



# The addition of whole-body vibration to a lifestyle modification on arterial stiffness in overweight and obese women

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## KEYWORDS

Arterial stiffness;  
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**Abstract** *Background:* Increased arterial stiffness is an independent risk factor for cardiovascular disease. Arterial stiffness increases in obese individuals as compared to normal weight. While weight loss by calorie-restriction alone decreases arterial stiffness in obesity, it decreases muscle mass. Resistance training is recommended treatment for this frailty, but it can also increase arterial stiffness. Whole-body vibration (WBV) has recently been indicated as an alternative for resistance training. The present study aimed to examine whether lifestyle modifications combined with WBV decrease arterial stiffness in overweight and obese women. *Methods:* Twelve overweight and obese women (age: 30–48 years) completed a 12-week lifestyle-modification program (1200 kcal/day diet, brisk walking for 30 min, 3 days/week) and WBV (30–35 Hz, 30 min, 3 days/week).

*Results:* Before and after this program, we measured body weight and indices of arterial stiffness, i.e., carotid-femoral pulse wave velocity (cfPWV) and brachial-ankle PWV (baPWV). Body weight, cfPWV, and baPWV of the overweight and obese women significantly decreased after this intervention. The concentration of plasma pentraxin 3, which has a cardioprotective effect, significantly increased after the program.

*Conclusion:* We recommend the addition of WBV to classical lifestyle modifications to decrease arterial stiffness, which would reduce the risk of cardiovascular disease and muscle weakness in obese individuals.

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## Introduction

Obesity is known to be an independent risk factor for cardiovascular disease.<sup>1–3</sup> Increased arterial stiffness is also known as an independent risk factor for cardiovascular morbidity and mortality.<sup>4,5</sup> It has already been reported that arterial stiffness in obese individuals is higher than that in individuals with a normal weight.<sup>6,7</sup> Previously, we have reported that dietary modification can induce remarkable weight loss and lowering of arterial stiffness in obese subjects.<sup>8</sup> However, diet modification alone decreases not only adipose tissue but also muscle mass and muscle strength.<sup>9</sup> Inclusion of exercise training in lifestyle modification is important for preventing a decrease in fat-free mass, increasing relative visceral fat-mass loss, improving dietary compliance, and maintaining long-term weight control.<sup>10</sup> We have previously reported that habitual aerobic exercise can decrease arterial stiffness in obese subjects.<sup>11</sup> Moreover, habitual aerobic exercise has a cardioprotective effect, as indicated by the increased in plasma pentraxin 3 (PTX3) concentration.<sup>12</sup> Compared to dietary modification, habituation of aerobic exercise alone is often insufficient to induce marked weight loss.<sup>9</sup> However, it is well known that a combination of diet modification and aerobic exercise is more effective than diet modification alone to induce weight loss, resulting from increased energy expenditure, in obese individuals.<sup>13</sup>

Aging is also associated with loss of muscle mass and strength, even in subjects of a normal weight, because of a decrease in physical activity level.<sup>14,15</sup> Not only aging but also obesity decrease in muscle mass, and the loss of muscle mass may be associated with deleterious health outcomes, e.g., muscle weakness and insulin resistance.<sup>15</sup> Obesity and sarcopenia in older adults may potentiate each other and maximize their effects on physical disability, morbidity, and mortality.<sup>14</sup> It is therefore important to prevent a decrease in muscle mass and to decrease adipose tissue for weight loss in middle-aged obese individuals. Although resistance training itself does not induce fat-mass loss, it prevents the loss of muscle mass and increases the resting metabolic rate.<sup>9</sup> Moreover, resistance training increases muscle mass and may improve glucose and insulin responses to a glucose load in healthy subjects and patients with diabetes.<sup>16</sup> Previous studies have recommended weight loss through dietary modification, aerobic exercise training, and muscle strength training in obese individuals.<sup>9</sup> Some studies, however, have indicated that resistance training increases arterial stiffness.<sup>17,18</sup> To resolve these contradictory points, novel resistance-training methods that cause neither loss of muscle strength nor increased arterial stiffness are needed for weight loss in obese subjects.

Recently, whole-body vibration (WBV) has been developed as a novel means of muscular strength training. The effects of 12-week WBV training appear similar to those of resistance training in young women and in middle-aged and elderly individuals.<sup>19,20</sup> However, in contrast to the effect of resistance training on arterial stiffness as described above, Otsuki et al. have reported that transient WBV decreases arterial stiffness.<sup>21</sup> Therefore, WBV training, as instead of resistance training, may become useful tool to

cause neither loss of muscle strength nor increased arterial stiffness in obese subjects who are needed for weight loss. Especially, a combination of WBV training and a classical lifestyle-modification weight loss program aerobic exercise might be effective. However, whether the addition of WBV training to dietary restriction and aerobic exercise decreases arterial stiffness in obese individuals remains unknown entirely. Taken together, the present study was undertaken to examine whether incorporation of WBV training in a classical lifestyle-modification weight loss program decreases arterial stiffness in premenopausal overweight and obese women. Furthermore, we measured concentrations of plasma PTX3 before and after the intervention.

## Methods

### Subjects

Twelve premenopausal sedentary overweight and obese women participated in the study (age:  $42 \pm 2$  years; body mass index [BMI]:  $32 \pm 1$  kg/m<sup>2</sup>). Candidates who were current smokers, who were taking any medications or who had regular exercise habit were excluded. No subjects had apparent cardiovascular disease, as assessed by medical history and physical examination. This study was reviewed and approved by the Institutional Review Board at the University of Tsukuba. All potential risks and procedures of the study were explained to the subjects who provided written informed consent to participate in the study.

### Experimental design

All participants were studied before and after a 12-week lifestyle-modification weight-reduction program (dietary modification, aerobic exercise training, and WBV). Dietary intake was assessed by 3-day weighed dietary records, and dietary recall interviews by a skilled dietician for each subject at the baseline and at the beginning of week 10 of the intervention. All measurements were performed after abstinence from caffeine and an overnight fast. The subjects were studied in supine resting conditions in a quiet, temperature-controlled room (24–26 °C). All measurements were performed after a resting period of at least 20 min.

### Dietary modification

The chosen protocol has been reported as a low-calorie diet intervention with effects on body composition, body-fat distribution, and coronary heart disease risk factors.<sup>8,22</sup> Based on the diet protocol, all participants were instructed to take meals consisting, on average, of 300 kcal of protein, 600 kcal of carbohydrate, and 300 kcal of fat per day (total: 1200 kcal/day). The subjects maintained daily food diaries during the 12-week intervention period and learned about proper daily nutrition (well-balanced protein, carbohydrate, fat, amino acids, vitamins, and minerals) through weekly lectures and counseling by skilled dieticians.

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