

Resistance exercise combined with aerobic exercise in hypertensive individuals: systematic review and meta-analysis

Exercício resistido combinado com exercício aeróbico em indivíduos hipertensos: revisão sistemática e meta-análise

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ABSTRACT

Introduction: Systemic arterial hypertension (SAH) is one of the most common cardiovascular diseases. Sedentarism and physical inactivity may contribute to worsening this condition, increasing treatment costs and decreasing rehabilitation chances and life expectancy. Combined exercise practice may be an alternative to address this health issue, offering excellent cost-effectiveness. **Objective:** To review the effect of combined exercise (aerobic exercise associated with resistance exercise) on rehabilitating patients with SAH. **Methods:** This is a systematic review using the PICO strategy, with searches conducted in the PubMed, OVID, Web of Science, PEDro, LILACS, and SciELO databases, using the following descriptors: arterial hypertension, elevated blood pressure, heart disease, hypertensive individuals, resistance exercise, aerobic exercise, combined exercise, resistance activities, and strength training, combined with the Boolean operators “AND” and “OR”. **Results:** Five studies were included after selection. The combined exercise was effective in reducing blood pressure in patients, with a mean reduction of systolic blood pressure -0.73 mmHg; 95% CI, -1.12 to -0.34 and diastolic blood pressure -0.67 mmHg; 95% CI, -1.06 to -0.29. **Conclusion:** Combined training proved to be effective in treating patients with SAH.

Keywords: arterial hypertension; resistance exercise; aerobic exercise; combined exercise.

RESUMO

Introdução: A hipertensão arterial sistêmica (HAS) é uma das doenças cardiovasculares mais comuns. O sedentarismo e a inatividade física podem contribuir para o agravamento dessa condição, aumentando os custos do tratamento e diminuindo as chances de reabilitação e a expectativa de vida. A prática de exercício combinado pode ser uma alternativa para lidar com esse problema de saúde, oferecendo excelente relação custo-benefício. **Objetivo:** Revisar o efeito do exercício combinado (exercício aeróbico associado ao exercício resistido) na reabilitação de pacientes com HAS. **Métodos:** Trata-se de uma revisão sistemática utilizando a estratégia PICO, com buscas realizadas nas bases de dados PubMed, OVID, Web of Science, PEDro, LILACS e SciELO, utilizando os seguintes descritores: hipertensão arterial, pressão arterial elevada, doença cardíaca, indivíduos hipertensos, exercício resistido, exercício aeróbico, exercício combinado, atividades resistidas e treinamento de força, combinados com os operadores booleanos “AND” e “OR”. **Resultados:** Após a seleção, cinco estudos foram incluídos. O exercício combinado foi eficaz na redução da pressão arterial dos pacientes, com uma redução média da pressão arterial sistólica de -0,73 mmHg; IC 95%, -1,12 a -0,34, e da pressão arterial diastólica de -0,67 mmHg; IC 95%, -1,06 a -0,29. **Conclusão:** O treinamento combinado mostrou-se eficaz no tratamento de pacientes com HAS.

Palavras-chave: hipertensão arterial; exercício resistido; exercício aeróbico; exercício combinado.

Introduction

Systemic arterial hypertension (SAH) is a common chronic condition that affects millions of people worldwide, being responsible for various functional limitations, such as reduced physical capacity and increased cardiovascular risk [1]. Hypertensive individuals often experience difficulty performing daily activities due to impairment of the cardiovascular system and muscle function [2]. Regular physical exercise, especially resistance exercise and aerobic exercise, has been identified as an effective intervention to improve cardiovascular function and quality of life in these patients [3,4].

Functional limitations in hypertensive individuals develop primarily due to increased arterial stiffness, endothelial dysfunction, and loss of muscle mass, processes that compromise the efficiency of the cardiovascular and muscular systems [5]. Additionally, hypertension can trigger a vicious cycle of sedentary behavior, further exacerbating these limitations and increasing the risk of comorbidities such as stroke and heart failure [6,7]. The progression of these limitations is often silent, making early diagnosis and effective management of the condition more challenging.

Aerobic exercise improves cardiovascular capacity and the efficiency of the circulatory system in hypertensive individuals, helping to reduce blood pressure levels and increase physical endurance [8]. On the other hand, resistance exercise contributes to increased muscle strength, improved body composition, and enhanced muscle functionality, which are essential for functional independence [9]. The combination of these two types of exercises has shown promising results in improving both cardiovascular health and the overall functional capacity of hypertensive individuals [10].

This study is justified by the need to gain a deeper understanding of the combined effects of resistance and aerobic exercise on the functionality and cardiovascular health of hypertensive individuals. Although there is evidence highlighting the benefits of each type of exercise separately, few studies have investigated the efficacy of a combined protocol. The aim of this study is to review the impacts of combining resistance and aerobic exercises on the blood pressure of individuals with systemic arterial hypertension.

Methods

Study type and registration

This systematic review was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [11]. This study was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the number CRD42025633308.

Eligibility criteria

For this systematic review, the PICOS strategy was used, where the population studied consisted of patients with systemic arterial hypertension. The intervention involved performing both aerobic and resistance training, in comparison with patients who did not engage in any of these activities or performed only one of them. The outcomes were related to blood pressure, lean body mass, strength, and cardio-respiratory function.

Randomized clinical trials were used, with no restrictions on language or year. To be eligible, the clinical trial had to study aerobic exercise combined with resistance training in individuals of both sexes, aged over 18 years, and diagnosed with systemic arterial hypertension. The studies were excluded if the patients had comorbidities other than systemic hypertension, if diuretics or beta-blockers were used with the exercise, if only aerobic or resistance exercise was assessed individually, or if blood pressure was assessed at a time other than pre- and post-training, for example during sleep.

Sources of information

We conducted a computer-based search, consulting PubMed, OVID, Web of Sciences, Physiotherapy Evidence Database (PEDro), Latin American and Caribbean Health Sciences Literature (LILACS), and Scientific Electronic Library Online (SciELO). We also searched the reference lists of previous systematic reviews and eligible clinical trials for this review. The search for articles was completed in December 2024.

Search

The research was based on the previously described PICOS¹¹ strategy and the Boolean operators AND and OR. The search strategy is presented in Supplement 1.

Data collection process

For the extraction of selected articles, titles were reviewed (first stage), followed by abstracts (second stage), and full-text reading (third stage). Subsequently, an exploratory reading of the selected studies was conducted, followed by a selective and analytical reading. The data extracted from the articles were summarized by author, journal, year, title, and conclusions to gather key information for the research.

The assessment of the methodological quality of the studies was conducted by two independent reviewers. In cases of disagreement between them, the article was read in fully for reevaluation. If the disagreement persisted, a third reviewer assessed the study and made the final decision.

Data items

Four authors independently extracted data from the published reports using a standardized data extraction process, considering study population aspects such as

mean age, sex, number of patients, and diagnosis, as well as aspects of the intervention performed, including sample size, type of inspiratory muscle training, presence of supervision, intensity, frequency, and duration of each session. Additionally, follow-up, loss to follow-up, outcome measures, and reported results were analyzed.

Quality of each study

The methodological quality was assessed using the PEDro scale, which scores 11 items: (1) eligibility criteria, (2) random allocation, (3) concealed allocation, (4) baseline comparison, (5) blinding of participants, (6) blinding of therapists, (7) blinding of assessors, (8) adequate follow-up, (9) intention-to-treat analysis, (10) between-group comparisons, and (11) point estimates and variability. Items are scored as present (1) or absent (0), resulting in a maximum total score of 10 points, as the first item is not included in the final score.

Synthesis of results

The presence of heterogeneity was evaluated using the Chi² test and the I² statistic. This statistic illustrates the percentage of variability in effect estimates from heterogeneity rather than sampling error.

Statistical assessment

The mean difference between groups and the respective 95% confidence intervals were calculated and used to quantify the effect of continuous outcomes. For the meta-analyses in which the studies used the same scales, the results were presented as mean difference (MD) and 95% confidence intervals. Otherwise, the effects were calculated using standardized mean difference (SMD) and 95% confidence intervals. The effect size of the interventions was defined as small (MD < 10% of the scale or SMD < 0.4); moderate (MD = 10% to 20% of the scale or SMD = 0.41 to 0.7) or large (MD > 20% of the scale or SMD > 0.7).

Results

Selection and characteristics of the studies

According to the data presented in the article selection flowchart (Figure 01), the database search yielded a total of 866 articles. Initially, 543 were excluded based on title screening. Then, out of the 189 articles evaluated based on abstract reading, 165 were considered not directly related to the topic of this study. Thus, 24 articles were selected for full-text reading. Of these, 10 were excluded for using only aerobic activity as a treatment for hypertension, and 9 for not evaluating both aerobic and resistance activities together. Therefore, this systematic review included 5 articles that met the eligibility criteria for inclusion in the present review.

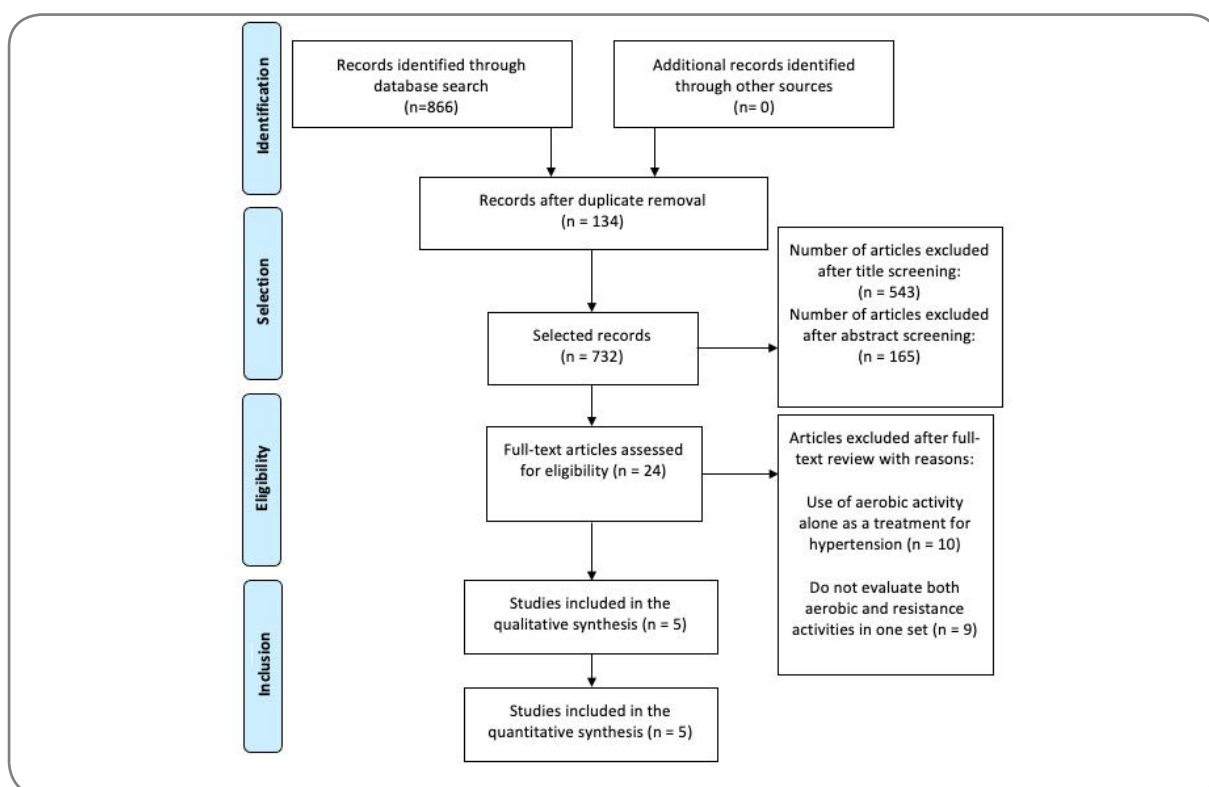


Figure 1 – Research strategy flowchart

Methodological quality results

According to the PEDro scale, four studies were classified as having moderate methodological quality, and only one was rated as high quality. All studies already had their scores available on the PEDro website. The criteria assessed by the PEDro scale and the scores obtained by each study are detailed below in Table I.

Table I – Classification of articles on the PEDro Scale

Study	0	1	2	3	4	5	6	7	8	9	10	Total
Caminiti <i>et al.</i> [14]		x		x				x		x	x	5b
Pedralli <i>et al.</i> [15]	x	x		x			x	x		x	x	6b
Pires <i>et al.</i> [16]	x	x	x	x				x			x	5b
Alemayehu <i>et al.</i> [17]	x	x		x				x		x	x	5b
Masroor <i>et al.</i> [18]		x		x			x	x	x	x	x	7a

Items on the PEDro Scale: (1) Eligibility criteria were specified (* - this item is not used to calculate the PEDro score); (2) Subjects were randomly allocated to groups; (3) Allocation of subjects was concealed; (4) Groups were initially similar concerning the most important prognostic indicators; (5) All subjects participated in the study blindly; (6) All therapists administering the therapy did so blindly; (7) All assessors measuring at least one key outcome did so blindly; (8) Measurements of at least one key outcome were obtained in more than 85% of the subjects initially allocated to the groups; (9) All subjects from whom outcome measurements were obtained received the treatment or control condition as allocated, or when this was not the case, data analysis was performed for at least one outcome by intention-to-treat; (10) Results of statistical inter-group comparisons were reported for at least one key outcome; (11) The study presents both precision measures and variability measures for at least one key outcome. Abbreviations: x = Item present; 0 = Item not present. Quality Rating: a = High methodological quality; b = Moderate methodological quality

Participants

Table II – General characteristics of the studies included in this review

Study (year)	Country	Participants	Intervention	Control	Outcomes and evaluation time points	Results
Caminiti <i>et al.</i> [14]	Italy	Male subjects 45 yr old, enrolled in a cardiac rehabilitation program, with established diagnosis of hypertension (BP > 140/90 mmHg).	Patients performed aerobic exercises before resistance exercises in each session.	Each exercise session included 10 min of warm-up, 10 min of cool-down, and 60 min of aerobic exercise on a treadmill.	Blood pressure 12 weeks	Systolic and diastolic 24-h BP values decreased significantly ($P < 0.01$) in both groups, without between-groups differences ($P = 0.11$)
Pedralli <i>et al.</i> [15]	Brazil	Participants were adults diagnosed with prehypertension or hypertension (resting SBP $\geq$ 130 mmHg or DBP $\geq$ 80 mmHg)	Combined aerobic and resistance training	Aerobic exercise training Resistance exercise training	Blood pressure 8 weeks	After 8 weeks of exercise training, blood pressure was reduced in all 3 groups: -5.1mmHg in SBP (95%CI -10.1, 0.0; $p=0.003$) in AT; -4.0mmHg in SBP (95%CI -7.8, -0.5; $p=0.027$) in RT; and -3.2mmHg in DBP (95%CI -7.9, 1.5; $p=0.001$) in CT.
Pires <i>et al.</i> [16]	Brazil	Resistant hypertension was defined as an uncontrolled BP despite the use of ≥ 3 antihypertensive medications at optimal doses, including a diuretic if possible, or patients with controlled BP using ≥ 4 antihypertensive medications	Combined aerobic and resistance training	Aerobic exercise training Resistance exercise training	Blood pressure 8 weeks	Significant reductions on ambulatory BP were found in people with RH after AER, RES, and COM sessions.
Alemayehu <i>et al.</i> [17]	Ethiopia	The study's source population consisted of all hypertensive patients who met the inclusion criteria	Combined training group (resistance plus aerobic; CTG)	Aerobic training group (ATG) Resistance training group (RTG), Control group (CG)	Blood pressure 12 weeks	Combined training resulted in significant reductions in BP: SBP - 17.75mmHg, DBP -12.5 mmHg.
Masroor <i>et al.</i> [18]	India	Sedentary women aged 30–50 years and diagnosed with either Stage 1 or Stage 2 hypertension	Combined aerobic and resistance training (CART)	Not receive any supervised exercise intervention and continued to follow their usual medical routine	Blood pressure 4 weeks	CART group demonstrated a significant decrease in systolic blood pressure, and diastolic blood pressure ($p < 0.05$).

Table III - General characteristics of the studies included in this review

Study (year)	Frequency	Intensity	Time	Type
Caminiti <i>et al.</i> [14]	Three times a week	Aerobic - RPE 13–14 during the whole study Resistance - 10 repetitions per set, two sets for each exercise at 60% of 1 RM, with 2min rest between sets	Each session lasting 80min	Aerobic
Pedralli <i>et al.</i> [15]	3 times a week, was reduced to 2 times a week	Aerobic - progressive intensity of 50–75% heart rate reserve or 11–14 of the rating of perceived exertion scale Resistance - 4 sets of 8–12 repetitions, with 60–80% 1-RM intensity	40 minutes	Aerobic and resistance
Pires <i>et al.</i> [16]	Not informed	Aerobic - 50–60% of maximal heart rate Resistance - 6 exercises with 4 sets of 12 submaximal repetitions performed at moderate intensity (3–5 on the adapted Borg scale)	45 minutes	Aerobic and resistance
Alemayehu <i>et al.</i> [17]	Not informed	Aerobic - initial heart rate of 64% HRmax and gradually increased to approximately 76%HRmax as the intervention progressed Resistance - circuit type of RT was used with intervals of 15–20s between exercises, with 3 sets of 10 repetitions with a rest of 1–2 minutes between sets.	Each session consisted of 30 minutes of resistance training and 30 minutes of aerobic exercise.	aerobic and resistance
Masroor <i>et al.</i> [18]	3 days/ week	Aerobic training was performed at 50–80% of HRmax Resistance training constituted 3 sets of 10 repetitions of 5 exercises	20 minutes	aerobic and resistance

Systolic blood pressure

Four studies analyzed the impact of exercise on systolic blood pressure. For the meta-analysis of this comparison, a random model was used ($I^2 = 92\%$, $df = 3$, $p < 0.00001$), in which there was a statistically significant difference between the groups in the comparison between the exercise and the control (difference between the means -0.73 mmHg; 95% CI, -1.12 to -0.34 ; Fig. 2).

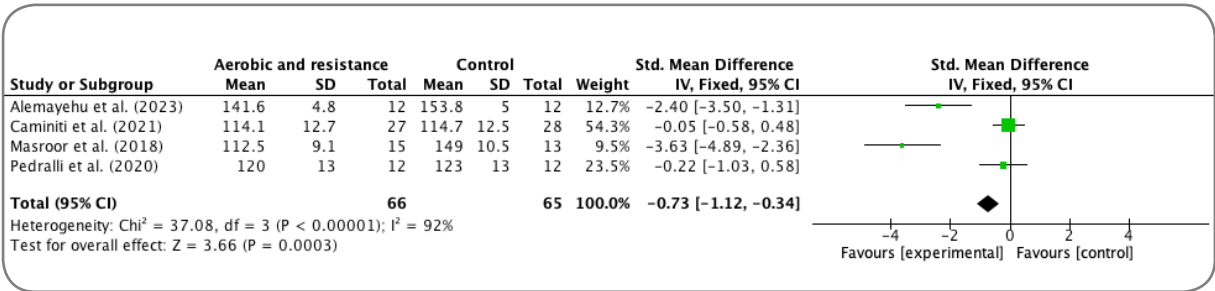


Figura 2 – Gráfico de floresta com os resultados da meta-análise.

Diastolic blood pressure

Four studies analyzed the impact of exercise on diastolic blood pressure. For the meta-analysis of this comparison, a random model was used ($I^2 = 91\%$, $df = 3$, $p < 0.00001$), in which there was a statistically significant difference between the groups in the comparison between the exercise and the control (difference between the means -0.67 mmHg; 95% CI, -1.06 to -0.29 ; Fig. 3).

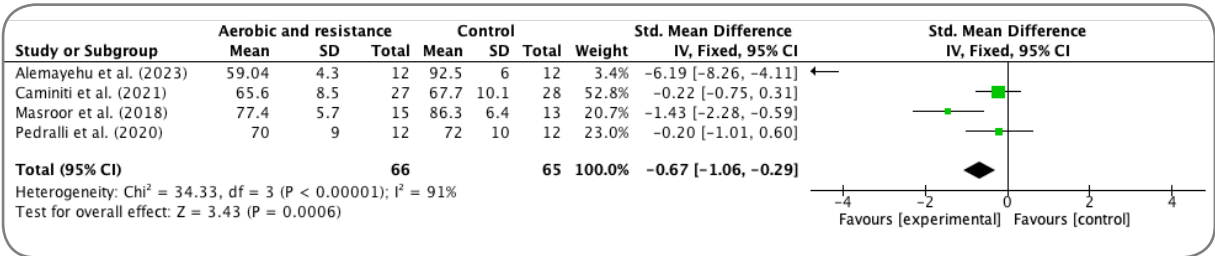


Figure 3 – Forest plot of the results of the meta-analysis

Discussion

The literature on the effects of physical exercise in reducing blood pressure in hypertensive individuals is extensive and consistently highlights the efficacy of both aerobic exercise and resistance exercise, whether performed separately or in combination. Although the magnitude of the response may vary depending on the type of exercise, the duration of the program, and the characteristics of the studied population, the findings suggest that physical exercise, in general, provides substantial benefits in hypertension management.

The reduction in blood pressure observed in the reviewed studies aligns with what is widely reported in the literature, where both aerobic and resistance exercise have positive effects on BP. Caminiti et al. [14], for example, observed significant BP

reductions after 12 weeks of training, with no differences between groups that performed aerobic exercise followed by resistance training. This lack of difference between modalities can be explained by the mechanics of exercise, where both aerobic and resistance training contribute to BP reduction through distinct but complementary mechanisms. Aerobic exercise, by improving cardiorespiratory fitness, helps decrease peripheral vascular resistance and enhances endothelial function. Meanwhile, resistance training, by increasing muscle mass, may reduce arterial stiffness and promote better regulation of the autonomic nervous system. These combined effects may be responsible for the overall BP reduction observed, regardless of the exercise order.

On the other hand, the study by Pedralli *et al.* [15], which investigated different training modalities (aerobic, resistance, and combined), indicated that aerobic exercise had a stronger impact on systolic blood pressure, with a reduction of 5.1 mmHg, while the resistance group experienced a decrease of 4.0 mmHg. This finding is consistent with previous studies suggesting that aerobic exercise has a more pronounced effect on systolic blood pressure due to increased blood volume and improved cardiac and vascular function, facilitating a reduction in pressure during physical exertion. The underlying mechanism involves cardiovascular adaptations that decrease arterial stiffness and enhance endothelial function, both critical factors in blood pressure regulation. Additionally, Alemayehu *et al.* [17] observed a more significant reduction in their participants after 12 weeks of combined exercise, with a drop of 17.75 mmHg in SBP and 12.5 mmHg in diastolic blood pressure. This could be explained by the broader range of physiological adaptations promoted by combined training, which impacts both the cardiovascular system and increases in muscle mass and strength—two factors that may interact to enhance BP control more effectively.

Another important aspect observed in the studies was the favorable response of exercise in managing more resistant cases of hypertension, as seen in the study by Pires *et al.* [16], which focused on patients with resistant hypertension. After eight weeks of aerobic, resistance, and combined exercise, participants showed a significant reduction in ambulatory blood pressure, a particularly relevant finding since patients with resistant hypertension often struggle to control blood pressure despite using multiple medications. In these cases, exercise may help not only by reducing peripheral vascular resistance but also by improving function and modulating the sympathetic nervous system, both of which are often dysregulated in resistant hypertensive patients. These findings are supported by Masroor *et al.* [17], who observed a significant BP reduction in sedentary women with hypertension after just four weeks of combined training, reinforcing the idea that even short-term exercise programs can provide substantial benefits.

The reduction in blood pressure observed after exercise can be explained by several physiological mechanisms. Aerobic exercise improves the efficiency of the cardiovascular system by increasing the heart's ability to pump blood and promoting the dilation of blood vessels, mainly through the improvement of endothelial function, which increases the release of nitric oxide, promoting vasodilation [19].

Additionally, aerobic exercise increases plasma volume, reducing blood viscosity and facilitating blood flow, which contributes to a decrease in peripheral vascular resistance [20]. On the other hand, resistance exercise increases muscle mass, creating a larger “reservoir” of blood in the muscles, which reduces peripheral resistance and, consequently, blood pressure [21]. It also improves endothelial function and decreases sympathetic nervous system activation, reducing vasoconstriction and contributing to blood pressure control [22]. The combination of both types of exercise results in a more robust response, affecting both the cardiovascular and musculoskeletal systems, with adaptations that help effectively control blood pressure [23].

Studies focusing on populations with resistant hypertension, such as Pires *et al.* [16], indicate that exercise can be a particularly valuable intervention, especially when combined with pharmacological therapy. Resistant hypertension is often associated with vascular control imbalances, impaired renal function, and heightened sympathetic nervous system activity, and exercise may help mitigate these effects. The activation of the parasympathetic nervous system and the reduction in sympathetic activity during exercise appear to be key factors contributing to the observed improvements in blood pressure.

Limitations

The main limitations of this study include high heterogeneity among the studies selected for the meta-analysis, which may have influenced the consistency of the results and the interpretation of the data. Variability in methods, populations, and interventions across the included studies makes it difficult to generalize the conclusions and may reduce the precision of the estimates. Additionally, the number of volunteers in the studies does not necessarily guarantee robustness in the findings, as there is the possibility of statistical errors leading to spurious results. These errors may occur due to uncontrolled variabilities or flaws in study design, affecting the validity of the conclusions. These limitations suggest that the results should be interpreted with caution, and further research with standardized methodologies is needed to confirm the findings.

Conclusion

In summary, the reviewed studies reinforce the importance of physical exercise in hypertension management, emphasizing aerobic and resistance modalities, particularly combined training, which appears to offer the greatest benefits. The physiological response to exercise involves cardiovascular and musculoskeletal adaptations that work synergistically to lower blood pressure. Although aerobic exercise seems to have a more pronounced effect on reducing systolic blood pressure, combined training provides additional benefits, especially for individuals with more severe or resistant hypertension. Thus, the prescription of physical exercise should be considered

an effective therapeutic strategy in hypertension treatment, serving as an alternative or complement to traditional pharmacological treatments.

Conflict of interest

The authors declare no conflict of interest.

Sources of funding

The authors declare that they have not received funding.

Author's contribution

Conception and design of the research: Cordeiro AL, Costa G, Freitas G, Bispo L; **Data collection:** Costa G, Freitas G, Bispo L; **Data analysis and interpretation:** Cordeiro AL; **Statistical analysis:** Cordeiro AL; **Manuscript writing:** Costa G, Freitas G, Bispo L; **Critical revision of the manuscript for important intellectual content:** Cordeiro AL

References

1. Kreutz R, Brunström M, Burnier M, Grassi G, Januszewicz A, Muiesan ML, et al. 2024 European Society of Hypertension clinical practice guidelines for the management of arterial hypertension. *Eur J Intern Med.* 2024;126:1-15. doi: 10.1016/j.ejim.2024.05.033
2. Madden BP, Shaw EJ. Skeletal muscle exercise training in pulmonary arterial hypertension. *Int J Cardiol.* 2017;246:59-60. doi: 10.1016/j.ijcard.2017.03.017
3. Dibben GO, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, Taylor RS. Exercise-based cardiac rehabilitation for coronary heart disease: a meta-analysis. *Eur Heart J.* 2023 Feb 7;44(6):452-469. doi: 10.1093/eurheartj/ehac747
4. Hansen D, Abreu A, Ambrosetti M, Cornelissen V, Gevaert A, Kemps H, et al. Exercise intensity assessment and prescription in cardiovascular rehabilitation and beyond: why and how: a position statement from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol.* 2022 Feb 19;29(1):230-245. doi: 10.1093/eurjpc/zwab007. Erratum in: *Eur J Prev Cardiol.* 2024 Sep 20;31(13):e102. doi: 10.1093/eurjpc/zwad397
5. Lopes S, Afreixo V, Teixeira M, Garcia C, Leitão C, Gouveia M, et al. Exercise training reduces arterial stiffness in adults with hypertension: a systematic review and meta-analysis. *J Hypertens.* 2021;39(2):214-222. doi: 10.1097/HJH.0000000000002619
6. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. *Nat Rev Nephrol.* 2019;15(1):45-57. doi: 10.1038/s41581-018-0093-4
7. Pescatello LS, Franklin BA, Fagard R, et al. Exercise and hypertension: American College of Sports Medicine position stand. *Med Sci Sports Exerc.* 2022;54(6):1077-1095. doi: 10.1249/MSS.0000000000002762
8. Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. *J Am Coll Cardiol.* 2020;75(5):500-10. doi: 10.1016/j.jacc.2019.11.052
9. Fyfe JJ, Hamilton DL, Daly RM. Minimal-dose resistance training for improving muscle mass, strength, and function: a narrative review of current evidence and practical considerations. *Sports Med.* 2022;52(3):463-79. doi: 10.1007/s40279-021-01605-8. Epub 2021 Nov 25. PMID: 34822137
10. Saeidi M, Ravanbod R. Effects of resistance added on aerobic training on autonomic function in cardiac patients. *Anatol J Cardiol.* 2022;26(2):80-89. doi: 10.5152/AnatolJCardiol.2021.215
11. Maher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* 2009;6(7):e1000097
12. Santos CMC, Pimenta CAM, Nobre MRC. The PICO strategy for the research question construction and evidence search. *Rev Lat-Am Enfermagem.* 2007;15(3):508-11. doi: 10.1590/S0104-11692007000300023
13. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther.* 2003; 83:713-21. PMID: 12882612
14. Caminiti G, Iellamo F, Mancuso A, Cerrito A, Montano M, Manzi V, Volterrani M. Effects of 12 we-

eks of aerobic versus combined aerobic plus resistance exercise training on short-term blood pressure variability in patients with hypertension. *J Appl Physiol* (1985). 2021;130(4):1085-92. doi: 10.1152/jappphysiol.00910.2020

15. Pedralli ML, Marschner RA, Kollet DP, Neto SG, Eibel B, Tanaka H, Lehnen AM. Different exercise training modalities produce similar endothelial function improvements in individuals with prehypertension or hypertension: a randomized clinical trial Exercise, endothelium and blood pressure. *Sci Rep*. 2020 May 6;10(1):7628. doi: 10.1038/s41598-020-64365-x. Erratum in: *Sci Rep*. 2020 Jun 24;10(1):10564. doi: 10.1038/s41598-020-67586-2

16. Pires NF, Coelho-Júnior HJ, Gambassi BB, Faria APC, Ritter AMV, Barboza CA, *et al*. Combined aerobic and resistance exercises evokes longer reductions on ambulatory blood pressure in resistant hypertension: a randomized crossover trial. *Cardiovasc Ther*. 2020;2020:8157858. doi: 10.1155/2020/8157858

17. Alemayehu A, Teferi G. Effectiveness of aerobic, resistance, and combined training for hypertensive patients: a randomized controlled trial. *Ethiop J Health Sci*. 2023;33(6):1063-1074. doi: 10.4314/ejhs.v33i6.17

18. Masroor S, Bhati P, Verma S, Khan M, Hussain ME. Heart rate variability following combined aerobic and resistance training in sedentary hypertensive women: a randomised control trial. *Indian Heart J*. 2018;70(Suppl 3):S28-S35. doi: 10.1016/j.ihj.2018.03.005

19. Li C, Wu S, Lei B, Zang W, Tao X, Yu L. Effect of aerobic exercise on endothelial function in hypertensive and prehypertensive patients: a systematic review and meta-analysis of randomized controlled trials. *J Hypertens*. 2025 May 1;43(5):727-38. doi: 10.1097/HJH.0000000000003980

20. Dawson EA, Green DJ, Cable NT, Thijssen DH. Effects of acute exercise on flow-mediated dilatation in healthy humans. *J Appl Physiol* (1985). 2013 Dec;115(11):1589-98. doi: 10.1152/jappphysiol.00450.2013

21. Ratajczak M, Krzywicka M, Szulińska M, Musiałowska D, Kusy K, Karolkiewicz J. Effects of 12-week combined strength and endurance circuit training program on insulin sensitivity and retinol-binding protein 4 in women with insulin-resistance and overweight or mild obesity: A randomized controlled trial. *Diabetes Metab Syndr Obes*. 2024;17:93-106. doi: 10.2147/DMSO.S432954

22. Akins JD, Washio T, Fu Q. Autonomic control of blood pressure in women: The roles of hypertension and aging. *Auton Neurosci*. 2025;260:103274. doi: 10.1016/j.autneu.2025.103274

23. Pescatello LS, Franklin BA, Fagard RH, Farguhar WB, Kelley GA, *et al*. American College of Sports Medicine position stand. Exercise and hypertension. *Med Sci Sports Exerc*. 2015;47(9):1973-83.

Anexo 1

((("hypertense"[All Fields] OR "hypertension"[MeSH Terms] OR "hypertension"[All Fields] OR "hypertension s"[All Fields] OR "hypertensions"[All Fields] OR "hypertensive"[All Fields] OR "hypertensive s"[All Fields] OR "hypertensives"[All Fields] OR ("hypertension"[MeSH Terms] OR "hypertension"[All Fields] OR ("blood"[All Fields] AND "pressure"[All Fields] AND "high"[All Fields]) OR "blood pressure high"[All Fields]) OR ("hypertension"[MeSH Terms] OR "hypertension"[All Fields] OR ("blood"[All Fields] AND "pressures"[All Fields] AND "high"[All Fields]) OR "blood pressures high"[All Fields]) OR ("hypertension"[MeSH Terms] OR "hypertension"[All Fields] OR ("high"[All Fields] AND "blood"[All Fields] AND "pressure"[All Fields]) OR "high blood pressure"[All Fields]) OR ("hypertension"[MeSH Terms] OR "hypertension"[All Fields] OR ("high"[All Fields] AND "blood"[All Fields] AND "pressures"[All Fields]) OR "high blood pressures"[All Fields])) AND ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR "exercises"[All Fields] OR "exercise therapy"[MeSH Terms] OR ("exercise"[All Fields] AND "therapy"[All Fields]) OR "exercise therapy"[All Fields] OR "exercising"[All Fields] OR "exercise s"[All Fields] OR "exercised"[All Fields] OR "exerciser"[All Fields] OR "exercisers"[All Fields] OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercise"[All Fields] AND "physical"[All Fields]) OR "exercise physical"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercises"[All Fields] AND "physical"[All Fields]) OR "exercises physical"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("physical"[All Fields] AND "exercise"[All Fields]) OR "physical exercise"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("physical"[All Fields] AND "activities"[All Fields]) OR "physical activity"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("activities"[All Fields] AND "physical"[All Fields]) OR "activities physical"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("activity"[All Fields] AND "physical"[All Fields]) OR "activity physical"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("physical"[All Fields] AND "activities"[All Fields]) OR "physical activities"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercise"[All Fields] AND "aerobic"[All Fields]) OR "exercise aerobic"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("aerobic"[All Fields] AND "exercise"[All Fields]) OR "aerobic exercise"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("aerobic"[All Fields] AND "exercises"[All Fields]) OR "aerobic exercises"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercises"[All Fields] AND "aerobic"[All Fields]) OR "exercises aerobic"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercise"[All Fields] AND "isometric"[All Fields]) OR "exercise isometric"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercises"[All Fields] AND "isometric"[All Fields]) OR "exercises isometric"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("isometric"[All Fields] AND "exercises"[All Fields]) OR "isometric exercises"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("isometric"[All Fields] AND "exercise"[All Fields]) OR "isometric exercise"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("acute"[All Fields] AND "exercise"[All Fields]) OR "acute exercise"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("acute"[All Fields] AND "exercises"[All Fields]) OR "acute exercises"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercise"[All Fields] AND "acute"[All Fields]) OR "exercise acute"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercises"[All Fields] AND "acute"[All Fields]) OR "exercises acute"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercise"[All Fields] AND "training"[All Fields]) OR "exercise training"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("exercise"[All Fields] AND "trainings"[All Fields]) OR "exercise trainings"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("training"[All Fields] AND "exercise"[All Fields]) OR "training exercise"[All Fields]) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields] OR ("trainings"[All Fields] AND "exercise"[All Fields])))) AND (clinicaltrial[Filter])

