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The Effects of Bodymax High-Repetition Resistance Training on Measures of Body Composition and Muscular Strength in Active Adult Women

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ABSTRACT

The purpose of this study was to investigate the effects of a light, high-repetition resistance-training program on skinfold thicknesses and muscular strength in women. 39 active women (mean age 38.64 ± 4.97) were randomly placed into a resistance-training group (RT; $n = 20$) or a control group (CG; $n = 19$). The RT group performed a resistance-training program called Bodymax™ 1 hour 3 $d \cdot wk^{-1}$ that incorporated the use of variable free weights and high repetitions in a group setting. The CG group continued its customary aerobic training 1 hour 3 $d \cdot wk^{-1}$. Five skinfold and seven muscular strength measures were determined pre-training and after 12 weeks of training. Sum of skinfolds decreased (-17mm; $p < 0.004$) and muscular strength increased (+57.4kg; $p < 0.004$) in the RT group. Effect sizes for individual skinfold sites and strength measures were 'medium' and 'high', respectively. Bodymax™ is an effective resistance-training program for reducing skinfold thickness and increasing muscular strength in active women. Therefore, women with a similar or lower activity status should consider incorporating such training into their regular fitness programs.

Key words: - skinfolds, muscular strength, resistance training, women

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Introduction

Interest has surged within the fitness industry in the use of resistance-training for promoting improvements in general fitness. An increasing number of women are incorporating resistance training into their physical conditioning programs (1), either to improve performance in a sport, or favorably affect body composition. Moreover, fitness centres have begun effectively to ‘bring the weight room into the aerobic room’ by providing group resistance exercise programs to music. Now, whereas research has established that heavy, low repetition (2) resistance training programs increase muscular strength and can significantly affect body composition (3,4,5,6) in untrained women, little is known about the affects of light (less than 5kg), high repetition resistance training in women who are already active.

A particular program to emerge from this movement is Bodymax™, which incorporates the use of light (1kg – 5kg), variable free weights and executes high repetitions (36 repetitions per set) in a group setting. As no empirical research has appeared in the scientific literature involving this program, the purpose of this study was to investigate the effects of the Bodymax™ program on skinfold measurements and muscular strength in active women.

Methods

Approach to the Problem

We studied the effect that a light, high-repetitious resistance-training program would have on already aerobically active women. A parallel, randomized control trial allowed the comparison of skinfold thicknesses and muscular strength capacity between women who trained with a resistance training program and those who did not. The volunteers were familiar with aerobic exercise and by randomization of the subjects to the resistance group and the control group, we could be sure that the changes were due to resistance training and not because the subjects had a preference for that type of training.

Subjects

Thirty-nine Caucasian women (mean age 38.64 ± 4.97 years) from the local community volunteered to participate in the study. The subjects were healthy and had participated in aerobic exercise 3 $d \cdot wk^{-1}$ for at least one year prior to the study. Written informed consent was obtained from each subject. The subjects were randomly assigned to a resistance-training group (n = 20) and a control group (n = 19). There was no statistical differences in age; height; weight; sum of skinfolds; and muscular strength between the two groups pre-training. For two months preceding the study the subjects did not include resistance exercise in their customary physical activity routine. Subjects were instructed not to partake in diets or commence other exercise programs for the duration of the study.

Measurement of Skinfolds

Skinfold thicknesses were determined by measuring the skinfold at four anatomical sites (i.e. triceps, abdomen, suprailiac and mid-thigh) in accordance with ACSM (7) guidelines. Measurements were taken by the same experienced tester to restrict systematic error with high-quality, metal Lange calipers (Cambridge Instrument Co., Cambridge, MD). Readings were taken three times at each site on the right side of the body and the median of these recorded. The sum of the four sites were adopted as an index of sub-cutaneous adiposity and not converted to a percent body fat value. This index is useful for monitoring changes in body composition without the need for predicting percent fat with its associated error (8).

Measurement of muscular strength

All subjects were familiarized and practiced with the one-repetition maximum (1-RM) testing technique (9,10) on the seated leg extension, seated leg curl, lateral pull-down, chest press, shoulder press and pec dec FLEX™ gym equipment (Flex Performance Systems, California). This particular method for measuring muscular strength was assessed because of its safe nature on seated and stable equipment. After a warm up involving the lifting of light loads (less than 5kg), the subjects progressed in incremental single attempts until their 1-RM was reached (defined as the highest load that could be lifted through one complete unassisted repetition). Total muscular strength was represented as the sum of the six components.

Procedures

Women in the control group (CG) performed group aerobic exercise for 60 minutes, 3 times per week for 12 weeks. The exercise intensity of the aerobic activity was between 60 – 90% age predicted heart rate (220 – age) as monitored by Polar heart rate monitors. No resistance-training component was incorporated into their exercise program.

The resistance group (RT) performed a specific resistance-training program called Bodymax™, 3 $d \cdot wk^{-1}$ for 12 weeks (see appendix A). Bodymax™ is an exercise concept that aims to utilize the science of resistance-training through the use of relatively light, variable free weights and high repetitions in a group setting. Sound weight training principles include voluntary maximal muscular actions; intensity; periodization; progressive overload; speed specificity, muscle group specificity and energy-source specificity. Bodymax™ resistance training is performed to music for stimulation and in a group setting for motivation and for monitoring. The same registered Bodymax™ professional led the sessions that commenced with a warm-up where the emphasis was placed on imitating the resistance-training moves without a weight. Afterwards, sets of resistance exercises (i.e. squats; lunges; rows; lateral side raises; shoulder press; biceps curls; tricep kickbacks; crunch sit-ups) were executed utilizing dumbbells. The weight of the dumbbells ranged from a minimum of 1 kg in each hand to a maximum that was performed safely by each individual (up to 4.5kg) and varied according to each specific exercise. Each set consisted of 36 repetitions that were performed consecutively to a cadence of 100 bpm - 125 bpm. Concentric and eccentric contractions were used as well as compound and isolation exercises in order to provide maximum stimulation and variation to the major muscle groups. The exercise intensity of the resistance training was 60 –

90% age predicted maximum heart rate (220 – age). As exercise heart rates decreased and repetitions were met with ease due to training adaptations, the dumbbell weights were incrementally increased by 0.5kg (up to 4.5kg) in order to raise workload intensity. A cool-down and stretching period concluded the Bodymax™ resistance-training program.

Statistical analysis

Repeated measures analysis of variance (ANOVA) with between subject (resistance and control group) and within subject (pre-test/post-test) factors was computed for all twelve dependent variables. The Bonferroni technique was used to offset the inflated risk of a Type 1 error due to multiple (twelve) ANOVAs being conducted (11). This yielded a significance level of 0.05 ÷ 12 = 0.004. Where appropriate, the Tukey HSD post-hoc procedure was used to identify the significant differences between specific pairs of mean values. An estimate of the magnitude of the effect of the resistance training was calculated in the manner suggested by Clarke-Carter (12), being the ratio of the mean difference (mean of pre-resistance minus mean post-resistance) and the standard deviation of the pre-resistance condition.

Results

The baseline data for the subjects' biometric characteristics are presented in Table I. The ANOVA yielded no significant difference between groups (resistance versus control) in terms of age, height, weight and BMI.

Skinfold Thicknesses

Table II presents the means and standard deviations of the subjects' skinfold variables. The key results from the ANOVA and post-hoc analyses were that significant reductions were observed in the sum of skinfolds and the thicknesses at each individual skinfold site between the pre- and post-training conditions of the resistance group only. In addition, the post-training values of the resistance group were significantly different (lower) than those of the post-training control group.

Muscular Strength

The means and standard deviations for muscular strength variables are presented in Table III. It is clear that significant improvements in total muscular strength occurred in the resistance-training group, and not the control group. Moreover, the post-training strength of the resistance group was significantly higher than that of the control group. These findings were repeated for the six individual strength measures, albeit the improvements in strength observed for the lateral pull-down, chest press and shoulder press exercises were not significant.

Body Weight

Table IV presents the means and standard deviations of the subjects' body weight. No significant changes in body weight occurred in either group over the course of the training program.

Discussion

The present study clearly demonstrates that a resistance-training program incorporating light weights and high repetitions can decrease skinfold thicknesses and increase muscular strength. Moreover, the concept of Bodymax™ employed in a group setting can be considered a sound resistance-training program for women who are already active.

On the basis of the computed effect sizes, the reductions in skinfold thicknesses due to Bodymax™ can be interpreted according to Cohen (13) as being a 'medium' amount - an amount Cohen coincidentally described as being "large enough to be visible to the naked eye" (p. 26). Whilst such effects have not been reported previously, the general reductions in skinfolds are consistent with the limited number of resistance training studies conducted amongst women in this age group (14,15,16). Butts and Price (14) reported small, but significant losses in the tricep, abdominal and thigh skinfolds, but no change in the suprailiac skinfold. Boyer's (15) three strength training programs produced significant decreases in the tricep, thigh and suprailiac skinfolds, while Gettman et al. (16) reported highly significant reductions in percent body fat. In another study (17), body fat was favorably affected when resistance training was combined with bench-step aerobics, although body fat was reduced in the bench-step only group as well.

The changes in skinfolds in the resistance group in the present study were not reflected in a significant decrease in total body weight (Table IV). This is consistent with previous findings (14,15,16) in this age group, as well as studies on college-age women (18-23). In addition, a study by Charette et al. (24) showed no significant weight loss in older women (69 ± 1.0 years) after resistance training. These results indicate that fat-free weight (FFW) may have increased as a result of the training to account for the stability of total body weight.

The effect sizes for all but two of the muscular strength variables are 'large' (13) and considerably higher than those of the skinfold variables, suggesting a relatively superior influence of the Bodymax™ resistance program. Again, whilst it is not possible to compare effect sizes, the magnitude of the increases in muscular strength in the present study is higher than that reported previously in similar studies (2,25) and comparable to other studies (16-18,26). Such gains in strength (due to light weights) can be explained as the product of wave summation of a relatively small number of slow-twitch oxidative motor units (27), rather than an increase in recruitment of fast-twitch motor units.

The continuum on which a high resistance/low repetition program primarily increases muscular strength and a low resistance/high repetition program elicits muscular endurance (28,29) is not to be ignored. However, the current study and those of others (2,25,28,29) have proven that muscular strength can still be increased with low resistance/high repetitions. In particular, the investigations of Anderson & Kearney and Stone & Coulter (2,25) compared high resistance/low repetition, medium resistance/medium repetition and low resistance/high repetition training programmes and revealed that they were equally effective in developing muscular strength and endurance. Moreover, for those women whose primary goal is to enhance muscular strength (not endurance) and prefer not to perform high resistance-training because they believe their muscles will hypertrophy (30), the use of low resistance/high repetition training may represent an optimal physical conditioning program.

Leg extension, leg curl, lateral pull-down and pec dec strengths were significantly larger in the resistance group than the control group, but those of shoulder press, lateral pull-down and chest press were not. Similarly, the study by Stone (2) found greater gains in lower-body strength than upper-body strength among college-age women, although they had hypothesized the reverse. Their expectation was based on the assumption that women recruited from aerobics classes were less likely to have trained their upper-bodies. In the absence of other similar research, we can assume that muscular strength improvements in the shoulder and chest areas of women require either a longer study program, or the use of heavier weights in these regions.

The use of dumbbells in the current program allows for superior strength gains over the use of machines because the movements are mechanically similar to those occurring naturally (34). Butts and Price (14) used machines in their study and Kraemer et al (17) used bands as the resistance modality. Therefore, further study is necessary in order to compare the choice of resistance-training tools and the physiological effects they may have. Other studies have added dumbbells as their resistance tools (35,36), however, these have used the weights as an addition to bench stepping and the weight used was very light (<0.91kg). No significant differences in body composition and muscular strength were found in either study. The present study used a minimum 1 kg dumbbell and progressively increased to a maximum of 4.5 kg.

Undoubtedly a group of untrained women would improve muscular strength and decrease body fat with the weights used in the Bodymax program and a limitation of the present study was the lack of a non-training control group. However, whilst such a group would have enhanced the internal validity of the intervention (resistance-training), the use of an equivalent, already active, non-resistance (aerobic endurance) exercising group provided a legitimate alternative. In essence, the only difference between the two groups was the form of training that they were exposed to. Moreover, the familiarity of the CG women with exercise probably reduced their risk of experimental mortality (drop-out), which would negatively influence the data analysis.

Practical Applications

Our report of the positive changes in body composition and muscular strength amongst active, young-middle-aged women as a result of light, high repetition resistance-training should be encouraging to all women, regardless of prior exercise experience. Presenting this type of program to music and in a group setting can provide variety to their resistance training and help them realize a safe and balanced fitness regimen.

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Table 1
Means +/- Standard Deviation of Subjects' Pre-intervention Data

Variable	**Resistance** (*n* = 20)	**Control** (*n* = 19)
Age (yr)	38.7	38.6
	5.0	5.1
Height (cm)	165	165
	0.1	0.1
Weight (kg)	61.4	63.5
	10.0	9.8
BMI (kg/m^2)	22.6	23.2
	3.4	2.7
Sum of skinfolds (mm)	99.4	105.8
	27.8	25.1
Total Muscular strength (kg)	228.4	227.6
	34.6	30.3
Predicted VO_{2max} (ml/kg/min)	42.3	42.2
	6.2	5.0

Table 2
Means and Standard Deviation of Skinfolds

Variable	Group	Pre-test	Post-test
Triceps (mm)	Resistance	22.8 ± 4.0	19.8 ± 3.9
	Control	24.5 ±4.7	24.4 ± 4.8
Suprailiac (mm)	Resistance	17.5 ± 8.8	12.5 ± 6.5
	Control	18.7 ± 8.2	18.4 ± 8.2
Abdominals (mm)	Resistance	24.2 ± 10.0	19.7 ± 9.1
	Control	26.3 ± 9.3	25.9 ± 9.4
Thigh (mm)	Resistance	34.8 ± 7.7	30.5 ± 7.8
	Control	36.3 ± 5.4	36.5 ± 5.1
Sum (mm)	**Resistance**	**99.4 ± 27.8**	**82.4 ± 25.3**
	Control	**105.8 ± 25.1**	**105.1 ± 24.6**

Table 3
Means and Standard Deviation of Strength Measures

Variable	Group	Pre-test	Post-test
Leg extension	Resistance	45.3 ± 11.3	69.4 ± 11.4
	Control	48.6 ± 11.0	52.5 ± 11.5
Leg curl	Resistance	65.3 ± 13.4	80.6 ± 12.4
	Control	64.7 ± 10.1	67.5 ± 10.6
Lateral pulldown	Resistance	33.8 ± 8.9	38.3 ± 4.1
	Control	31.1 ± 6.6	31.8 ± 4.8
Chest press	Resistance	30.8 ± 7.9	33.0 ± 7.1
	Control	29.1 ± 5.4	29.0 ± 4.3
Pec dec	Resistance	27.8 ± 4.4	34.5 ± 5.1’
	Control	28.2 ± 4.8	28.4 ± 4.4
Shoulder press	Resistance	25.5 ± 5.1	30.0 ± 6.9
	Control	26.1 ± 3.9	26.5 ± 3.9
Total Strength	**Resistance**	**228.4 ± 34.6**	**285.8 ± 33.5**
	Endurance	**227.6 ± 30.3**	**235.7 ± 29.5**

Figure 1.
Interaction of Group x Test for Sum of Skinfolds

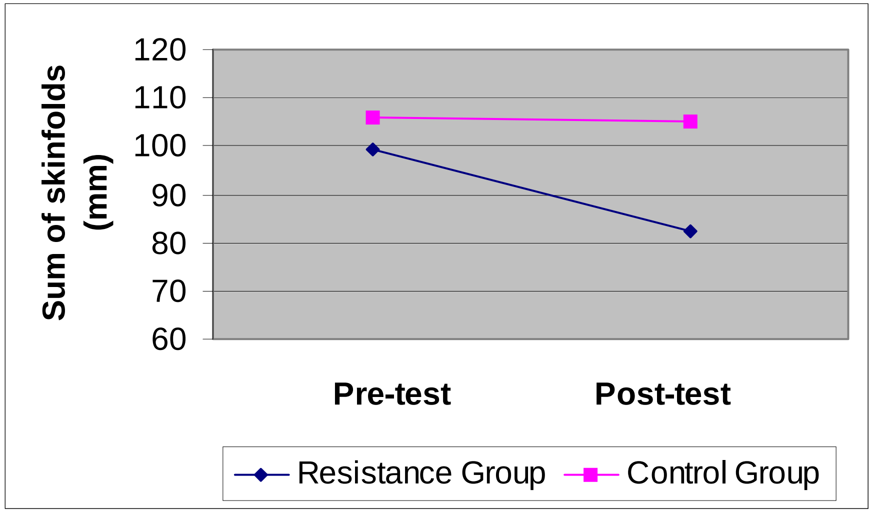

Figure 2
Interaction of Group x Test for Total Muscular Strength