Short-Term Resistance Exercise Does Not Alter the Hypotensive Effect of Low-Energy Dieting

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ABSTRACT

Very-low-kilojoule diets (VLKDs) commonly reduce blood pressure. Before this study, the combined influences of VLKDs and resistance exercise on blood pressure, to our knowledge, had not been investigated. Twenty premenopausal women, with a body mass index greater than 25 kg/m², were pair matched on body mass index and then randomly assigned to a diet-only (3400 kJ/d) group and a combined diet and resistance training group (each n = 10). Before and after the 4-week treatment period, subjects were tested for body composition and resting supine blood pressure using a Dinamap (model 8100). Both groups had significantly (p < 0.05) lower fat mass, total mass, and systolic and mean blood pressure in the posttests compared with the pretests, but diastolic blood pressure did not significantly change. However, there were no significant between-group differences. We concluded that resistance exercise did not significantly alter the blood pressure reduction observed with short-term severe dieting.

Key Words: strength exercise, diet, hypotension, weight loss


Introduction

Very-low-kilojoule-diets (VLKDs), or diets in which people ingest 800 calories per day or less, have been shown to reduce the blood pressure of obese hypertensive and normotensive people (4, 12). The greatest proportionate blood pressure reduction in response to VLKDs has been observed within the first 2–3 weeks (3) of these regimens. In addition, VLKDs have been shown to promote adverse effects, including the loss of lean body mass (11) and reduction in resting metabolic rate (6, 8). In obese hypertensive people, the decrease in blood pressure accompanying weight loss is advantageous, but for some obese normotensive people unwanted orthostatic hypotension may result (9, 14).

Recently, investigators have explored the possibility of overcoming some of these adverse effects by combining VLKDs with regular strength training (7, 11). Although recent research indicates that resistance training can minimize the loss of lean body mass and drop in basal metabolic rate associated with moderate energy restriction (5) but not with severe dieting (VLKDs) (7), no research, to our knowledge, has focused on the combined blood pressure responses.

The research presented in this article specifically focuses on the effects of the combination of VLKDs and resistance training on the blood pressure of overweight normotensive women compared with the effects of VLKDs alone. We chose 4 weeks for the treatment period, since the largest VLKD-induced reductions in blood pressure occur in 2–3 weeks (3). Furthermore, in weight loss programs VLKDs are commonly used for a few weeks rather than for much longer periods. Although it was understood that 4 weeks of resistance training would not be sufficient to induce major muscular adaptations, the study was performed to determine if resistance exercise may alter the VLKD-induced short-term blood pressure reduction.

Methods

Subjects

Twenty-two premenopausal women (mean age = 33 years) were selected from a group of volunteers. The criteria for inclusion in the study were as follows: a body mass index of more than 25 kg/m² (mean = 29 kg/m²); a regular menstrual cycle; nonparticipation in regular resistance training or a weight loss program for at least 6 months before the study; and no medical conditions that would influence the study. The women were pair matched on body mass index, since this correlates highly with blood pressure (1), and then randomly assigned to 2 groups. During the experimental period, one group dieted (DO) but did not exercise regularly, and the other group combined the same diet with regular resistance exercise (DR).
Diet and Resistance Training Regimen

On the day after the pretests, all subjects began the same diet, which consisted of 3,400 kJ/d (about 800 calories) of which 60% was carbohydrate (120 g), 20% fat (18 g), and 20% protein (40 g). In addition to this diet, the DR group also began regular resistance training consisting of three 55-minute (10 minutes of stretching warm-up, 40 minutes of weight training, and 5 minutes of cool down) sessions per week of progressive overload resistance exercise using free weights and a Universal machine. Initially, each subject’s 10 repetition maximum (10RM) weight was determined for bench press, latissimus pull down, leg extension, leg press, overhead press, hamstring curl, and triceps extension. In subsequent sessions, subjects were asked to attempt 3 sets of 10 repetitions using the 10RM, with 1–2 minutes of rest between sets. If they successfully completed 3 sets of 10 with the 10RM, then the weight used for this exercise was increased by 2.5 kg in the next session. If not, the weight remained the same in the next session. Pretraining and posttraining strength indexes were estimated for each subject by adding the 10RMs for all exercises and dividing by the number of exercises in the program. The DR group attended 100% of the training sessions.

Testing Procedures

Blood pressure, body composition, and resting metabolic rate were tested 1 day before (pretests) and 2 days after (posttests) the 4-week experimental period. These tests were performed on approximately the same day of the month in each woman’s menstrual cycle. All tests were performed in the morning after the subjects had fasted overnight.

After 30 minutes of complete rest at 20° centigrade, supine systolic, diastolic, and mean arterial blood pressures and heart rates were measured with the Dinamap Vital Signs Monitor Model 8100 (CV = 5%). Total body mass, fat mass, and fat-free mass were analyzed by dual-energy x-ray absorptiometry (Lunar DPX-L, Lunar Radiation Corporation, WI). The inter-test reliability was 1%.

Statistical Analyses

Data were analyzed using a Statview 512+ software program (Brainpower, Inc., Calabasas, CA). A 2 × 2 (treatment by time) analysis of variance (ANOVA), with repeated measures across times, was used to analyze the blood pressure and body composition changes. The significance level was set at 0.05.

Results

Before the treatment period, the groups were closely matched on age, height, and body mass index (body mass index: DO = 29.1 kgm²; DR = 28.6 kgm²). Furthermore, there were no significant differences (unpaired t-tests) between the groups for any of the body compositional and blood pressure variable means (Table 1). The repeated-measures ANOVAs revealed that there were significant main effects (p < 0.05) on the time factor, with the pretest values being higher than the posttest values for total body mass, fat-free mass, fat mass, systolic blood pressure, and mean arterial blood pressure (Table 1). However, there were no significant differences on the treatment factor (between the DO and DR groups) for any of the variables nor were there any significant interactions between time and treatment for any of the variables. The strength index of the resistance trained group was significantly (t = −9.22; p < 0.05) higher after the training compared with the baseline index (pretest mean = 38.4 kg; SE = −3.9 kg; and posttest mean = 70.81 kg; SE = −4.8 kg). The statistical power of the study for the body composition and blood pressure variables was calculated from standard tables to be about 0.25.

Table 1. Body composition and blood pressure variables before and after treatments.

<table>
<thead>
<tr>
<th></th>
<th>Diet only</th>
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<th>Diet and resistance trained</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>±SE*</td>
<td>Post</td>
<td>±SE</td>
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<tr>
<td>Body composition</td>
<td></td>
<td></td>
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<tr>
<td>Body mass (kg)*</td>
<td>75.78</td>
<td>3.02</td>
<td>70.30</td>
<td>2.78</td>
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<tr>
<td>Body fat (kg)*</td>
<td>32.77</td>
<td>2.27</td>
<td>28.73</td>
<td>2.31</td>
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<tr>
<td>Lean body mass (kg)*</td>
<td>39.02</td>
<td>1.11</td>
<td>37.99</td>
<td>1.15</td>
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<tr>
<td>Total body water (kg)*</td>
<td>34.67</td>
<td>0.94</td>
<td>33.32</td>
<td>1.11</td>
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<tr>
<td>Blood pressure</td>
<td></td>
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<tr>
<td>Systolic (mm Hg)*</td>
<td>119.70</td>
<td>3.16</td>
<td>116.60</td>
<td>3.36</td>
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<tr>
<td>Diastolic (mm Hg)</td>
<td>66.40</td>
<td>1.61</td>
<td>65.70</td>
<td>1.01</td>
</tr>
<tr>
<td>Mean arterial (mm Hg)*</td>
<td>83.64</td>
<td>1.76</td>
<td>82.21</td>
<td>1.62</td>
</tr>
</tbody>
</table>

* Indicates that pretreatment means were significantly different (p < 0.05) from posttreatment means.
Discussion and Practical Application

A group of premenopausal, overweight, normotensive women who combined resistance training with a VLKD had similar (no significant difference between them) modest decreases in their systolic and mean arterial blood pressures compared with women using the same VLKD but no training (Table 1). These data indicate that 4 weeks of resistance training did not significantly alter the expected reduction in mean arterial blood pressure typically observed (4, 12) with short-term severe dieting. The mean weight lost by the subjects (both groups combined) in this study was about 5 kg in 4 weeks, which supports other findings of blood pressure reduction with weight losses of 3–5 kg (10, 13).

In this study, the small number of subjects used may not have been sufficient for the tests of significance to have adequate power (calculated to be about 0.25) to detect the small blood pressure changes. Furthermore, 4 weeks of resistance training may have been too short to induce typical cardiovascular adaptations, even though VLKD-induced blood pressure adaptations are commonly observed in this time (3). Fat mass reduction during the treatment period was most strongly correlated with the mean blood pressure reduction ($r = 0.511; p < 0.05$). Body weight change was also significantly correlated with mean blood pressure change, whereas change in resting metabolic rate was poorly correlated. Sowers et al. (1982), cited by Eliahou et al. (3), observed a similarly strong correlation between reduction in body weight and mean arterial blood pressure in a study on the effects of a VLKD on 20 obese subjects. Perhaps decreased fat and total mass may reduce resting cardiac output and thereby contribute to the reduced resting blood pressure (2). Alternatively, according to Eliahou et al. (3), body weight reduction may only be a by-product of low energy intake and does not directly reduce blood pressure.

References