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COMMENT

Resistance exercise and hypertension: comparable benefits to aerobic exercise?

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Hypertension is a significant contributor to global morbidity and mortality, accounting for an estimated 1.13 billion affected individuals worldwide [1]. Nonpharmacological interventions, particularly exercise, have emerged as critical strategies for managing this condition. Aerobic exercise is widely recognized for its ability to reduce blood pressure (BP) and is recommended in current guidelines by organizations such as the European Society of Hypertension (ESH) and the Japanese Society of Hypertension (JSH) [2, 3]. However, resistance exercise has historically been underutilized in clinical practice due to limited and inconsistent evidence, and it is recommended in the guidelines primarily as a complementary approach to aerobic exercise. The meta-analysis by Morita et al., published in this issue of *Hypertension Research*, provides compelling evidence that resistance exercise—both dynamic and isometric—yields antihypertensive effects comparable to aerobic exercise [4]. This study represents a landmark in exercise physiology and hypertension management, offering robust data from 84 randomized controlled trials (RCTs) involving 5065 hypertensive patients.

Mechanisms of BP reduction

The physiological mechanisms through which different types of exercise reduce BP are diverse but converge on improving vascular health. Aerobic exercise enhances endothelial function by increasing nitric oxide bioavailability, reducing oxidative stress, and improving arterial compliance [5]. It also induces structural adaptations in the vasculature, such as increased capillary density and enhanced arterial elasticity, which collectively contribute to sustained blood pressure reductions over time [6]. Resistance exercise, particularly dynamic resistance, has been shown to stimulate the release of vasodilatory substances, such as adenosine, potassium ions, and CO2, which collectively improve microvascular function [7]. Moreover, dynamic resistance exercise is associated with reductions in systemic vascular resistance and improvements in metabolic parameters, including lipid profiles and insulin sensitivity, which further support its antihypertensive effects.

Isometric resistance exercise, on the other hand, operates through mechanisms such as autonomic modulation and baroreceptor sensitivity enhancement [8]. Sustained muscle contractions during isometric exercise generate localized increases in intramuscular pressure, promoting adaptations in neural reflex pathways. Edwards et al. reported that isometric exercise leads to significant reductions in peripheral vascular resistance and improvements in heart rate variability, suggesting a central role of neural regulation [9]. Additionally, isometric exercise has been linked to enhanced endothelial-dependent vasodilation in the trained muscle groups, although the systemic implications of these localized effects remain an area of ongoing investigation [10]. These findings underscore the distinct pathways through which aerobic and resistance exercises achieve BP reduction.

Comprehensive analysis of exercise modalities

Morita et al. systematically analyzed 84 RCTs involving 5065 hypertensive patients, making this one of the most comprehensive meta-analyses in the field of exercise and hypertension [4]. The authors demonstrated significant

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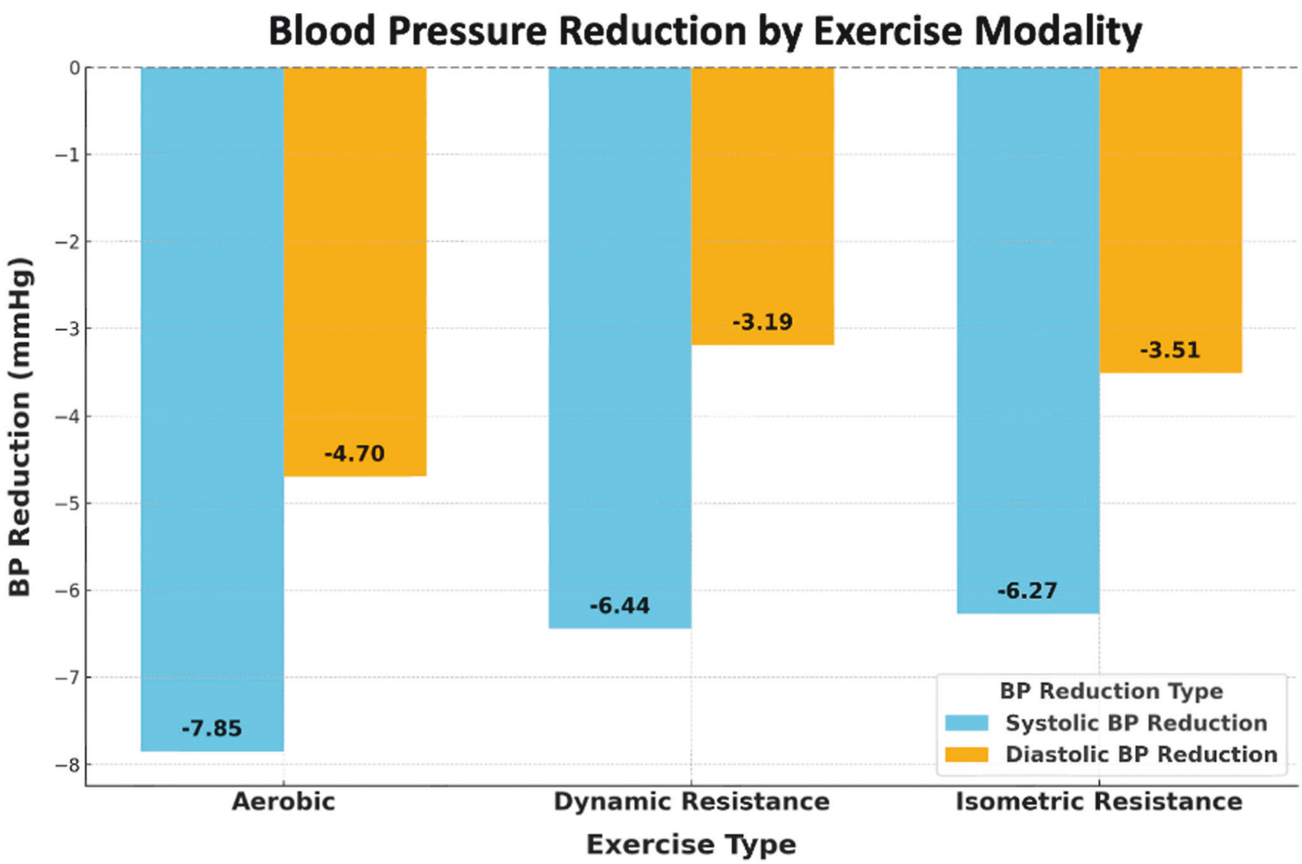

Fig. 1 Blood pressure reduction by exercise modality. This figure illustrates the average reductions in systolic and diastolic blood pressure achieved through different exercise modalities, based on the study by Morita et al. [4]. The modalities include aerobic exercise, dynamic resistance exercise, and isometric resistance exercise

reductions in both systolic BP (SBP, −7.52 mmHg) and diastolic BP (DBP, −4.36 mmHg) across all exercise types compared to non-exercise controls. Notably, there were no statistically significant differences in BP reduction between aerobic, dynamic resistance, and isometric resistance exercises (interaction $p = 0.815$ for SBP, $p = 0.417$ for DBP) (Fig. 1).

These findings are clinically significant as they support resistance exercise—traditionally viewed as complementary in hypertension guidelines—as an equally effective intervention. This expands therapeutic options, particularly for patients with mobility limitations or those unable to perform aerobic exercise.

Clinical and public health implications

The demonstrated equivalency of resistance exercise to aerobic exercise challenges the current emphasis in guidelines, such as those from the ESH and JSH, which prioritize aerobic exercise for BP reduction. Incorporating resistance exercise into recommendations provides additional benefits, such as improved muscle mass, strength, and functional independence, especially for older adults at risk of sarcopenia. Moreover, resistance exercise's low cost and accessibility make it an attractive option for resource-limited settings, where hypertension prevalence is high and access to pharmacologic treatments may be constrained.

Limitations and future directions

While this meta-analysis provides valuable insights into the antihypertensive effects of resistance exercise, several limitations should be considered. The extremely high heterogeneity ($I^2 = 99.1\%$) among the included studies poses a significant challenge in interpreting the pooled results. This likely reflects considerable variation in participant characteristics, exercise regimens, and study settings, yet the analysis does not sufficiently explore these sources of heterogeneity. Additionally, the absence of 24-h ambulatory blood pressure monitoring data limits the ability to fully evaluate the circadian effects of exercise interventions, which could provide critical insights into their broader impact on blood pressure regulation.

Moreover, the lack of long-term follow-up data precludes an understanding of the sustainability of blood pressure reductions over time, particularly for resistance exercise modalities. This is a critical gap, as long-term adherence and efficacy are essential considerations for integrating these interventions into clinical practice. Furthermore, the safety of resistance exercise, especially in hypertensive patients with comorbidities, was not assessed in this analysis. Without information on adverse events or potential risks, the clinical applicability of these findings is limited.

Additionally, exploring the potential synergistic benefits of combining aerobic and resistance exercises is crucial to determine whether specific combinations of these modalities can optimize blood pressure control. The meta-analysis highlights the individual efficacy of these exercise types but does not address whether their combination could produce additive or complementary effects, an area that warrants further investigation.

Finally, potential publication bias, suggested by the asymmetry in the funnel plots, raises concerns about the completeness of the evidence base. This bias may result in an overestimation of the reported effects, highlighting the need for future analyses to include unpublished or non-significant findings. Addressing these limitations will be essential to fully establish the role of resistance exercise in hypertension management and to refine recommendations for its clinical use.

Compliance with ethical standards

Conflict of interest The author declares no competing interests.

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References

1. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 368 population-based measurement studies with 19·1 million participants. Lancet. 2017;389:37–55.
2. McEvoy JW, McCarthy CP, Bruno RM, Brouwers S, Canavan MD, Ceconi C, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. Eur Heart J. 2024;45:3912–4018.
3. Umemura S, Arima H, Arima S, Asayama K, Dohi Y, Hirooka Y, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). Hypertens Res. 2019;42:1235–481.
4. Morita H, Abe M, Suematsu Y, Uehara Y, Koyoshi R, Fujimi K, et al. Resistance exercise has an antihypertensive effect comparable to aerobic exercise in hypertensive patients: a meta-analysis of randomized controlled trials. Hypertens Res. 2024; https://doi.org/10.1038/s41440-024-01998-9.
5. Di Francescomarino S, Sciartilli A, Di Valerio V, Di Baldassarre A, Gallina S. The effect of physical exercise on endothelial function. Sports Med. 2009;39:797–812.
6. Gliemann L, Buess R, Nyberg M, Hoppeler H, Odriozola A, Thaning P, et al. Capillary growth, ultrastructure remodelling and exercise training in skeletal muscle of essential hypertensive patients. Acta Physiol. 2015;214:210–20.
7. Fecchio RY, de Sousa JCS, Oliveira-Silva L, da Silva Junior ND, Pio-Abreu A, da Silva GV, et al. Effects of dynamic, isometric and combined resistance training on blood pressure and its mechanisms in hypertensive men. Hypertens Res. 2023;46:1031–43.
8. Taylor KA, Wiles JD, Coleman DD, Sharma R, O'driscoll JM. Continuous Cardiac Autonomic and Hemodynamic Responses to Isometric Exercise. Med Sci Sports Exerc. 2017;49:1511–9.
9. Edwards JJ, Wiles J, O'Driscoll J. Mechanisms for blood pressure reduction following isometric exercise training: a systematic review and meta-analysis. J Hypertens. 2022;40:2299–306.
10. McGowan CL, Visocchi A, Faulkner M, Verduyn R, Rakobowchuk M, Levy AS, et al. Isometric handgrip training improves local flow-mediated dilation in medicated hypertensives [published correction appears in Eur J Appl Physiol. 2008 May;103(2):251]. Eur J Appl Physiol. 2007;99:227–34.