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CONCURRENT EXERCISE INTERVENTION AND ITS EFFECT ON HYPERTENSIVE PATIENTS

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ABSTRACT

Hypertension remains a major global health challenge due to its strong association with cardiovascular diseases and premature mortality. Lifestyle interventions, particularly physical activity, play a crucial role in managing hypertension. This systematic review aimed to analyze the effectiveness of concurrent training on blood pressure reduction in hypertensive patients. A systematic literature search was conducted across four databases (Scopus, ScienceDirect, PubMed, and Web of Science) from 2020 to 2025, following PRISMA guidelines. 8 studies (one RCT and seven quasi-experiments) involving 571 participants were included. The interventions ranged from 4 to 30 weeks, with most using treadmill walking or cycling for aerobic training and free weights or machines for resistance training. The results showed that seven out of eight studies reported significant reductions in blood pressure. Additionally, concurrent training was associated with improvements in body composition, functional performance, and health-related quality of life. The physiological mechanisms underlying these benefits likely include improved endothelial function, enhanced nitric oxide availability, and increased baroreflex sensitivity. This review concludes that concurrent training is an effective, safe, and holistic intervention for blood pressure management in middle-aged hypertensive populations.

KEYWORDS:

Blood Pressure, Concurrent Training, Hypertension, Physical Activity, Resistance Training

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INTRODUCTION

Hypertension is a leading cause of premature death and cardiovascular disease worldwide, contributing to approximately 10.8 million deaths annually and responsible for more than half of all cardiovascular deaths, including stroke, hearth failure, and chronic kidney disease. [1,2]. Hypertension control remains a significant challenge, given that this condition is influenced by a variety of complex factors in various life contexts [3]. Approximately 60% of the determinants of health and quality of life of individuals are closely related to lifestyle, indicating that individuals with unhealthy lifestyles have a higher risk of experiencing hypertension. One aspect of this lifestyle is lack of physical activity [4].

An estimated 1.28 billion adults aged 30-79 years have hypertension [5]. Only 54% of hypertensive patients were diagnosed and 42% received treatment, while 21% achieved blood pressure control targets [2]. Global estimates show that in 2016, approximately 27.5% of the adult population worldwide did not achieve

recommended levels of physical activity. [6]. The average daily duration of sedentary behavior was 8.3 hours among the Korean population and 7.7 hours among the American adult population [4].

The main factor driving the onset of hypertension due to sedentary behavior is thought to originate from the accumulation of venous blood in the lower extremities, which is caused by decreased muscle activity and reduced skeletal muscle pump function [7]. Sedentary behavior contributes to decreased lipoprotein lipase activity, muscle glucose uptake, and transporter protein function, which overall disrupts lipid and carbohydrate metabolism. In addition, this condition also causes decreased cardiac output and systemic blood flow, accompanied by activation of the sympathetic nervous system [4].

Thus, lifestyle interventions such as physical activity have an important role in the management of hypertension [8]. Although the benefits of regular physical exercise have been widely reported [9], scientific evidence evaluating the effects of concurrent training that consist of aerobic exercise and resistance training in individuals with hypertension is still relatively limited. The aim of this study was to analyze the effectiveness of concurrent training interventions in lowering blood pressure in a population with hypertension.

METHODS

This study applies a systematic review approach, in this context, the study was conducted by systematically exploring topics related to concurrent training in reducing blood pressure in patients with hypertension.

The literature search process was carried out on 4 databases from February 20, 2025 to February 22, 2025. The search was conducted on research in the last 5 years (2020-2025), namely Scopus, Sciencedirect, Pubmed, and Web of Science. Writing the results of the article follows the protocol and rules of the Preferred Reporting Items for Systematic Review (PRISMA). Searching for articles or journals uses keywords and Bollean operators (AND, OR, OR NOT or AND NOT) which are used to expand or specify the search so that it is easier to determine articles or the number of articles. Keywords in the review system that are adjusted to the Medical Subject Heading (MeSH) of the article are identified with the keywords (("Concurrent" OR "Training" OR

"physical activity") AND ("Hypertension" OR "Essential Hypertension")). The article search strategy was carried out using the PICOS framework (Table 1).

The articles in this study were analyzed for quality assessment using instruments sourced from The Joanna Briggs Institute Guideline (JBI) Critical Appraisal Tools or commonly known as JBI, with the type of JBI adjusted to the one used. The assessment on JBI is divided into the answer choices "yes", "no", "not clear" or "not appropriate", with a value of 1 given to the answer "yes", and a value of 0 for the other answer choices. The critical appraisal stage aims to assess the quality of an article. Articles can be included in this study if the JBI score is more than 70% meeting the critical appraisal criteria, so that it is considered feasible and the research article is included in the criteria.

Tabel 1. PICOS Framework

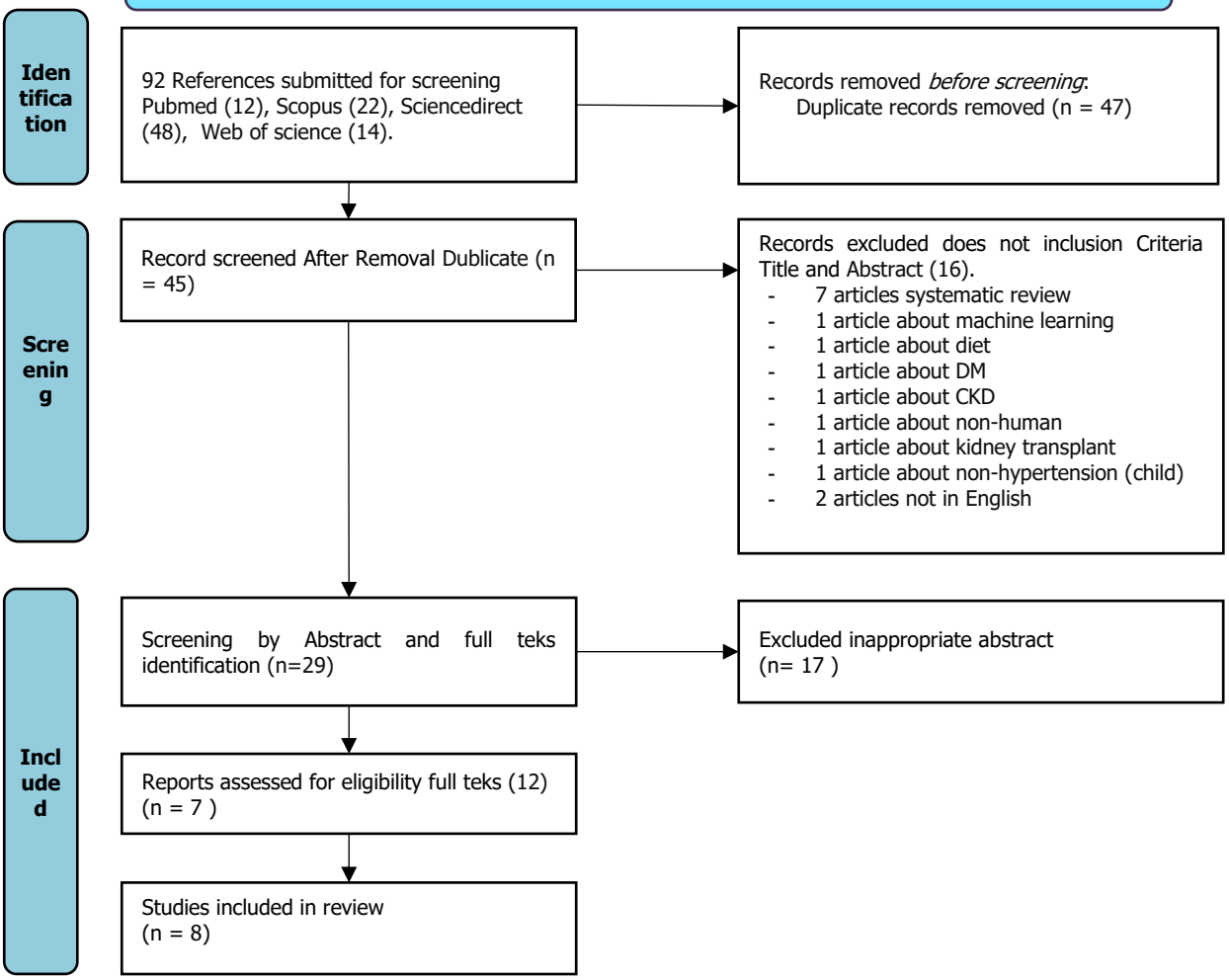
PICOS *framework*	**Inclustion criteria**	**Exclusion criteria**
Population	Studies reviewing Hypertension patients	Studies that did review other than patients with hypertension
Intervention	Studies examining *Concurrent training* interventions	Studies that do not examine *Concurrent training* interventions
Comparator	there are no inclusion criteria	there are no exclusion criteria
Outcomes	Study explaining *Concurrent training* in hypertension patients	Studies that do not describe *Concurrent training* interventions in hypertension patients
Study design and publication type	*Randomized control trial (RCTs), Quasy-Experiment,*	*Review and analysis : literature review, systematic review, meta-analysis, qualitative study*
Publication years	2020 - 2025	
Language	English	

The inclusion criteria in this study were articles taken within the last 5 years using the Randomized Control Trial (RCTs) method, Quasy experiment. The purpose of this study was to determine the effectiveness of concurrent training interventions on hypertension in detail. The search results based on keywords and selection carried out obtained 8 articles from 92 articles found. Selection was carried out using PRISMA (Figure 1). According to the PRISMA guidelines, the first step taken was to search for appropriate articles in the database, then select articles if there were duplicate articles, after that abstract selection was carried out and excluded if they did not meet the inclusion criteria so that full text was obtained that was suitable for further evaluation.

The screening and content analysis process in this systematic review was conducted by two

independent reviewers. Initial screening was based on titles and abstracts, followed by full-text review to ensure compliance with the inclusion criteria. Disagreements between reviewers were resolved through discussion or by involving a third reviewer. Content analysis involved coding and categorizing important data from selected studies, including study design, participant characteristics, type and duration of intervention, and reported outcomes. The results of the analysis were then narratively synthesized to provide a comprehensive overview of the findings.

Figure 1. Identification of studies via databases and registers



Content analysis in this systematic review research was conducted through the process of identifying, categorizing, and synthesizing the main findings of articles that had met the inclusion criteria. Once the selected studies were collected, each article was thoroughly analyzed based on important elements, such as research objectives, study design, participant

characteristics, type of intervention used, and reported outcomes.

RESULT AND DISCUSSION

The articles analyzed in this study were publications that met the inclusion criteria that had been set (n = 8), consisting of one article with a randomized controlled trial (RCT) design and seven articles with a Quasy-Experiment design. All of these articles were published between 2020 and 2024. The articles analyzed in this study came from various countries, including 2 from Brazil [10,11], 3 from Chile [12–14] 1 from Iran (Baghban Baghdadabadsi et al., 2024), 1 from Spanyol [16] and 1 from South Africa [17] (table 2).

Table 2. Data Extraction

Title	DSVIA	Result
[12] Country : Chile	D : RCT S : 58 Respondent V : **Independent** Concurrent Training Therapy **Dependent** - Flow-Mediated Dilation - Pulse wave velocity I : Observation sheet A : ANOVA	The hypertensive exercise group exhibited a significant increase in flow mediated dilation and a reduction in pulse wave velocity. The six-week concurrent exercise, characterized by its clinical time-efficiency, was effective in improving endothelial function.
[15] Country : Iran	D : Quasy-Experiment S : 120 Respondent V : **Independent** Concurrent Training **Dependent** Selected variables of blood and vascular biomechanics I : - Observation sheet - Modified Bruce Exercise test protocol - Borg Scale A : ANOVA	Resulting in an Increase in the resting lumen diameter in the systolic and diastolic phases. No interaction effect was reported on artery compliance, blood flow intensity, and intima-media thickness to resting lumen diameter ratio and the decrease in the variables of blood flow velocity and blood pressure in the systolic and diastolic phases of the left femoral artery.
[17] Country : South Africa	D : Quasy-Experiment S : 98 Respondent V : **Independent** Cardiorespiratory Exercise (CET) **Dependent** Hypertension among HIV-infected individuals on antiretroviral therapy (PLHIV on ART) I : - Observation sheet - WHO stepwise questionnaire A : Logistic Regression	the finding indicated that a reduction in waist circumference and body mass index had a significant positive association with hypertention treatment amongst the intervention group. CET has the potential to be an efficient and economical non-pharmacological intervention for the management and control of hypertension in people living with HIV.
[14] Country : Chile	D : Quasy-Experiment S : 30 Respondent	the Concurrent Training order of ET+ RT and RT + ET promote similar

Title	DSVIA	Result
	V : **Independent** Concurrent Training **Dependent** Blood Pressure responses in patients with morbid obesity I : - Observation sheet - Submaximal test based on Brzycki's equation - Modified borg scale - 6-minutes walking test (6Mwt) A : Two-way ANOVA	'magnitude' in the posexercise hypotensive effects during the eight sessions of bot concurrent training order in 4 weeks of training duration. It showed significant reduction in SBP and DBP. There's a significant association between SBP with body fat, skeletal muscle mass, fasting glucose, triglycerides and the 6-min walking test.
[13] Country : Chile	D : Quasy-Experiment S : 174 Respondent V : **Independent** Concurrent Training **Dependent** Metabolic Markers and Physical Performance in young, adult and older adult women I : - Observation sheet - International Physical Activity Quetionnaire (IPAQ) - 6-minutes walk test (6Mwt) A : - One-way ANOVA - ANCOVA	The Concurrent Training group induced significant improvements in waist circumference, and the distance achieved in the six-minute walking test (6Mwt) across all age groups, without significant differences between groups. In conclusion, the result showed that a 10 week concurrent training intervention improved metabolic syndrome (MetS) risk factors in women.
[11] Country : Brazil	D : Quasy-Experiment S : 14 Respondent V : **Independent** Concurrent Exercise **Dependent** Post-exercise hypotension in older individuals with pre- to established hypertension I : - Observation sheet A : Two-way ANOVA	SBP, DBP, Q, and baroreflex sensitivity decreased after concurrent exercise as compared with the control session. By contrast, the hear rate increased and systemic vascular resistance remained stable throughout the posexercise period as compared with the control session. There's no significant difference between the concurrent exercise and control group to the heart rate variability indexes reflecting autonomic modulation.
[16] Country : Spain	D : Quasy-Experiment S : 56 Respondent V : **Independent** Nueromotor multicomponent training **Dependent** Executive function, functional fitness, blood pressure, body composition, and HRQOL I : - SF12v2 quetionnaire - Stroop test - 8-ft Timed Up and Go Test (TGUT) A : Repeated-measures MANCOVA	MCTP enhanced body composition and HRQOL. Both exercise groups showed lowered blood pressure values.
[10] Country : Brazil	D : Quasy-Experiment S : 31 Respondent	Concurrent training partially reversed the negative effects of T2DM on

Title	DSVIA	Result
	V : **Independent** Concurrent Training **Dependent** Specific domain of cognitive function and metabolic markers I : - Adapted Senior Fitness Test - 6 min Walking test (6Mwt) - Australia Active Questionnaire - Montreal Cognitive Assessment (MoCA) A : Linear Regression	specific cognitive domains and there were a clinically relevant reduction of peripheral insulin sensitivity, resistin levels, diastolic and mean blood pressure. Conversely, no changes were observed for glucose, furctosamine and blood lipids.

In addition to being conducted in various countries, this study also covers a wide range of ages and genders as shown in table 3.

Tabel 3. Gender and Average Age Data

Variable		F	%
Gender	Woman	481	84.24
	Man	90	15.76
Total		571	100
Average Age	Treatment Group	52.82	
	Control group	52.70	

The results of this study showed that the average age of the treatment group was 52.82 years and the average age of the control group was 52.70 years or included in the middle age group, with the majority of the gender being female at 84.24%.

In this study, the intervention used was concurrent training consisting of a combination of aerobic exercise and resistance training. Aerobic exercise, also known as cardiorespiratory endurance training, refers to a structured physical activity program aimed at enhancing the muscles' capacity to utilize energy efficiently. Resistance exercise is a physical activity in which muscle contractions are challenged by an external force. This force can be applied either manually or through mechanical equipment. The contractions may be dynamic, involving movement, or static, where the muscle remains tense without changing length [18]. However, there is one study that also integrates concurrent training with a motor learning approach [16]. In the aerobic exercise component, 5 articles [10,11,15,19] used the treadmill walking method, while three articles [12–14] applied High-Intensity Interval Training

(HIIT) using a cycling ergometer. The resistance training used in concurrent training covers six major muscle groups, with two articles [10,15] using resistance machines and six articles [11–14,16,19] using the free weight lifting method.

In this study, 7 articles reported a significant reduction in blood pressure following the implementation of concurrent training intervention. Meanwhile, one article [15] In addition, several other findings from this intervention include changes in body composition and improvements in functional performance 4 articles [10,13,16,19], and improvements in Health-Related Quality of Life (HRQoL) 1 article[16].

Of the 8 articles reviewed, there were a number of similarities and differences in the research approaches used. The main similarity found was that all studies used a randomized controlled trial or Quasy Experiment design. The majority of the research results showed that concurrent training interventions, especially aerobic exercise and resistance training, were effective in lowering blood pressure. All articles reviewed used concurrent training that consist between aerobic exercise and resistance training as the main intervention in an effort to lower blood pressure.

One article [16], implemented a combination of interventions that included three types of exercise: aerobic exercise, resistance training, and motor learning. The study evaluated of a 30 week multicomponent training program which combined aerobic, resistance, and motor learning on older women. The results of this combined intervention showed demonstrates the effectiveness of integrating aerobic, resistance, and motor learning exercises in improving both physical and cognitive outcomes among older adults. By combining endurance activities (such as fast walking), strength training using resistance tools, and cognitively engaging motor tasks like coordination and dual-task exercises, the program addresses multiple aspects of health simultaneously. This holistic approach not only led to significant reductions in blood pressure and improvements in body composition, but also enhanced executive function, which is crucial for maintaining independence and quality of life in aging populations.

In this study, most articles stated that concurrent exercise interventions were able to

reduce the incidence of high blood pressure which can be seen from the decrease in average blood pressure, . There are 7 articles discussing the effect of concurrent training on reducing blood pressure [10–14,16,17], this is in line with [20] concurrent exercise has a significant effect on reducing blood pressure compared to aerobic exercise or resistance exercise alone. Sedentary lifestyle is an independent risk factor for increased blood pressure and the development of hypertension. Sedentary lifestyle causes decreased metabolic activity and decreased blood flow requirements in muscles, leading to narrowing of small blood vessels (capillaries) and increased peripheral resistance [21]. rolonged sitting is also associated with increased activation of the sympathetic nervous system, which is characterized by increased levels of norepinephrine. This activation causes vasoconstriction (narrowing of blood vessels) and increased blood pressure. On the other hand, prolonged sitting also decreases the release of nitric oxide (NO) [22], a natural vasodilator, and increases endothelin-1 (ET-1), which is a vasoconstrictor substance. This imbalance worsens endothelial function and increases the risk of vascular damage [23].

Concurrent training has the advantage of exploiting the synergistic effects of both types of training. Aerobic training works primarily through decreasing peripheral vascular resistance and improving endothelial function [12], while resistance training contributes through increasing muscle strength, insulin sensitivity [10], and body composition [24]. The combination of the two creates a holistic intervention that has a broad impact on the cardiovascular and metabolic systems. Physiologically, concurrent training has shown several mechanisms that contribute to lowering blood pressure and improving cardiovascular function, one of the main mechanisms being the increased bioavailability of nitric oxide (NO), an endogenous vasodilator molecule that plays an important role in maintaining endothelial function and vasomotor responses [25]. This increase in NO levels supports more effective vasodilation, thereby reducing peripheral vascular resistance [26]. On the other hand, baroreflex sensitivity also increased after training intervention. This improvement in baroreflex sensitivity is accompanied by a decrease in sympathetic nerve activity, which is often excessive in people with hypertension and

is one of the triggering factors for increased blood pressure.

Other findings found, concurrent training also contributed to changes in body composition discussed in 3 articles [13,16,19]. As in the study [27] where concurrent training for 5 weeks had a significant effect on changes in body composition, muscle strength and maximum oxygen uptake compared to aerobic exercise and/or resistance training performed independently. Resistance training functions to stimulate muscle hypertrophy by increasing mechanical and metabolic stress on muscle fibers while aerobic exercise increases the use of body fat as an energy source especially when done at moderate intensity [28]. The increase in muscle mass obtained from resistance training also provides long-term benefits because it can increase the basal metabolic rate. This makes the process of reducing body fat more effective because the body needs more energy even at rest [29].

In addition, concurrent training shows an effect on increasing Health-Related Quality of Life (HRQoL) 1 article [16]. As this finding is in line with [30] where concurrent training between aerobic exercise and resistance training has been shown to have a significant effect on improving quality of life, both directly through improving physical performance and indirectly through improving metabolic and psychological status.

CONCLUSION

This systematic review shows that concurrent training between aerobic exercise and resistance exercise is an effective and safe intervention to lower blood pressure in hypertensive patients. Not only does it provide broad physiological benefits for blood pressure management, concurrent training has also been shown to show effects in changes in body composition, improvements in functional performance, and quality of life and is safe to apply in the middle-aged population with hypertension. Therefore, this intervention can be mined as part of a lifestyle-based hypertension management strategy in the middle-aged population with hypertension. However, further research is needed to better understand the long-term effects of combined training, as well as to optimize the most effective exercise dose in various clinical populations.

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