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Isometric Exercise Training for Blood Pressure Management: A Systematic Review and Meta-analysis

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Abstract

Objective: To conduct a systematic review and meta-analysis quantifying the effects of isometric resistance training on the change in systolic blood pressure(SBP), diastolic blood pressure (DBP), and mean arterial pressure in subclinical populations and to examine whether the magnitude of change in SBP and DBP was different with respect to blood pressure classification.

Patients and Methods: We conducted a systematic review and meta-analysis of randomized controlled trials lasting 4 or more weeks that investigated the effects of isometric exercise on blood pressure in healthy adults (aged ≥18 years) and were published in a peer-reviewed journal. PubMed, CINAHL, and the Cochrane Central Register of Controlled Trials were searched for trials reported between January 1, 1966, and July 31, 2013. We included 9 randomized trials, 6 of which studied normotensive participants and 3 that studied hypertensive patients, that included a total of 223 participants (127 who underwent exercise training and 96 controls).

Results: The following reductions were observed after isometric exercise training: SBP—mean difference (MD), −6.77 mm Hg (95% CI, −7.93 to −5.62 mm Hg; $P<.001$); DBP—MD, −3.96 mm Hg (95% CI, −4.80 to −3.12 mm Hg; $P<.001$); and mean arterial pressure—MD, −3.94 mm Hg (95% CI, −4.73 to −3.16 mm Hg; $P<.001$). A slight reduction in resting heart rate was also observed (MD, −0.79 beats/min; 95% CI, −1.23 to −0.36 beats/min; $P=.003$).

Conclusion: Isometric resistance training lowers SBP, DBP, and mean arterial pressure. The magnitude of effect is larger than that previously reported in dynamic aerobic or resistance training. Our data suggest that this form of training has the potential to produce significant and clinically meaningful blood pressure reductions and could serve as an adjunctive exercise modality.

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Current National Health and Nutrition Examination Survey data suggest that the prevalence of hypertension varies with ethnicity and sex but is between 25% and 43% in the US population, with an upward trend noted over the past 3 surveys.[1] Hypertension, or the long-term elevation of resting arterial blood pressure (BP) above 140 mm Hg systolic (SBP) and/or 90 mm Hg diastolic (DBP) remains one of the most significant modifiable risk factors for cardiovascular disease (eg, coronary artery disease, stroke, heart failure).[2] In light of the prevalence of hypertension,[3] the associated economic health care costs are considerable. Additionally, although antihypertensive medications generally have minimal adverse effects, they are efficacious in perhaps 50% of those who are prescribed treatment.[4] Both national and international treatment guidelines for primary and secondary prevention of hypertension recommend nonpharmacological lifestyle modifications as the first line of therapy, including increasing levels of physical activity.[5] There is class I, level B evidence that 150 minutes of physical activity weekly offers an alternative that may be used to complement antihypertensive medication,[6] although the optimal exercise training prescription remains unclear.

One important factor that may impact the effectiveness to lower BP is the type of exercise performed. Recent analyses suggest that isometric exercise may elicit BP reductions greater than those seen with dynamic aerobic and resistance exercise.[7,8] Currently, dynamic aerobic endurance activity is the preferred exercise modality for BP management. Aerobic exercise often

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requires access to a gymnasium or suitable equipment; moreover, considerable energy expenditure is required to elicit BP reductions, which is also time-consuming. For these reasons, adherence to aerobic exercise is often suboptimal. Isometric exercise involves sustained contraction against an immovable load or resistance with no or minimal change in length of the involved muscle group. Low- to moderate-intensity isometric activity can be performed anywhere, requires relatively inexpensive equipment, and does not elicit the same level of cardiovascular stress (eg, rate-pressure product) as aerobic activity. Isometric activity has previously been associated with exaggerated hypertensive responses, but recent work has suggested that isometric handgrip activity may become a new tool in the nonpharmacological treatment of high BP.[9,10] Relative to aerobic activity, isometric exercise has the potential for superior adherence due to simplicity, lower cost, and perhaps less exercise time. Previous meta-analyses have examined the effects of endurance training,[11] dynamic resistance training,[12,13] and isometric resistance training[10] on BP. The findings revealed that isometric resistance exercise does lower BP; however, the sample sizes of the trials to date are generally small. Recently, several isometric exercise training trials have been reported that necessitate an updated analysis of data from randomized, controlled, and crossover trials.

The aims of this study were (1) to conduct a systematic review and meta-analysis quantifying the effects of isometric resistance training on the change in SBP, DBP, and mean arterial pressure (MAP) in subclinical populations and (2) to examine whether the magnitude of change in SBP and DBP was different with respect to BP classification.

PATIENTS AND METHODS

Search Strategy

Potential studies were identified by conducting a systematic search using PubMed for randomized controlled trials lasting 4 or more weeks that investigated the effects of isometric exercise on blood pressure in healthy adults (aged ≥18 years) and were published in a peer-reviewed journal between January 1. 1966, and July 31, 2013. The PubMed search strategy is presented in Supplemental Figure 1 (available online at http://www.mayoclinicproceedings.org). CINAHL and the Cochrane Central Register of Controlled Trials were also searched for the same period. The search strategy included the terms *hypertension*, *blood pressure*, *isometric exercise*, *isometric resistance training*, *physical training*, and *exercise training*. These terms were combined with a sensitive search strategy to identify randomized controlled and crossover trials. Reference lists of selected articles were scrutinized for new references. All identified articles were assessed independently by 2 reviewers (G.D. and D.J.C.), and a third reviewer (N.A.S.) was consulted to resolve disputes. The latest editions of relevant journals (through July 31, 2013) were also examined.

Study Selection

Randomized controlled trials and crossover studies of isometric exercise training in adults were included. There were no language restrictions. Animal studies, review articles, short-term exercise studies, and nonrandomized controlled trials were excluded. Studies that did not have any of the desired outcome measures or a sedentary control group were excluded. Several authors were contacted to provide missing data or to clarify whether data were duplicated in multiple publications. Incomplete data, or data from an already included study, were excluded. Studies using interventions other than pure isometric exercise (eg, aerobic or dynamic resistance exercise) were excluded.

Our initial search identified 1288 articles, and examination of the latest editions of relevant journals yielded 1 more article. Of the 1289 studies, 368 were excluded at first inspection as duplicates, 152 were removed after reading titles or abstracts, and 598 studies were not trials of isometric exercise therapy in adults, leaving 171 studies; 159 of the 171 studies were not randomized controlled trials with a duration of 4 weeks or longer, and 3 others were excluded because of data duplication, leaving 9 studies for analysis (Figure 1) that included 223 participants (127 who underwent exercise training and 96 controls).

Data Synthesis

Information on outcome measures was archived in a database. The outcome measures were SBP, DBP, MAP (which was calculated by

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