QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

Cite as: KOŁKOWSKI, Wiktor, JANISZEWSKA, Anna, JAKUBCZYK, Jan, WĄDOŁOWSKA, Monika, ANTOSZEWSKA, Magdalena, GRABOWSKA, Maria, GOZDERA, Katarzyna, PIELAK, Wiktoria, KOSZEWSKI, Jakub and OSZAST, Katarzyna. Beyond Aerobic Exercise: The Role of Resistance and Isometric Training in Hypertension Management in Older Adults — A Narrative Review. Quality in Sport. 2026;59:72762. https://doi.org/10.12775/QS.2026.59.72762

ARTICLE TIMELINE
Received: 26.05.2026. Revised: 20.06.2026. Accepted: 20.06.2026. Published: 21.06.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines: Medical Sciences; Health Sciences.
Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Nauki medyczne; Nauki o zdrowiu.

Beyond Aerobic Exercise: The Role of Resistance and Isometric Training in Hypertension Management in Older Adults — A Narrative Review

1. **Wiktor Kołkowski**
Independent Public Healthcare Complex in Pruszków, Al. Armii Krajowej 2/4, 05-800 Pruszków, Poland
https://orcid.org/0009-0003-6304-0368
wiktorkolkowski@gmail.com

2. **Anna Janiszewska**
Grochowski Hospital, Dr. Rafał Masztak Memorial Hospital Ltd. Ul. Grenadierów 51/59, 04-073 Warsaw, Poland
https://orcid.org/0009-0008-9347-1296
anna.julia.janiszewska@gmail.com

3. **Jan Jakubczyk**
District Medical Center in Grojec. UL. Piotra Skargi 10, 05-600 Grojec, Poland
https://orcid.org/0009-0003-3012-5218
janjakubczyk@onet.pl

4. **Monika Wądołowska**
Grochowski Hospital, Dr. Rafał Masztak Memorial Hospital Ltd. Ul. Grenadierów 51/59, 04-073 Warsaw, Poland
https://orcid.org/0009-0002-4166-2249
monikawadolowska@onet.pl

5. **Magdalena Antoszewska**

Infant Jesus Clinical Hospital, Lindleya 4, 02-005 Warsaw, Poland

https://orcid.org/0009-0005-9820-6940

magdalena.antoszewska21@gmail.com

6. **Maria Grabowska**

Dr Tytus Chałubiński District Hospital in Zakopane, ul. Kamieniec 10, 34-500 Zakopane, Poland

https://orcid.org/0009-0007-4515-6606

maragrab2000@gmail.com

7. **Katarzyna Gozdera**

Central Clinical Hospital, Ul. Banacha 1A, 02-097 Warsaw, Poland

https://orcid.org/0009-0009-2784-061X

kagozdera@interia.pl

8. **Wiktoria Pielak**

Wojskowy Instytut Medyczny, Szaserów 128, 04-141 Warsaw, Poland

https://orcid.org/0009-0006-2391-996X

wiktoriapielak@gmail.com

9. **Jakub Koszewski**

Mazovian "Bródnowski" Hospital, Ludwika Kondratowicza 8, 03-242 Warsaw, Poland

https://orcid.org/0009-0001-7817-3302

koszewski.jakub2@gmail.com

10. **Katarzyna Oszast**

Grochowski Hospital, Dr. Rafał Masztak Memorial Hospital Ltd. Ul. Grenadierów 51/59, 04-073 Warsaw, Poland

https://orcid.org/0009-0001-3980-1548

kasia.oszast@icloud.com

Abstract

Background

Hypertension is a leading modifiable risk factor for cardiovascular morbidity and mortality, particularly in older adults. While aerobic exercise has traditionally been considered the foundation of non-pharmacological management, growing evidence suggests that other exercise modalities may provide comparable or even greater antihypertensive effects.

Aim

The aim of this review was to compare the effects of aerobic, dynamic resistance, and isometric exercise on blood pressure in older adults with hypertension, with particular emphasis on clinical effectiveness, safety, and practical usefulness.

Materials and methods

A narrative review of the literature was conducted using PubMed and Google Scholar. Studies published between 2021 and 2026 were included, with a focus on randomized controlled trials, systematic reviews, and meta-analyses evaluating the effects of different exercise modalities on blood pressure.

Results

All major exercise modalities were associated with clinically meaningful reductions in blood pressure. Aerobic exercise demonstrated consistent antihypertensive effects and remains the most established intervention. Dynamic resistance training showed comparable reductions in blood pressure and provided additional functional benefits relevant to older adults. Isometric exercise, particularly handgrip protocols, demonstrated the largest reductions in resting blood pressure in several analyses, although results were less consistent and based on more heterogeneous evidence.

Conclusions

Exercise remains a key component of hypertension management in older adults. While aerobic exercise continues to play a central role, resistance training should be considered an equally important therapeutic strategy. Isometric exercise appears to be a promising adjunct but requires further standardization and long-term evaluation. A multimodal and individualized approach to exercise prescription is likely to provide the greatest clinical benefit.

Keywords: hypertension, aerobic exercise, resistance training, isometric exercise, blood pressure, older adults.

1. Introduction

1.1. Burden of hypertension in older adults

Hypertension remains one of the most important modifiable risk factors for cardiovascular morbidity and mortality worldwide, with its prevalence increasing substantially with age. In older adults, elevated blood pressure is strongly associated with coronary artery disease, stroke, heart failure, and functional decline, playing a major role in both mortality and reduced quality of life [23]. As populations continue to age, effective and sustainable strategies for blood pressure control have become an increasing focus of clinical practice.

1.2. Role of physical activity in hypertension management

Lifestyle modification, particularly regular physical activity, is a cornerstone of non-pharmacological hypertension management. Current guidelines recommend exercise-based interventions, and aerobic exercise has traditionally been regarded as a first-line strategy because of its well-documented antihypertensive effects and favorable impact on overall cardiovascular risk [4,23]. In addition to lowering blood pressure, aerobic exercise contributes to improvements in cardiorespiratory fitness and metabolic health, supporting its broad clinical relevance.

1.3. Expanding the role of resistance training

In recent years, the traditional emphasis on aerobic exercise as the primary modality for blood pressure control has been increasingly re-evaluated. Dynamic resistance training, previously considered mainly as a supportive component of exercise programs, is now gaining attention as a potentially important element of hypertension management.

This shift is particularly relevant in older adults, in whom maintaining muscle strength, functional capacity, and independence is a central aspect of overall health. Resistance training may therefore offer benefits that extend beyond cardiovascular outcomes, making it a clinically meaningful option in this population.

1.4. Isometric exercise: emerging interest

Isometric exercise has more recently attracted interest as a potential alternative or adjunct approach in hypertension management. Simple and time-efficient protocols, such as handgrip

training, have been widely studied and are easy to implement in both supervised and home-based settings.

Despite the increasing number of studies, its role in clinical practice remains less clearly defined. Differences in training protocols, limited long-term data, and uncertainty regarding its broader functional effects make its place in routine clinical practice less certain, particularly in older adults with comorbidities [5,15].

1.5. Knowledge gap and rationale

Although different forms of exercise are known to lower blood pressure, their relative clinical value in older adults remains uncertain [4,5,7,9]. This is particularly relevant in routine practice, where patients vary widely in functional capacity, comorbidities, and ability to engage in specific types of exercise.

A clearer understanding of how different exercise modalities compare in terms of effectiveness, safety, and practical applicability may help guide more individualized treatment strategies.

1.6. Aim of the study

The aim of this review is to compare the effects of aerobic, dynamic resistance, and isometric exercise on blood pressure in older adults with hypertension, with particular emphasis on clinical effectiveness, safety, and real-world effectiveness. Additionally, this review seeks to determine whether current evidence supports a shift from a predominantly aerobic-focused model to a more individualized and multimodal approach to exercise prescription in this population.

2. Materials and methods

A narrative review approach was used in the present study. The literature search was conducted using major scientific databases, including PubMed and Google Scholar. The search strategy included combinations of the following keywords: hypertension, aerobic exercise, resistance training, isometric exercise, blood pressure, older adults.

The review focused primarily on studies published between 2021 and 2026 to ensure the inclusion of the most recent and clinically relevant evidence. Preference was given to high-quality publications, particularly randomized controlled trials, systematic reviews, and meta-analyses, although other relevant study types were also considered where appropriate. Key

large-scale analyses, including network meta-analyses comparing different exercise modalities, were also included due to their high level of evidence [4].

The primary population of interest comprised older adults (≥60 years) with hypertension. However, due to the limited number of studies conducted exclusively in this age group, selected studies involving broader adult populations were also included when they provided relevant insights into the comparative effectiveness, safety, or mechanisms of exercise interventions.

The review examined the effects of different exercise modalities, including aerobic training, dynamic resistance training, and isometric exercise, on blood pressure outcomes. Additional aspects such as safety, adherence, and practical usefulness were also considered.

The selection of articles was based on relevance to the research question, methodological quality, and applicability to clinical practice. Additional studies were identified through manual screening of reference lists of selected publications. Given the narrative nature of this review, no formal quantitative synthesis or meta-analysis was conducted. Therefore, the findings should be interpreted with consideration of potential selection bias and heterogeneity across included studies.

3. Results

3.1. Aerobic training

Aerobic exercise remains one of the most consistently studied and effective non-pharmacological interventions for blood pressure reduction. Across contemporary meta-analyses, it is associated with modest but clinically meaningful reductions in both systolic and diastolic blood pressure. Large-scale analyses confirm its reproducible antihypertensive effect and support its long-standing role as a reference standard in hypertension management [4].

Evidence in older adults is consistent with these findings [7]. Recent systematic reviews focusing on hypertensive populations aged ≥60 years demonstrate significant reductions in both SBP and DBP following aerobic interventions, although pooled estimates are not always uniformly reported [7]. In addition to its effect on resting blood pressure, aerobic exercise has been shown to improve autonomic regulation and may favorably influence blood pressure variability, further supporting its cardioprotective role [8,24].

Overall, aerobic training provides a reliable reduction in blood pressure and is still a cornerstone of treatment, particularly due to its well-established effects on cardiorespiratory fitness and global cardiovascular risk.

3.2. Dynamic resistance training

Dynamic resistance training should now be viewed as more than a secondary option in hypertension management. Contemporary meta-analyses demonstrate that its antihypertensive effect is comparable to that of aerobic exercise, with no significant difference in the magnitude of blood pressure reduction between these modalities [4,9]. This finding is reinforced by recent evaluations of randomized controlled trials in hypertensive populations, which consistently show clinically meaningful reductions in both SBP and DBP following resistance training interventions [6,9,20]. Evidence specific to older adults further supports its effectiveness [2,7]. Importantly, resistance training offers additional benefits, particularly relevant in older populations, including improvements in muscle strength, functional capacity, and independence [2,7]. These effects extend beyond blood pressure control and strengthen its clinical value.

3.3. Isometric exercise

Isometric exercise, particularly handgrip-based protocols, has gained increasing attention because of its antihypertensive effects. In recent network meta-analyses, isometric training has demonstrated the largest reductions in resting systolic blood pressure among exercise modalities and consistently ranks highest in comparative effectiveness analyses [4]. Systematic reviews suggest that isometric exercise may produce greater reductions in blood pressure than traditional aerobic or resistance training, although the results are not entirely uniform across studies [1,5,10,13]. Some analyses indicate that differences between modalities are not always statistically significant, and outcomes may depend on factors such as protocol design, supervision, and patient characteristics [5,10,15].

Data in older hypertensive populations suggest that isometric training may be particularly effective, although the evidence remains limited and heterogeneous [7,16].

3.4. Comparison of modalities

Taken together, current evidence supports three key observations. First, all major exercise modalities, aerobic, resistance, and isometric, are effective in lowering blood pressure [4,6,7,9]. Second, dynamic resistance training appears broadly comparable to aerobic exercise in terms of antihypertensive efficacy [4,9]. Third, isometric exercise often demonstrates the largest

reductions in resting blood pressure, although its evidence base is less robust and less standardized [1,4,5,10].

It is important to note that the relative effectiveness of each modality depends on the outcome considered. While isometric exercise may provide the greatest reductions in office blood pressure, aerobic and resistance training offer broader physiological benefits, including improvements in functional capacity, cardiovascular fitness, and overall health status [4,7,20,23]. Combined training may therefore represent a particularly attractive strategy in clinical practice [7,19].

Table 1. Comparative effects of different exercise modalities on blood pressure based on network meta-analysis of randomized controlled trials [4].

Exercise modality	Effect on SBP (mmHg)	Effect on DBP (mmHg)	Key characteristics	Clinical interpretation
Aerobic training	−4.49	−2.53	Continuous, moderate-intensity activities (e.g. walking, cycling)	Established standard; reliable BP reduction with strong evidence and additional cardiometabolic benefits
Dynamic resistance training	−4.55	−3.04	Repetitive muscle contractions against external resistance	Comparable antihypertensive effect to aerobic exercise; additional benefits for strength and functional capacity
Isometric exercise	−8.24	−4.00	Static contractions (e.g. handgrip, wall squat)	Largest BP reduction; promising modality, but limited standardization and long-term evidence
Combined training (aerobic and resistance)	−6.04	−2.54	Integrated aerobic and resistance exercise programs	Broadest overall benefit; effective for BP reduction and functional outcomes

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure. **Data adapted from [4].**

4. Discussion

4.1. Aerobic and resistance training: complementary roles

Aerobic exercise retains its central role in clinical practice for good reason. Its efficacy is well established, its safety profile is familiar, and its benefits go beyond blood pressure reduction to cardiorespiratory fitness, metabolic health, and overall cardiovascular risk reduction [4,8,23].

At the same time, current evidence indicates that dynamic resistance training provides a comparable antihypertensive effect [4,9]. This has important implications in older adults, in whom prolonged aerobic exercise may be limited by frailty, musculoskeletal disorders, or reduced exercise tolerance. Beyond its effect on blood pressure, it contributes to the maintenance of muscle strength, functional capacity, and independence—factors that are central to health in older populations [2,7,20].

Aerobic and resistance training should therefore be considered complementary rather than competing strategies.

4.2. Isometric exercise: interpretation and limitations

Isometric exercise is one of the most interesting areas in this literature, but it is also prone to overinterpretation. In several recent reviews, isometric protocols rank highest for reductions in resting office blood pressure, and the effect is at least numerically greater than that seen with traditional aerobic or dynamic resistance training [1,4,5,10,13]. This makes isometric exercise highly relevant, particularly for patients who need a brief, simple, low-equipment intervention.

At the same time, caution is warranted. The isometric literature remains heterogeneous with respect to protocol design, contraction intensity, supervision, and mode of delivery [5,15]. Much of the evidence is based on handgrip exercise, which is easy to study and easy to prescribe, but does not provide the wider functional and conditioning benefits associated with aerobic or dynamic resistance exercise [5,10]. In addition, effects beyond resting office blood pressure, including ambulatory blood pressure and blood pressure variability, remain less consistently characterized than office BP responses [17,24].

For these reasons, isometric exercise should not be framed as a replacement for walking, cycling, or structured resistance training. At present, it can be considered a promising adjunct or, in selected patients, a pragmatic alternative when other modalities are poorly tolerated, inaccessible, or unlikely to be maintained.

4.3. Multimodal and individualized prescription

From a practical standpoint, no single exercise modality addresses all of the clinical priorities seen in older adults with hypertension. Aerobic training supports cardiovascular fitness, resistance training contributes to the preservation of strength and physical function, and isometric exercise may offer a time-efficient option for blood pressure reduction in selected patients [1,4,5,7].

This favors a multimodal approach, particularly where aerobic and resistance components can be combined. Available evidence also suggests that combined training may have favorable effects on blood pressure while providing broader functional benefits [7,19].

At the same time, exercise prescription should remain individualized. Age, frailty, musculoskeletal limitations, comorbidities, medication burden, access to supervision, and patient preference all matter. If two strategies offer similar antihypertensive benefits, the strategy a patient can actually perform consistently is usually the better one.

4.4. Safety, limitations, and clinical implications

Exercise interventions appear to be generally safe in patients with hypertension when appropriately prescribed [5,15,23]. Aerobic exercise has the most established safety profile, while resistance training requires attention to proper technique and avoidance of excessive Valsalva maneuvers [6,20,23]. Isometric exercise also appears well tolerated in selected populations, although the available safety data remain more limited and less standardized [5,15].

Adherence remains a key determinant of real-world effectiveness, particularly in older adults, where feasibility and patient preference may influence the choice of exercise modality [4,16,23].

Several limitations of the available evidence should be acknowledged. Many studies include heterogeneous populations, and although data in older adults are available, they remain relatively limited compared with the broader adult literature [2,7]. In addition, variability in exercise protocols and outcome measures complicates direct comparisons across modalities [4,5]. Most studies focus on office blood pressure, with fewer data on ambulatory measurements, blood pressure variability, and long-term cardiovascular outcomes [17,24].

These limitations are particularly relevant for isometric exercise, where short-term reductions in resting blood pressure are reported more consistently than longer-term clinical outcomes [5,15].

From a practical standpoint, these findings support an individualized approach to exercise prescription. Given the comparable antihypertensive effects of aerobic and resistance training, the choice of modality should be guided by patient characteristics and feasibility. Isometric exercise may be incorporated as a complementary option, particularly in patients unable to perform more demanding forms of exercise.

5. Conclusions

Exercise-based interventions remain a fundamental part of hypertension management in older adults. Aerobic exercise continues to be the most established approach, but current evidence indicates that dynamic resistance training provides a comparable antihypertensive effect and deserves a routine place in clinical practice.

Isometric exercise, particularly handgrip protocols, appears capable of lowering blood pressure to a clinically relevant degree. However, the heterogeneity of available studies and the limited long-term data make it more appropriate as a complementary option than as a primary standalone strategy.

In practice, exercise prescription in older adults should not be reduced to a single preferred modality. The most useful strategy is likely to be one that reflects the patient's functional status, comorbidities, and capacity to adhere over time.

Disclossure

Author Contributions:

Conceptualization: Wiktor Kołkowski

Methodology: Magdalena Antoszewska, Jan Jakubczyk

Software: Wiktor Kołkowski, Anna Janiszewska

Validation: Maria Grabowska, Monika Wądołowska

Formal analysis: Katarzyna Gozdera, Jakub Koszewski

Investigation: Wiktoria Pielak

Resources: Katarzyna Oszast, Jakub Koszewski, Anna Janiszewska

Data curation: Maria Grabowska, Monika Wądołowska

Writing – original draft: Jan Jakubczyk, Magdalena Antoszewska, Wiktoria Pielak, Wiktor Kołkowski

Writing – review & editing: Wiktor Kołkowski, Anna Janiszewska, Katarzyna Gozdera

Visualization: Jan Jakubczyk, Magdalena Antoszewska, Maria Grabowska, Monika Wądołowska

Supervision: Wiktor Kołkowski

Project administration: Wiktor Kołkowski

All authors have read and approved the published version of the manuscript.

Funding: The study did not receive external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgements: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

Declaration of the use of generative AI and AI-assisted technologies in the writing process: During the preparation of this manuscript, the authors utilized AI tools for language correction and stylistic refinement in order to enhance clarity and readability. Following the use of these tools, the authors carefully reviewed and revised the content as necessary and assume full responsibility for the accuracy, integrity, and conclusions presented in the publication.

References

1. *Zhou, C., Li, S., Zhang, Z. et al. Efficacy and moderators of isometric resistance training (IRT) on resting blood pressure among patients with pre- to established hypertension: a multilevel meta-review and regression analysis. BMC Sports Sci Med Rehabil 17, 243 (2025). https://doi.org/10.1186/s13102-025-01286-0.*
2. *Negin Ghasemi Kahrizsangi, Mohammad Ali Faridi Dastjerdi, Faraz Golafshan, Navidreza Ghasemi Kahrizsangi, Mohammad Hossein Shafieyoun, MohammadHadi Parsaeifar, Resistance training and blood pressure: Insights from a meta-analysis of the aging population, Archives of Gerontology and Geriatrics, Volume 137,2025,105941,ISSN 0167-4943, https://doi.org/10.1016/j.archger.2025.105941.*
3. *Barbosa RM, Santos ACND, Sacramento MDSD, Santos CPCD, Souza PES, Santana US, Petto J. Effect of isometric resistance exercise on blood pressure in normotensive adults: a systematic review of randomized clinical trials. Ann Transl Med 2025;13(2):16. https://doi.org/10.21037/atm-24-124.*

4. Edwards JJ, Deenmamode AHP, Griffiths M, Arnold O, Cooper NJ, Wiles JD, O'Driscoll JM. Exercise training and resting blood pressure: a large-scale pairwise and network meta-analysis of randomised controlled trials. Br J Sports Med. 2023 Oct;57(20):1317-1326. https://doi.org/10.1136/bjsports-2022-106503. Epub 2023 Jul 25. PMID: 37491419.

5. Edwards JJ, Coleman DA, Ritti-Dias RM, Farah BQ, Stensel DJ, Lucas SJE, Millar PJ, Gordon BDH, Cornelissen V, Smart NA, Carlson DJ, McGowan C, Swaine I, Pescatello LS, Howden R, Bruce-Low S, Farmer CKT, Leeson P, Sharma R, O'Driscoll JM. Isometric Exercise Training and Arterial Hypertension: An Updated Review. Sports Med. 2024 Jun;54(6):1459-1497. https://doi.org/10.1007/s40279-024-02036-x. Epub 2024 May 19. PMID: 38762832; PMCID: PMC11239608.

6. Correia, R.R., Veras, A.S.C., Tebar, W.R. *et al.* Strength training for arterial hypertension treatment: a systematic review and meta-analysis of randomized clinical trials. *Sci Rep* **13**, 201 (2023). https://doi.org/10.1038/s41598-022-26583-3.

7. Keyvan Hejazi, Zahra Ataran Iraj, Ayoub Saeidi, Anthony C. Hackney, Fatiha Laziri, Katsuhuko Suzuki, Ismail Laher, Zouhal Hassane, Differential effects of exercise training protocols on blood pressures and lipid profiles in older adults patients with hypertension: A systematic review and meta-analysis, Archives of Gerontology and Geriatrics, Volume 131, 2025, 105737, ISSN 0167-4943, https://doi.org/10.1016/j.archger.2024.105737.

8. Wang J, Mao S, Xia F and Li X (2025) Effects of aerobic and resistance exercise on patients with hypertension: a systematic review and meta-analysis focusing on the sympathetic nervous system. Front. Cardiovasc. Med. 12:1569638. https://doi.org/10.3389/fcvm.2025.1569638.

9. Morita, H., Abe, M., Suematsu, Y. *et al.* Resistance exercise has an antihypertensive effect comparable to that of aerobic exercise in hypertensive patients: a meta-analysis of randomized controlled trials. *Hypertens Res* **48**, 733–743 (2025). https://doi.org/10.1038/s41440-024-01998-9.

10. Baffour-Awuah, B., Pearson, M.J., Dieberg, G. *et al.* Isometric Resistance Training to Manage Hypertension: Systematic Review and Meta-analysis. *Curr Hypertens Rep* **25**, 35–49 (2023). https://doi.org/10.1007/s11906-023-01232-w

11. Zinszer, K., Isabirye, H., Kalumuna, C. *et al.* Estimating the efficacy of isometric handgrip training to lower resting blood pressure in patients with stage 1 hypertension in Eastern Uganda compared to standard of care: study protocol for a randomized controlled trial. *Trials* **26**, 582 (2025). https://doi.org/10.1186/s13063-025-09258-y.
12. Yan Y, Sun C, Pan L, Ma H and Xie H (2026) Effects of isometric training based on the entire population on blood pressure regulation: systematic review and meta-analysis of randomized controlled trials. Front. Public Health 14:1774541. https://doi.org/10.3389/fpubh.2026.1774541.
13. Almeida, J.P.A.d.S., Bessa, M., Lopes, L.T.P. *et al.* Isometric handgrip exercise training reduces resting systolic blood pressure but does not interfere with diastolic blood pressure and heart rate variability in hypertensive subjects: a systematic review and meta-analysis of randomized clinical trials. *Hypertens Res* **45**, 930–931 (2022). https://doi.org/10.1038/s41440-022-00883-7.
14. Chen, Y. C., Cheng, C. Y., McNally, B., Benn, J., Varnom, H., Robbins, K., & Metcalfe, R. S. (2025). Low and high frequency isometric handgrip exercise training similarly reduce resting blood pressure in young normotensive adults: A randomised controlled trial. *Journal of Sports Sciences*, *43*(3), 234–244. https://doi.org/10.1080/02640414.2024.2448638.
15. Baffour-Awuah, B., Pearson, M.J., Smart, N.A. *et al.* Safety, efficacy and delivery of isometric resistance training as an adjunct therapy for blood pressure control: a modified Delphi study. *Hypertens Res* **45**, 483–495 (2022). https://doi.org/10.1038/s41440-021-00839-3.
16. Champaiboon J, Jitkaew T, Rangkla S, Petchlorlian A (2026) Effect of home-based isometric handgrip exercise with a commercially available device on blood pressure in older adults with hypertension: A randomized controlled trial. PLOS ONE 21(3): e0342563. https://doi.org/10.1371/journal.pone.0342563.
17. Jung SW, Seong JY, Kim S, Min HJ, Choi TG, Kim HJ, Heffernan KS, Jae SY. Acute effects of isometric plank exercise on 24-hour ambulatory blood pressure in young adults with prehypertension: a randomized cross-over trial. Clin Hypertens. 2025;31(1):e40. https://doi.org/10.5646/ch.2025.31.e40.
18. Kobayashi, H. Resistance exercise and hypertension: comparable benefits to aerobic exercise?. *Hypertens Res* **48**, 1236–1238 (2025). https://doi.org/10.1038/s41440-024-02076-w.

19. Addis Alemayehu, & Getu Teferi. (2023). Effectiveness of Aerobic, Resistance, and Combined Training for Hypertensive Patients: A Randomized Controlled Trial. *Ethiopian Journal of Health Sciences*, *33*(6). https://doi.org/10.4314/ejhs.v33i6.17.
20. Banks NF, Rogers EM, Stanhewicz AE, Whitaker KM, Jenkins NDM. Resistance exercise lowers blood pressure and improves vascular endothelial function in individuals with elevated blood pressure or stage-1 hypertension. Am J Physiol Heart Circ Physiol. 2024 Jan 1;326(1):H256-H269. https://doi.org/10.1152/ajpheart.00386.2023. Epub 2023 Nov 17. PMID: 37975709; PMCID: PMC11219052.
21. Fecchio, R.Y., de Sousa, J.C.S., Oliveira-Silva, L. *et al*. Effects of dynamic, isometric and combined resistance training on blood pressure and its mechanisms in hypertensive men. *Hypertens Res* **46**, 1031–1043 (2023). https://doi.org/10.1038/s41440-023-01202-4.
22. Craighead DH, Heinbockel TC, Freeberg KA, Rossman MJ, Jackman RA, Jankowski LR, Hamilton MN, Ziemba BP, Reisz JA, D'Alessandro A, Brewster LM, DeSouza CA, You Z, Chonchol M, Bailey EF, Seals DR. Time-Efficient Inspiratory Muscle Strength Training Lowers Blood Pressure and Improves Endothelial Function, NO Bioavailability, and Oxidative Stress in Midlife/Older Adults With Above-Normal Blood Pressure. J Am Heart Assoc. 2021 Jul 6;10(13):e020980. https://doi.org/10.1161/JAHA.121.020980. Epub 2021 Jun 29. PMID: 34184544; PMCID: PMC8403283.
23. McEvoy JW, McCarthy CP, Bruno RM, Brouwers S, Canavan MD, Ceconi C, Christodorescu RM, Daskalopoulou SS, Ferro CJ, Gerdts E, Hanssen H, Harris J, Lauder L, McManus RJ, Molloy GJ, Rahimi K, Regitz-Zagrosek V, Rossi GP, Sandset EC, Scheenaerts B, Staessen JA, Uchmanowicz I, Volterrani M, Touyz RM; ESC Scientific Document Group. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. Eur Heart J. 2024 Oct 7;45(38):3912-4018. https://doi.org/10.1093/eurheartj/ehae178. Erratum in: Eur Heart J. 2025 Apr 7;46(14):1300. https://doi.org/10.1093/eurheartj/ehaf031. Erratum in: Eur Heart J. 2025 Dec 1;46(45):4949. https://doi.org/10.1093/eurheartj/ehaf659. PMID: 39210715.
24. Hao, Z., Tran, J., Lam, A., Yiu, K. and Tsoi, K. (2025), Aerobic, Resistance, and Isometric Exercise to Reduce Blood Pressure Variability: A Network Meta-Analysis of 15 Clinical Trials. J Clin Hypertens, 27: e70050. https://doi.org/10.1111/jch.70050.