

Editorial

Lifestyle modifications to attenuate the exaggerated blood pressure response to exercise in men

Takeshi Otsuki^{1,*}¹Faculty of Sport and Health Sciences, Ryutsu Keizai University, 120 Ryugasaki, 301-8555 Ibaraki, Japan***Correspondence:** takeshi.otsuki17@gmail.com (Takeshi Otsuki)**Abstract**

The blood pressure response to physical activities is an essential contributor to ambulatory blood pressure and a risk factor for future cardiovascular disease. Peak exercise blood pressure and the blood pressure elevation from rest to peak exercise are higher in apparently healthy men without a prior history of hypertension than in their female peers. Lifestyle modifications can decrease blood pressure during aerobic and resistance exercise. However, there may be sex differences in the effects of lifestyle modifications on blood pressure responses to exercise. Additionally, the optimal blood pressure interventions probably differ between men and women due to sex differences in lifestyles. In men, hypertension not only increases the risk of cardiovascular disease but also worsens quality of life by contributing to erectile dysfunction. Further studies are warranted to attenuate the exaggerated blood pressure response to exercise in men.

Keywords

Aerobic exercise; Dietary habit; Dietary supplementation; Exercise blood pressure; Exercise training; Resistance exercise; Sex difference

The prevalence of hypertension differs by sex; specifically, a higher proportion of young and middle-aged men have hypertension compared with age-matched women. The National Health and Nutrition Examination Survey 2013–2016 in the United States reported that the prevalences of hypertension in men and women, respectively, were 26% and 13% in those aged 20–34 years, 43% and 32% in those aged 35–44 years, 56% and 50% in those aged 45–54 years, and 66% and 65% in those aged 55–64 years [1]. The proportion of men with hypertension further increases after age 65 (71% in those 65–74 years and 80% in those 75 years and older), even though it is lower than in women of the same age (78% and 86%, respectively) [1]. Consistent with the link between hypertension and mortality, age-adjusted death rates attributable to hypertension were higher in men relative to women [1].

Adults with normal resting blood pressure should still pay attention to ambulatory blood pressure (ABP). Banegas *et al.* [2] reported that masked hypertension (i.e., normal office blood pressures and elevated 24-hour ABP) had a larger hazard ratio for all-cause mortality versus sustained hyperten-

sion. An essential contributor to ABP is the blood pressure response to physical activities, since an exaggerated response to aerobic exercise, such as walking or cycling, is a risk factor for future cardiovascular disease [3]. Additionally, resistance exercise, such as lifting objects and mopping, is a component of many activities of daily living. Elevated blood pressure during resistance exercise is a risk factor for elevated 24-hour ABP, independent of resting blood pressure [4]. It is also a marker of masked hypertension [5] and a risk factor for future essential hypertension [6].

The role of exercise blood pressure as a risk factor for cardiovascular disease may be more crucial in men than in women. Daida *et al.* [7] demonstrated that peak exercise blood pressure and the blood pressure elevation from rest to peak exercise (i.e., delta blood pressure) were higher in apparently healthy men without a prior history of hypertension than in their female peers. The sex differences in peak and delta blood pressure during exercise persisted in individuals aged 70–79 years [7]. Lifestyle modifications to attenuate the exaggerated blood pressure response to exercise is a significant research issue, particularly in men.

Regarding blood pressure during aerobic exercise, several excellent studies have investigated the effects of lifestyle modifications. Kokkinos *et al.* [8] and Pitsavos *et al.* [9] demonstrated that 16 weeks of aerobic exercise training decreased blood pressure during submaximal and peak exercise in normotensive and hypertensive men. Kim *et al.* [10] reported that blood pressure during submaximal ergometer cycling decreased 2 hours after the intake of grape seed extract in prehypertensive men. These results suggest that exercise training and dietary supplementation decrease blood pressure during aerobic exercise in men. Additionally, Michishita *et al.* [11] showed that a 12-week lifestyle modification program consisting of aerobic exercise and diet counseling decreased blood pressure elevation during ergometer cycling in women with an exaggerated blood pressure response to exercise.

With respect to blood pressure during resistance exercise, Kruse *et al.* [12] reported that 8 weeks of sodium nitrate supplementation decreased mean blood pressure during hand grip exercise in men and women with peripheral artery disease. In healthy middle-aged and older men and women, we demonstrated that 6 weeks of aerobic exercise training decreased systolic blood pressure during arm curl exercise [13]. The aerobic training-induced reduction in blood pressure during resistance exercise may be associated with improved nitric oxide bioavailability [14]. These results suggest that lifestyle modifications can decrease the blood pressure response to resistance exercise.

However, there may be sex differences in the effects of lifestyle modifications on blood pressure responses to exercise. For example, Collier *et al.* [15] reported that arterial stiffness, a crucial factor contributing to increased blood pressure during aerobic [16] and resistance [4, 5] exercise, was increased in men but not in women during 4-week resistance exercise training. Resistance exercise is an essential training modality to prevent frailty. If resistance training increases the blood pressure response to exercise in men, measures including aerobic exercise training, dietary modifications, and supplementation may be needed. Regarding another potential difference between men and women, Hayashi *et al.* [17] demonstrated that estrogen receptor- α polymorphism affects arterial stiffness in postmenopausal women who engaged in daily physical activity. If polymorphisms were implicated in the blood pressure response to exercise in men, this would help guide decisions regarding lifestyle modifications. Finally, lifestyles differ between men and women. For instance, Japanese men are more likely to be smokers and to have a higher sodium intake than women. Thus, the optimal blood pressure interventions probably differ between men and women. The beneficial effects of sex-specific lifestyle modifications can be detected in implementation and epidemiological studies, even if sex differences are not observed in well-controlled intervention studies with small sample sizes.

In men, hypertension not only increases the risk of cardiovascular disease but also worsens quality of life by contributing to erectile dysfunction. Further studies are warranted to attenuate the exaggerated blood pressure response to exercise

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Author contributions

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Conflict of interest

The author declare that no conflicts of interest exist.

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