-intensity interval training (HIIT) also contribute to lowering blood pressure and enhancing vascular health. These findings support integrating physical activity programs in managing hypertension in the elderly and highlight the need for further research to refine exercise prescriptions.

Keywords*: Elderly, hypertension, physical activity, low blood pressure*.

BACKGROUND

Hypertension, one of the serious cardiovascular diseases, poses a risk of fatal conditions such as stroke, dementia, and various heart-related diseases (Choi & Choi, 2020). Prehypertension and stage 1 hypertension, characterized by a specific range of blood pressure, contribute significantly to the increasing prevalence of hypertension-related events (Alfaqeeh et al., 2023). The number of people with hypertension doubled from 650 million to 1.3 billion between 1990 and 2019, as reported by the World Health Organisation (WHO, 2023). Therefore, hypertensive disease requires special attention to reduce morbidity and mortality.

Hypertension is defined as constant and recurring systolic blood pressure (SBP) of ≥140mmHg and or diastolic blood pressure (DBP) ≥90mmHg. (Bergler-Klein, 2019). Hypertension affects more than half of the elderly aged 60 years and above (Oliveros et al., 2020). According to the National Health and Nutrition Examination Survey, 70% of older people have high blood pressure (Beth et al., 2018). This prevalent condition threatens the health and well-being of millions of people worldwide if not properly controlled. As the population ages, identifying accessible treatment options is crucial.

The primary interventions to manage hypertension include medication and lifestyle changes such as increasing physical activity. Prescription drugs effectively lower blood pressure but often cause side effects and accessibility issues (Vitarello et al., 2022). In addition, research shows lifestyle modifications, including increasing physical activity, are recommended as first-line therapy for hypertension (Barone Gibbs et al., 2021). The role of physical activity in a multifactorial approach to managing hypertension may improve outcomes among vulnerable older adults.

Without adequate control, prolonged high blood pressure causes extensive organ damage. Target organs such as the heart, brain, kidneys, and eyes are particularly vulnerable (Sandhya Pruthi, 2022).

The leading causes of uncontrolled hypertension are stroke, myocardial infarction, heart failure, dementia, vision problems, kidney failure, and death (Meher et al., 2023). In addition to damaging physical health and well-being, these impacts also lead to disability, dependency, lower quality of life, and a burden on the healthcare system (Mills et al., 2020). Therefore, the impact of sustainable lifestyle changes on blood pressure reduction in the elderly is essential.

Although existing reviews have evaluated the antihypertensive effects of aerobic, dynamic resistance, isometric resistance, and combined exercise training in adults up to 85 years (Bafageeh & Loux, 2022), they have not explicitly focused on those over 60 years of age with a diagnosis of hypertension. A deeper understanding of adequate physical activity prescriptions for blood pressure management in the elderly hypertensive age group is needed, given the increasing prevalence of hypertension with age and the increased cardiovascular risk in this age group.(Briasoulis et al., 2020) Determining the optimal frequency, intensity, duration, and type of physical activity may assist healthcare providers in promoting better blood pressure control through a lifestyle approach in elderly hypertensive patients.

This integrative review, therefore, aims to systematically evaluate the current literature on the evidence for the influence of frequency, intensity, type, and duration of physical activity on blood pressure in the elderly population. These findings may guide targeted lifestyle recommendations and future research focused on older adults with hypertension, a high-risk group that requires blood pressure management.

METHODS

This study is integrative and uses an integrative review design. An *integrative review* is a literature search using a relevant and accessible database. The article search results are selected based on themes based on the research. Then, the data is evaluated by screening the data and selecting articles that meet the requirements and criteria specified (Fadilah &

Sefrina, 2022). This study focuses on the effect of frequency intensity, type, and duration of physical activity on blood pressure in the elderly population and the main physiological mechanisms involved in the blood pressure lowering effect.

More specifically, the researcher elaborated in the form of the following questions:

1. What type, frequency, intensity, and duration of aerobic physical activity are most effective for reducing systolic and diastolic blood pressure in people with hypertension who are 60 years or older?
2. What are the main physiological mechanisms involved in the blood pressure-lowering effects of physical activity in elderly patients with hypertension?

Literature search method

An integrative approach provides a way to summarise individual research studies and other types of articles, integrating existing knowledge about an issue to provide a comprehensive picture of it. (Oermann & Knafl, 2021).

In 2023, the literature search was conducted using five electronic databases: PubMed, Proquest, Cinahl, Scopus, and Garuda. These databases are a source of scientific publication information that can be accessed worldwide, except for the Garuda database, which is an Indonesian scientific publication platform under the control of the Ministry of Education, Culture, Research, and Technology.

Table 1. Literature Search

Literature Search Technique

No.	Keywords.	Filters	Data Base	Search Date	Results
1	((Hypertensive older adults[MeSH Terms])) OR (Hypertensive older adults[MeSH Terms])) AND ((physical activity[MeSH Terms]) OR (physical exercise[MeSH Terms])) OR (Isometric handgrip training[MeSH Terms])) OR (High intensity interval training[MeSH Terms])) OR (walking exercise[MeSH Terms])) OR (aerobic exercise[MeSH Terms])) OR (brisk walking[MeSH Terms])) OR (cycling[MeSH Terms])) OR (swimming[MeSH Terms]) AND ((Lower blood pressure[MeSH Terms]) OR (Lowering hypertension[MeSH Terms])) OR (Lower* blood pressure[MeSH Terms]))	Filters : Full Text, in the last 5 years, english	PUBMED	16 December 2023	294
2	(Older adults with hypertension) OR (Hypertensive older adults) OR (Older adults with high blood pressure) AND (physical activity) OR (physical exercise) OR abstract(physical activities) OR (Isometric handgrip training) OR (High-intensity interval training) OR (walking exercise) OR (aerobic exercise) OR (brisk walking) OR (cycling) OR (swimming) AND (Lowering hypertension) OR (Lower* blood pressure)	Filters : Full Text, in the last 5 years, english	ProQuest	16 December 2023	67

3	Older patients with hypertension OR Older adults with hypertension OR Hypertensive older adults AND physical activity OR physical exercise OR Isometric handgrip training OR High-intensity interval training OR walking exercise OR aerobic exercise OR brisk walking OR cycling OR swimming AND Lower blood pressure pressure OR Lowers blood pressure OR Lowering hypertension OR Lower* blood	Filters : Full Text, in the last 5 years, english	Cinahl	17 December	20 Article
4	older AND patients AND with AND hypertension OR older AND adults AND physical AND activity OR physical AND exercise OR physical AND activities OR isometric AND handgrip AND training OR high-intensity AND interval AND training OR walking AND exercise OR aerobic AND exercise OR brisk AND walking OR cycling OR swimming AND lower AND blood AND pressure OR lowerers AND blood AND pressure OR lowering AND hypertension OR lower*. AND blood AND pressure.	Filters : Full Text, in the last 5 years, english	Scopus	18 December 2023	21
5	Elderly and walking and Blood pressure reduction	Filter 5 years	Garuda	17 December 2023	43

In the integrative review, the researchers used standardized studies, including quantitative ones. Researchers collected and then described the original research. Discusses the effect of frequency, intensity, type, and duration of physical activity on blood pressure in the elderly population and the main physiological mechanisms involved in the impact of lowering blood pressure.

Inclusion criteria in this study are

1. Original research
2. Written in English and Bahasa Indonesia.
3. The article lasts five years
4. Quantitative research
5. Research subjects aged 60 years and above
6. Exposure to any type, frequency, intensity, or duration of physical activity, exercise, or balance training.

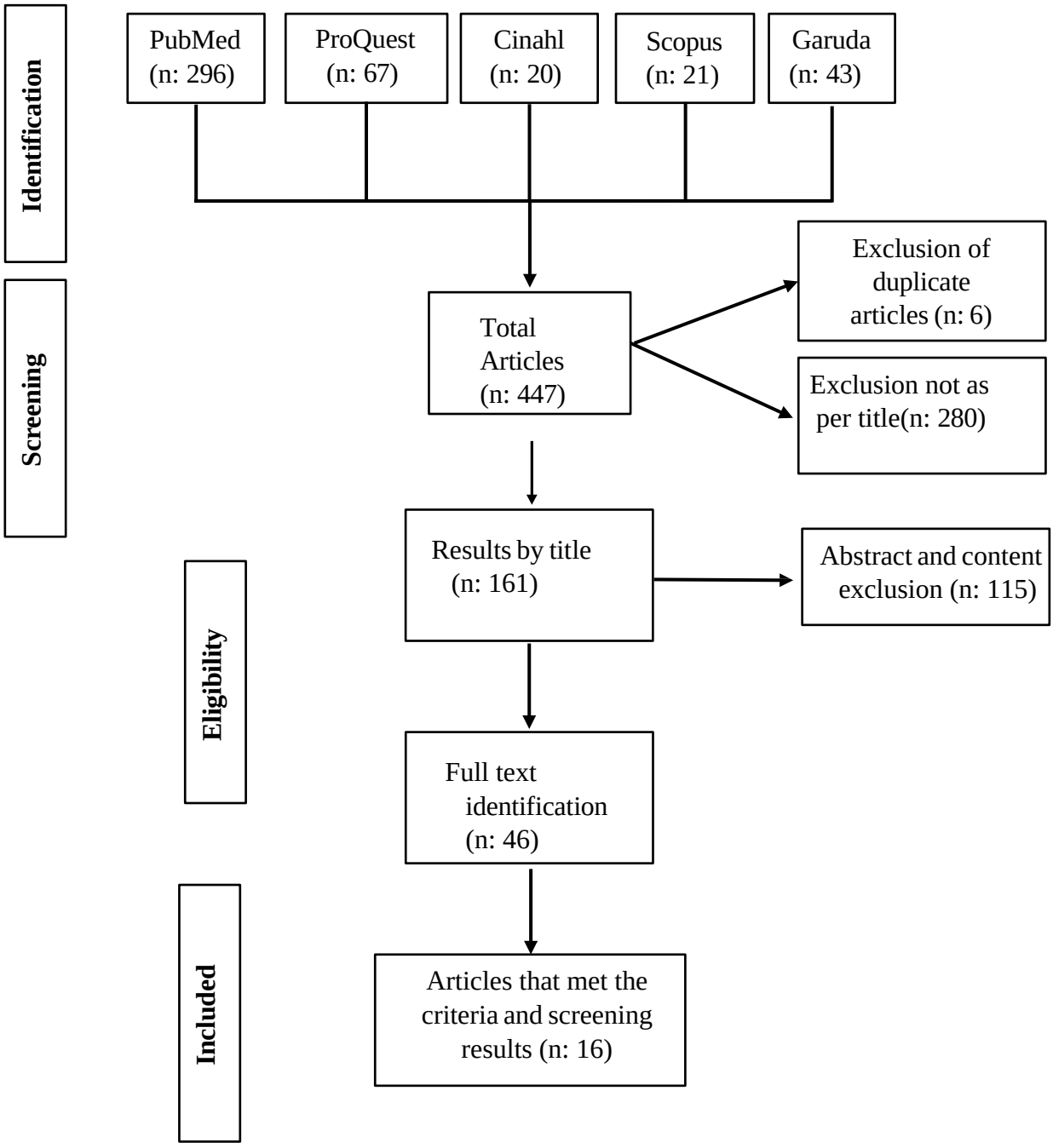
The exclusion criteria in this study are as follows:

1. Unpublished research
2. Literature articles, Review studies.
3. Qualitative and descriptive research
4. Review of development instruments.
5. Participants aged 59 years and below.
6. Activities where there is no type, frequency, intensity, or duration of physical activity, such as exercise training or balance training.

Search results

The initial search resulted in 447 articles. After checking for duplicates, there were six duplicate articles, leaving 441. Of the 441 articles, 280 were excluded because they did not match the title, leaving 161 articles. Furthermore, a review of the abstracts was carried out from 161 articles, and 115 articles needed to match the topic of the review, so 46 articles remained. Then, the 46 articles were read in full, and only 16 met the inclusion criteria for this review.

Chart 1: Flow in determining the sample of articles



Data extraction and quality assessment.

The first step involved searching using predefined keywords, which resulted in articles from 5 databases. Duplicate articles were then removed. The next stage involved selecting articles relevant to the complete text, publication within the last five years, and appropriateness to the topic. This aimed to obtain full-text articles that met the eligibility criteria. The next stage involved thoroughly examining the identified full-text articles, with the final selection focussing on articles that met the inclusion criteria for the integrative review process.

The methodological quality of the included quantitative studies was assessed using a 9-item checklist adapted from the Critical Appraisal Skills Program (CASP) tool for randomized controlled trials. This tool evaluates study quality across domains, including appropriateness of study design, recruitment strategy, confounding, data collection methods, results presentation, and results accuracy (Ma et al., 2020). As this review focused specifically on the elderly hypertensive population, an additional quality criterion assessed was the inclusion of participants aged 60 years and older with a diagnosis of hypertension. Studies were rated as high or low quality based on their total score compared to the total possible score.

Table 2. Quality Appraisal of Studies Review (CASP)

No.	Author/Year	Objectives are clearly explained.	The design study is clearly described.	Appropriate Research Methods	Description of adequate sample and Exclusion Criteria	Ethics presented	Results are reported	The results are in line with the research questions and literature	Limitations presented	Implications discussed	Value / level
1.	(Sardeli et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8/9 High
2.	(Oliveira-Dantas et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9 High
3.	(Costa et al., 2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8/9 High
4.	(Pereira & Cipriano, 2020)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	8/9 High
5.	(Silva et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9 High
6.	(Hou et al., 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8/9 High
7.	(Møller et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9 High
8.	(Ferrari et al., 2021)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	8/9 High
9.	(Sosner et al., 2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8/9 High
10.	(Prasertsri et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9 High

11.	(Alzahrani et al, 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9 High
12.	(Eduardo et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8/9 High
13.	(Gargallo et al, 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9
14.	(Júnior et al., 2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Retrieved	Yes	8/9 High
15.	(Herrod et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9/9 High
16.	(Alfitiah & Oktaviani syh, 2020)	Yes	Yes	Yes	No	No	Yes	Yes	Not reported	Yes	7/9 Average

Table 3. Data Extraction

No.	Author Year	Title	Country	Destination Research	Design and Methods	Sample and Settings	Key Findings	Type, Frequency, Intensity and duration.	Mechanism Physiological
1.	(Sardeli et al., 2022)	**Comprehensive Time-Course Effects of Combined Training on Hypertensive Older Adults: A Randomised Control Trial**	Brazil	• To investigate the effect of 16 weeks of combined training on blood pressure in hypertensive elderly. • To identify critical fitness, hemodynamic, autonomic, inflammatory, oxidative, glucose, and lipid mediators of this intervention over time	A prospective interventional randomized controlled trial with a parallel control group.	The sample and setting consisted of a randomized controlled trial involving 52 people aged over 60 years with hypertension, recruited from the community and currently taking antihypertensive medication.	• Training does not lower blood pressure in hypertensive elderly. • Improves cardiorespiratory fitness by about 18% after 16 weeks, • Increase strength by About 8%, slightly reduce body mass by about 1% and reduce the number of individuals with metabolic syndrome by about 7%	• combination of strength and aerobic training • Strength training is performed twice a week, consisting of one set of 15 reps for each of seven exercises targeting the major muscle groups... • Aerobic exercise was performed three times a week, with two sessions that included walking and running on a treadmill for 50 minutes after strength training and one session that consisted of only aerobic exercise for 50 minutes. • Aerobic exercise intensity was set at 63% of individual capacity, and strength training loads were adjusted to achieve moderate intensity using the Borg scale. • (5-6 on a 10-point scale	Exercise can stimulate the production of nitric oxide, which causes vasodilation. This decreases vascular resistance, lowering blood pressure.

2.	(Oliveira-Dantas et al., 2021)	**Effect of High-velocity Resistance Exercise on 24-h Blood Pressure in Hypertensive Older Women.**	Brazil	To investigate the acute post-exercise effects of exercise high speed on ambulatory blood pressure in elderly women with hypertension. resistance	Controlled crossover clinical trial design random.	The sample consisted of 14 hypertensive elderly women aged 60-75 years old. They recruited between August 2018 and August 2019 through advertisements on social media, healthcare units, and community centres.	• high speed resistance exercise (HVRE) cause significant reduction in systolic ambulatory blood pressure (BP) within 4 hours. • a decrease of 6.7 mmHg	• These activities include speed endurance training high with using Thera- Band rubber bands. • Participants performed 8 exercises, with 3 sets of 6 reps as fast as possible in a concentric phase at a moderate intensity. • The frequency is one session, and the duration of blood pressure monitoring is 12 • post session hours	Resistance training can cause post - hypotension exercise through mechanisms such as changes in cardiac output, peripheral resistance, and possibly baroreflexion sensitivity
3.	(Costa et al., 2020)	**Acute Effect of High-Intensity Interval Versus Moderate-Intensity Continuous Exercise on Blood Pressure and Arterial Compliance in Middle-Aged and Older Hypertensive Women With Increased Arterial Stiffness.**	Canada	The purpose of this study is to examine the acute effects of high- intensity interval training (HIIE) and moderate-intensity continuous exercise (MICE) on blood pressure.	This study used a randomized controlled trial design with computer-based randomization to determine the order of the control and training sessions (HIIE and MICE).	The sample consisted of nineteen middle-aged and older hypertensive women recruited from the Large and Small Artery Elasticity Assessment for Early Detection of Cardiovascular Disease trial database. The University of Manitoba Education/Nursing Research Ethics Board approved the study, and the subjects provided written informed consent. Exclusion criteria included specific conditions related to cardiovascular, cerebrovascular, or metabolic diseases and musculoskeletal conditions that limit exercise. The research also supports infrastructure from various research centers and institutions in University of Manitoba.	• The HIIE and MICE interventions reduced systolic blood pressure by 6.3 and 5.8 mm Hg, respectively, and diastolic blood pressure by 3.8 and 3.8, respectively. 3.5 mmHg. • HIIE improved cardiorespiratory fitness more significantly than MICE (4.3 vs. 1.6 ml - kg- ^{1}- min-^{1}, respectively	• The types of activities studied were high-intensity interval training (HIIE) and moderate- intensity continuous training (MICE). • Frequency: 30 - 60 minutes per day in one week. • The intensity of MICE is medium, while HIIE involves periods of high intensity. • Duration not specified	Physiological adjustment to repeated exercise sessions and post-exercise hypotension (PEH), a well-documented blood pressure-lowering effect that starts minutes after exercise and can be maintained for hours.

4.	(Pereira & Cipriano, 2020)	**Effects of a personalised physical exercise programme in peripheral and central blood pressure in community dwelling older hypertensive adults: the AGA@4life intervention model.**	Portugal	To examine the effect of a tailored physical exercise intervention programme on brachial and central blood pressure in a group of hypertensive elderly.	A non-randomised intervention study with participants divided into an intervention group and a control group.	Sample This study included 33 participants with an average age of 82 ± 9 years old, who was recruited from a daycare centre in Portugal.	• The intervention group had a decrease in bSBP by about 10 mmHg and cSBP by about 8 mmHg. • The intervention group showed improvements in functional capacity and strength, as well as improvements in arterial stiffness parameters • and cognition,	• Types of aerobic, strength, balance, and coordination training activities. • The frequency of physiotherapy sessions which included strength and balance/coordination exercises was three times a week. Each session was managed by a physiotherapist. • 1 hour in total.	Physical exercise can improve cardiovascular function, enhance endothelial function, and reduce arterial stiffness, which collectively contribute to lower blood pressure.
5.	(Silva et al., 2021)	**Acute effect of bodyweight-based strength training on blood pressure**	Brazil	to evaluate the acute effects on blood pressure and satisfaction with the practice of	This study used a crossover clinical trial design.	This study involved 11 older adults (65.8 ± 4.6 years; 7 males) who were hypertensive patients of both sexes	• The observed reduction in blood pressure was 7 mm Hg compared to the	• Activity types include resistance training and bodyweight-based strength training. • The frequency, intensity	The main physiological mechanisms involved in the blood pressure-
		of hypertensive older adults: A randomised crossover clinical trial.		body weight-based strength training (BWST) in hypertensive elderly.		and members of the Cardiorespiratory Prevention and Rehabilitation Programme (PROCOR).	control session, and 3 mm Hg compared to the baseline value.	and duration of these activities are not mentioned.	lowering effects of resistance exercise include the acute post-exercise hypotensive response, which may be related to haemodynamic changes and heart rate
									variability following exercise. Sports.
6.	(Hou et al., 2023)	**Effects of exergame and bicycle exercise intervention on blood pressure and executive function in older adults with hypertension: A three-group randomised controlled study.**	China	The aim of this study was to explore the effectiveness of moderate intensity exercise and bicycle exercise interventions on blood pressure and executive function in elderly hypertensive patients.	The study used a randomised controlled trial design with three groups: an exergame intervention group, a bicycle exercise intervention group, and a control group.	The sample consisted of 128 participants who met the inclusion criteria and were randomly divided into three groups	• There was a significant reduction in diastolic blood pressure (DBP) after the bicycle exercise intervention compared to baseline.	• The types of activities in the study included exergame and bicycle exercise interventions. • The frequency is three times a week, and each session lasts for an hour, including a 5-minute warm-up, 50-minute workout, and 5-minute cooldown. • The intensity is moderate, aiming for 60% - 69% of max heart rate. • The duration of the intervention was 16 weeks.	• increased nitric oxide bioavailability and reduced oxidative stress. Nitric oxide is essential for vascular health as it is responsible for vasodilation. During exercise. • increased nitric oxide bioavailability contributes to vasodilatation , which may help reduce blood pressure.
7.	(Møller et al., 2022)	**Exercise Training Lowers Arterial Blood Pressure**	Denmark	To examine the impact of high- intensity aerobic exercise on	Design and Methods included an 8-week intensive	Middle-aged men who were not physically active, including 13 people with normal	• intensiv e cycling aerobic exercise is	• High-intensity aerobic cycle type of exercise. • Frequency: three times a week.	Blood pressure is determined by cardiac output and vascular tissue

		Independently of Pannexin 1 in Men with Essential Hypertension .		blood pressure and microvascular function in individuals with essential hypertension To assess the involvement of pannexin 1 (Panx1) in this effect	aerobic cycle training intervention for middle-aged men.	blood pressure and 14 people with stage 1 hypertension who were not on treatment.	highly effective in reducing blood pressure in nonmedically hypertensive men • Systolic and diastolic blood pressure was reduced by about 5 mm Hg after training in the hypertension group.	• Intensity varied within each session, including intervals of 60-70%, 70-80%, 80%, 85%, 90%, and up to 95% of individual capacity • Duration: 8 weeks of training.	resistance, and it is influenced by the balance between vasoconstrictor signals, such as sympathetic noradrenaline release, and vasodilator substances, such as blood vessels. Nitric oxide. A change in the balance towards more significant constriction may affect the blood pressure
8.	(Ferrari et al., 2021)	**Effects of combined training performed two or four times per week on 24- h blood pressure, glycosylated haemoglobin and other health-related outcomes in aging individuals with hypertension: Rationale and study protocol of a randomised clinical trial.**	Brazil	To compare the effects of a combined exercise programme performed four and twice a week on 24-hour ambulatory blood pressure, glycosylated haemoglobin.	Randomised controlled trial (RCT) with stratified randomisation.	The sample consisted of 98 participants aged 50- 80 years with a previous doctor's diagnosis of hypertension, randomised to perform two or four combined training sessions per week.	• Comparing the effects of combined exercise performed at different frequencies on 24-hour blood pressure and glycosylated haemoglobin levels in middle- aged and older adults with hypertension. • The hypothesis is that the four- times-a-week group training may have a more pronounced decrease in this measure compared to the two-times-a- week group training. • times a week.	• Aerobic exercise involves walking or running, with volumes ranging from 20 to 50 minutes per session. Aerobic exercise intensity is set at 60-70% VO2peak, corresponding to a perceived exertion rating (RPE) of 5-6. • Resistance training is performed at an intensity of 50-60% of 1 repetition maximum (1RM) for beginners, progressing to 60-60% of 1RM. • 70% (4-5 to 5-6 RPE) as participants adapt. The frequency of activities is twice a week (CT2) or four times a week (CT4).	The main physiological mechanism involved in the blood pressure lowering effect of the activities studied in this article is post-exercise hypotension. This phenomenon refers to the acute fall in blood pressure that occurs after a single bout of exercise, which can accumulate over time with regular exercise contributing to a chronic fall in blood pressure.
9.	(Sosner et al., 2019)	**Ambulatory blood pressure reduction following 2 weeks of high-intensity interval training on an immersed ergocycle.**	Canada	To evaluate the effects of high-intensity interval training (HIIT) performed in water compared with HIIT on dry land and moderate-intensity continuous training (MICT) on ambulatory blood pressure reduction in individuals with hypertension	The research design described in this article is an experimental study.	The sample consisted of 42 individuals with a mean age of 65 ± 7 years, who were recruited at the Cardiovascular Prevention and Rehabilitation Centre (EPIC) at the Montreal Heart Institute.	The magnitude of the decrease in outpatient SBP/DBP after HIIT immersion was greater than the average decrease in SBP/DBP by -4.1/-2.8 mmHg for a 24-hour period, -3.8/-2.7 mmHg for daytime, and - • 2.4/-1.7 mmHg for nighttime reported in a recent meta-analysis	• The types of activities listed in the article include Moderate Intensity Continuous Training (MICT) and two forms of High Intensity Interval Training (HIIT): one conducted on dry land (dry land HIIT) and one with participants immersed chest-deep in water (immersed HIIT). • The frequency of the exercise intervention was three times a week for two weeks, totalling six sessions • The intensity of the HIIT session is based on the peak power output (PPO) determined from the maximal graded exercise test performed at baseline. • Specific intensity levels	Physical training in hypertensive individuals induces functional and structural adaptations. These adaptations include an increase in capillary density and the ratio of arteriolar wall to lumen, which may improve microvascular function. In addition, physical training can modulate the activity of the renin-angiotensin-aldosterone system and reduce arterial stiffness, thus

								performed at baseline. Specific intensity levels for MICT or intervals for HIIT were not provided in the text excerpt. • The duration of each training session is not explicitly mentioned in the quote • text provided.	reduce arterial stiffness, thus contributing to better vascular health.
10.	(Prasertsri et al., 2022)	**Effects of Long- Term Regular Continuous and Intermittent Walking on Oxidative Stress, Metabolic Profile, Heart Rate Variability, and Blood Pressure in Older Adults with Hypertension**	Thailand	For find out Effects of regular low- intensity exercise, specifically continuous and intermittent walking, on oxidative stress, heart rate variability, metabolic profile, and blood pressure in elderly people with hypertension	Research design which is used in the article is a controlled intervention study.	The sample of this study consisting of 50 participants, including 10% dropouts, who were recruited from the Aging Society of Mueang District and the Aging Society of Burapha University Hospital, Chonburi Province, Thailand.	• In the continuous walking group continuously, the systolic blood pressure (SBP) and diastolic blood pressure (DBP) decreased by about 2 and 0.5 mmHg respectively. • In the intermittent walking group, SBP and DBP decreased by about 4 and 0.5 mmHg, respectively.	• The activities researched in this article arecontinuous and intermittent road training. • The frequency of activities is not explicitly mentioned in the citation provided. • The intensity is low, suitable for elderly people with hypertension, and the duration of walking exercise is 10 minutes for both continuous and intermittent walking. • Intermittent walking includes a 1-minute rest period after each minute of walking, adjusted to the fitness level of the participant	• Exercise improves production of nitric oxide (NO) by the endothelium, which causes vasodilation and thus reduces blood pressure • Regular walking can increase the sensitivity of baroreceptors, which are responsible for detecting changes in blood pressure and initiating compensatory mechanisms to maintain homeostasis
11.	(Alzahrani et al., 2023)	**Feasibility and Efficacy of Low-to-Moderate Intensity Aerobic Exercise Training in Reducing Resting Blood Pressure in Sedentary Older Saudis With Hypertension Living in Social Home Care: A Pilot Randomised Controlled Trial**	Saudi Arabia	To evaluate the efficacy of low to moderate intensity aerobic exercise in reducing resting blood pressure in sedentary Saudi elderly with presenting hypertension stay in residential care.	• This study used a nonblinded randomised controlled trial (RCT) design. • Participants are randomly assigned to the experimental group and control using computer-generated sequences	The sample consisted of 27 participants, all elderly with hypertension, residing in the Medical Department of Social Home Care in Makkah, Saudi Arabia. Due to dropouts, the final analysis involved 24 participants, with 12 in the experimental group and 12 in the control group	• The study showed significant reductions in both systolic and diastolic blood pressure, with reductions of -2.75 mmHg and -0.83 mmHg. • Decreased heart rate, BMI, and cholesterol in the exercise group	Physical activity in the study consisted of light to moderate intensity aerobic exercise using a stationary bike. Participants in the experimental group performed 24 sessions lasting 45 minutes each, three times a week for eight weeks. The intensity starts from 30% of their heart rate and progressing to 50%, with each session including a 10- minute warm-up and cool- down routine.	The main physiological mechanisms involved in the blood pressure-lowering effects of physical activity in this study include increased shear stress on blood vessels, which increases the Establishment vasodilator nitric oxide (NOx), which contributes to vasodilation of blood vessels. This process may lead to a decrease in vascular resistance and a consequent decrease in pressure blood.
12.	(Eduardo et al., 2021)	**Low-volume cycling training improves body composition and functionality in older people with multimorbidity : a**	Spain	To determine the effect of physical activity on blood pressure and other health parameters in elderly people	Randomised controlled trial design with multilevel permuted block randomisation.	The sample consisted of 24 participants aged 65 years and above, who were either daycare patients or nursing home residents.	• The reduction in blood pressure observed in this study was significant, with systolic blood pressure at rest (SBPrest) reduced by 6.5	• The activity in this study was cycling training. • The frequency is 3 days per week, • The intensity is low to medium, and • The duration is 20 minutes per session for 6 weeks.	• Improved endothelial function, which increases vasodilation and blood flow • Increased production of nitric oxide,

		randomised controlled trial					mmHg post-		which helps
							intervention. • males in the exercise group experienced a more pronounced reduction in SBPrest by approximatel y 18.0 mmHg and blood pressure average when rest (MBPrest) of about 12.7 mmHg		relax blood vessels • Reduction of arterial stiffness, allowing better accommodatio n of blood flow • Decreased activity of the sympathetic nervous system, thereby decreasing vascular resistance • Improves kidney function, contributing to better fluid and electrolyte balance • These mechanisms collectively contribute to the chronic reduction in systolic and diastolic blood pressure after exercise regular aerobics
13.	(Gargallo et al., 2022)	**Minimal Dose of Resistance Exercise Required to Induce**	Spain	To determine the effect of resistance training on blood pressure in hypertensive	The research design included a familiarisation session, followed by four	The sample consisted of 19 patients, 13 males and 6 females, who had no previous resistance training experience. The	• a single session of resistance training using elastic bands for the upper	• Resistance training using rubber bands on the upper limbs. training sessions every 48 hours, with a total of four	Blood pressure reduction from resistance training activities is thought to be
		Immediate Hypotension Effect in Older Adults with Hypertension : A Randomised Cross-Over Controlled Trial.		patients	experimental sessions with different volumes of resistance training using biceps curl exercises.	venue was a primary care centre.	extremities, consisting of 6 or 9 sets, resulted in a 1- hour reduction in post-exercise blood pressure in older people with controlled hypertension (HT) • At 30 minutes, the effect size is larger with 6 sets, while at 60 minutes, the effect size is larger with 9 sets.	experimental sessions after the socialisation session. • Intensity was determined with a maximum test of 20 repetitions (RM), with the elastic band stretched to approximately 50% of its initial length to achieve the desired intensity. Activity duration varies based on number of sets performed: the study included conditions of 3 sets, 6 • sets, and 9 sets of 20 RM, with 1 minute rest between sets and 1 second rhythm for concentric and concentric. eccentric phase of the biceps curl exercise	related to a decrease in cardiac output and/or peripheral vascular resistance. This decrease is mainly due to decreased sympathetic activity, which may lead to a decrease in heart rate and vasodilation. In addition, there may be a decrease in shock volume, increased baroreflex sensitivity, and release of vasodilator substances such as nitric oxide and prostaglandins. These changes contribute to an overall reduction in blood pressure after exercise

14.	(Júnior et al., 2020)	**The effects of aquatic and land exercise on resting blood pressure and post-exercise hypotension response in elderly hypertensives.**	Brazil	To compare resting blood pressure (BP) and post-exercise hypotension (PEH) in hypertensive elderly women trained in both land exercise (LE) and water exercise.	This study used a controlled clinical trial design.	The sample consisted of 40 hypertensive elderly women, 20 trained in land sports and 20 in aquatic sports, at the Exercise Physiology Laboratory (LABFE) of the Ouro Preto School of Physical Education, Minas Gerais, Brazil.	Aquatic exercise led to a greater reduction in blood pressure, with a reduction of 10.58 mmHg compared to land aerobic exercise which showed a reduction of 3.5 mmHg, and resistance training which showed a reduction of 3.5 mmHg. 1.8 mmHg	Activities include a cardiopulmonary test and an exercise session at 75% resting heart rate (RHR) for 50 minutes, conducted in an aquatic or terrestrial environment.	The main physiological mechanisms include increased fluid and electrolyte excretion, suppression of fluid-regulating hormones (renin, angiotensin II, aldosterone, and arginine vasopressin), and decreased peripheral vascular resistance.
15	(Herrod et al., 2021)	**Time-efficient physical activity interventions to reduce blood pressure in older adults: a randomised controlled trial**	English	To evaluate Effectiveness time-efficient interventions, such as high-intensity interval training (HIIT) and isometric handgrip training (IHG), in reducing blood pressure in the elderly	Controlled trial design randomised with computerised randomisation	The sample consisted of 48 participants with a mean age of 71 years old on average, with even distribution of gender and antihypertensive drug use across groups	high intensity interval training (HIIT) and isometric grip training (IHG) led to a statistically significant decrease in resting systolic blood pressure (SBP) by 9 mmHg.	Activities include HIIT with exercise tests additional to determining intensity, RIPC with blood pressure cuff inflation, and IHG with repetitions at 30% of maximum voluntary contraction. Each session lasted approximately 15 minutes, three times a week for six weeks	This exercise improves Function cardiovascular and may cause a drop in blood pressure
16.	(Aliftitah & Oktavianisya 2020)	**Effect of 30 Minutes Walking on Systolic Blood Pressure Reduction in Elderly Group in Errabu Village**	Indonesia	To determine the effect of a 30-minute walking intervention on reducing systolic blood pressure in the elderly in Errabu Village.	A quasi-experimental design with a pretest-posttest control group.	The sample consisted of 30 elderly people in Errabu Village who were divided into an intervention group and a control group. The background is the community of Errabu Village	The average systolic blood pressure of the intervention group decreased from 127.27 mmHg before the intervention to 116.87 mmHg after the intervention.	The activity listed in the article is walking, with a frequency of one time, intensity not specified, and duration of 30 minutes.	The main physiological mechanism involved in the blood pressure-lowering effect of walking is the strengthening of the heart muscle, which allows for more efficient pumping of blood back to the heart and normalisation of blood pressure in the heart. hypertension cases.

RESULTS AND DISCUSSION

Sixteen articles were critically analyzed, resulting in answers to the review questions on the most effective type, frequency, intensity, and duration of physical activity for lowering systolic and diastolic blood pressure in older adults aged 60 years and above suffering from hypertension as well as the main mechanisms of blood pressure reduction. This study was conducted in various countries with details: Brazil (n: 5), Canada (n: 2), Spain (n: 2), Portugal (n: 1), United Kingdom (n: 1), and the United Kingdom (n: 1), Denmark (n: 1), China (n: 1), Saudi Arabia (n: 1), Thailand (n: 1), Indonesia (n: 1).

Type, frequency, intensity, duration of physical activity

Based on the table provided, physical activities such as light to moderate-intensity aerobic exercise on a stationary bike showed effectiveness in lowering blood pressure, with sessions performed three times a week for eight weeks.(Alzahrani et al., 2023) High-intensity interval training (HIIE) and moderate-intensity continuous exercise (MICE) also provide benefits, although the specific duration is not specified(Costa et al., 2020). This is also in line with research from (Leal et al., 2020), which states that HIIT and MICT encourage SBP reduction in adults with hypertension, and HIIT shows a greater magnitude of DBP reduction.

Elderly aged 60 years old, a street walk with a duration of 30 minutes is recommended as it strengthens the heart muscle and allows the pumping of blood back to the heart to be more efficient (Aliftitah & Oktavianisya, 2020). Meanwhile, high-intensity exercise may be less recommended for this population due to higher risks and the need for closer monitoring. Therefore, low to moderate- intensity activities, such as walking or aerobic exercise on a stationary bicycle, are more recommended for the elderly (Alzahrani et al., 2023) The most effective activity in reducing blood pressure was intensive cycling aerobic exercise, which showed decreased pressure systolic and diastolic blood pressure by about 5 mm Hg in nonmedically hypertensive men. In addition, aquatic exercise also showed a significant reduction in blood pressure, with a decrease of 10.58 mmHg compared to land aerobic exercise.

This is by research from (Trindade et al., 2022), which says water-based and aquatic exercise causes cardiovascular changes in healthy and cardiac patients. There was a more significant increase in cardiac output and pulse pressure during water immersion exercises than on land. A 30-minute walk also effectively reduced systolic blood pressure in the elderly group.

The primary mechanism of blood pressure lowering

The main physiological mechanisms involved in lowering blood pressure through physical activity are multifaceted and vary depending on the type of exercise performed (Gambardella et al., 2020). Aerobic exercise, such as walking or cycling, increases vascular shear stress, producing vasodilators such as nitric oxide (NOx). This process contributes to blood vessel dilation and decreased vascular resistance, ultimately reducing blood pressure (Otsuki et al., 2019).

Regular aerobic exercise has been associated with a chronic reduction in systolic and diastolic blood pressure, as it increases cardiac muscle strength, allowing for more efficient pumping of blood back to the heart and normalizing blood pressure in cases of hypertension. (Alzahrani et al., 2023)(Aliftitah & Oktavianisya, 2020) In contrast, resistance training is thought to be associated with reduced cardiac output and peripheral vascular resistance, mainly due to decreased sympathetic activity, which may lead to decreased heart rate and vasodilation.(Gargallo et al., 2022).

Other physiological changes that contribute to lower blood pressure include a decrease in the volume of the heartbeat, an increase in sensitivity baroreflex, and the release of vasodilators such as nitric oxide and prostaglandins. (Singh JN, Nguyen T, Kerndt CC, et al. Physiology, 2023). These changes collectively contribute to the overall decrease in blood pressure after exercise. In addition, post-exercise hypotension (PEH), a well-documented

blood pressure-lowering effect that begins minutes after exercise and can persist for hours, is a typical response to repeated exercise sessions. (Costa et al., 2020)

CONCLUSION

Physical activity is necessary to manage and lower blood pressure in the elderly. Aerobic exercises, such as walking and cycling, have effectively lowered resting blood pressure and improved cardiovascular function in older adults with hypertension. Resistance training and high-intensity interval training (HIIT) are also essential in inducing direct hypotensive effects and improving overall vascular health. These activities contribute to acute blood pressure lowering and provide long-term cardiovascular benefits, making them an essential component of hypertension management in the elderly population.

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