Effects of a 12-Week Weight Training Program on the Body Composition of Women Over 30 Years of Age

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Reference Data

ABSTRACT

This study investigated changes in body composition in women over 30 (n = 68) after a 12-wk weight training program. A control group (n = 27) was used for comparison of body composition measures only. The experimental group performed 13 exercises 3 days a week for 12 weeks. Initially there were no significant differences in gross body weight, % body fat, FFW, and sum of skinfolds between groups. The experimental group reduced their % body fat and sum of skinfolds while increasing their FFW. There were no significant changes in the controls. To determine the influence of age, the experimental group was subdivided into those under 40 (UF) and those over 40 (OF). Although there were no significant differences in gross body weight between UF and OF at pre or posttests, the UF had significantly lower % body fat and skinfold sums and higher FFW than the OF. As a result of the weight training program, neither age group's gross body weight changed significantly, but both groups significantly decreased their % body fat and increased FFW.

Key Words: age, resistance training, muscle endurance, % fat, skinfolds

Introduction

In their 1990 revised guidelines, the American College of Sports Medicine (2) recommended that resistance training should be an integral part of an adult fitness program for improving and maintaining muscular strength and endurance. Alterations in fat and fat-free mass (FFM) with age may have important health consequences (27). Furthermore, the location of changes in body fat, as reflected in skinfolds, also may have health implications (9). These potential health benefits of resistance training for both sexes were recently summarized by Stone et al. (28) and Despres et al. (9). Training studies involving women have clearly demonstrated that resistance training can increase the muscular strength and endurance of college-age women (5, 20-23, 26, 30) as well as elderly women (1, 7, 12, 13).

Many women participate in resistance training programs mostly to lose weight and improve their appearance. Unfortunately, few strength training studies involving non-college-age women have assessed body composition (7, 13, 14). It is generally accepted that resistance training increases FFM as well as decreasing % body fat and total fat (25). However, there is little research as to what specific alterations in body composition the typical nonathletic woman should expect from a resistance training program such as that recommended by the ACSM (2). Therefore the purpose of this investigation was to document the changes in body composition in women over 30 after completing a 12-wk weight training program.

Methods

Initially 92 women, ages 30 to 63 yrs, volunteered to participate in the training group. Of that total, 75 completed all pretests and 68 completed all training and posttest requirements. An additional group of 27 women served as a control group for body composition assessments only. Both groups were instructed not to go on diets or start other exercise programs for the duration of the study. Prior to the experiment, the complete testing procedures and training requirements were thoroughly explained to each subject both orally and in writing. The women signed informed consent statements indicating they understood the requirements and had no medical limitations that would prohibit their participation.

Body density was determined by hydrostatic weighing with 6 to 10 trials until three similar readings were obtained (17). Two residual volumes were determined by oxygen dilution (29) in a seated position outside the weighing tank. If the resulting volumes were not within 150 mls, a third trial was performed and the average of the three trials was used to calculate density. The body density obtained from hydrostatic weighing was converted to % body fat according to the equation of Brozek et al. (6). To further investigate
potential alterations in body composition, four skinfold measures (triceps, suprailiac, abdominal, thigh) were taken on the right side in triplicate (4) by the same investigator.

The weight training group participated in several orientation sessions in order to become familiar with the Nautilus machines, procedures, and techniques of training prior to testing. Although only eight machines (hip & back, leg extension, leg curl, pull-over, multi-curl, multi-triceps, abdominal) were used in testing, the subjects were oriented and trained on an additional four machines (hip flexion, abductors, rotary torso, low back). A trial-and-error technique was used during the orientation sessions to determine the maximal resistance that could be moved a maximum of 8 to 10 repetitions on each of the eight machines to measure pretest muscular endurance. The same resistance was then used to determine the total number of repetitions that could be completed at posttest for comparison purposes.

After orientation and testing, the weight training subjects were to complete one circuit of all 12 exercises 3 days a week over a 12-wk period for a total of 36 training sessions. Since the major purpose of this study was to determine the effects of a resistance training program on body composition, the training was designed to incorporate as many major muscle groups as possible. Additional sets may have enhanced strength gains, but it was felt that keeping the exercise sessions under 1 hr would reduce the dropout rate, as suggested by Pollock (24).

The training program was based on one set of 8 to 12 reps for each of the 12 stations. When the individual was able to perform more than 12 reps of a given exercise, the resistance was increased accordingly. The amount of weight lifted and number of reps performed at each session were recorded for every workout throughout the 12 wks of training.

Standard descriptive statistics were computed for all variables. All data were analyzed with a two-way mixed design ANOVA, group and test, to determine if any differences occurred in body composition or muscular endurance between groups and tests.

**Results**

Of the 75 women in the weight training group who completed the initial testing, 68 (91%) completed all 36 training sessions and posttest requirements. Pre/post body composition data were obtained on all 27 women in the control group. All subjects were queried at posttesting to determine whether they had altered their diets, outside activities, and so forth during the test period. All indicated they had made conscious attempts to maintain their normal lifestyle. Their physical characteristics are presented in Table 1.

Initially there were no significant \( p > 0.05 \) between-group differences in gross body weight, % body fat, fat-free weight (FFW), or sum of skinfolds. Although there were no significant \( p > 0.05 \) changes in gross body weight for either group at posttest, the weight training group reduced their % body fat \( p < 0.001 \) and sum of skinfolds \( p < 0.01 \) while increasing their FFW \( p < 0.001 \). There were no significant \( p > 0.05 \) changes in these variables after 12 weeks in the control group.

To determine whether age influenced these results, the weight training group was arbitrarily subdivided into two age groups for further analysis, those under 40 and those over 40. The average age of the 39 women under 40 yrs of age (UF) was 33.6 yrs (30 to 39 yrs), while the 29 women over 40 (OF) averaged 44.6 yrs of age (40 to 63 yrs). The physical characteristics of these subgroups are presented in Table 2. Although there were no significant \( p > 0.05 \) differences in gross body weight between these subgroups at either pretest or posttest, the UF had significantly \( p < 0.05 \) lower % body fat and skinfold sums and higher FFW than the OF during both pre- and posttest.

Neither age group's gross body weight changed significantly \( p > 0.05 \) as a result of the weight training program, but both groups had a significant \( p < 0.001 \) decrease in % body fat. The FFW of both groups increased significantly \( p < 0.01 \). These changes were accompanied

<table>
<thead>
<tr>
<th>Variable</th>
<th>Weight training ( (n = 68) )</th>
<th>Control ( (n = 27) )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163.1</td>
<td>163.1</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.8</td>
<td>63.7</td>
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<tr>
<td>Density</td>
<td>10.9</td>
<td>10.5</td>
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<tr>
<td>Body fat (%)</td>
<td>0.0152</td>
<td>0.0155</td>
</tr>
<tr>
<td>FFW (kg)</td>
<td>44.3</td>
<td>45.6</td>
</tr>
<tr>
<td>Skinfolds (mm)</td>
<td>5.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Triceps</td>
<td>19.7</td>
<td>19.0</td>
</tr>
<tr>
<td>Suprailiac</td>
<td>16.8</td>
<td>16.4</td>
</tr>
<tr>
<td>Abdominal</td>
<td>8.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Thigh</td>
<td>9.1</td>
<td>9.6</td>
</tr>
<tr>
<td>Sum</td>
<td>27.9</td>
<td>27.2</td>
</tr>
</tbody>
</table>

Note. Significant levels between pre- and posttest values: \( p < 0.05 \); \( p < 0.01 \); \( p < 0.001 \).
by significant decreases in the triceps (p < 0.01), abdominal (p < 0.01), and thigh (p < 0.05) skinfolds. Although the suprailiac skinfold was not altered significantly (p > 0.05), the sums of all four skinfolds were significantly (p < 0.01) reduced. Since both age groups demonstrated similar changes in all body composition variables, there were no significant (p > 0.05) interactions between the two age groups as a result of training.

The number of repetitions performed during the initial test and the number completed at that same resistance at posttest are presented in Table 3. These values are also expressed as percent increases in the number between pre- and posttest. Although there were no significant (p > 0.05) differences in total number of reps completed between age groups at pretest, both groups significantly (p < 0.001) increased the number of reps performed on each of the eight measures at posttest.

### Discussion

#### Body Composition

Height and weight of the subjects were similar to those reported for women of comparable age (13, 23). Although % body fat for women in the subgroups was slightly higher than the 22.7% for women in their 30s and the 27.3% for women in their 40s reported by Jackson et al. (16), they were lower than the 32.9% and 35.3% reported by Gettman et al. (14) and Pollock et al. (26), respectively. The various skinfold values in the present study also are comparable to those reported for women in these age ranges (10, 26). It is generally accepted that body density decreases with age (10, 13, 15, 16); the results of this study support this in that the OF had significantly higher % body fat and sum of skinfolds than the UF even though overall body weight was similar for both groups.

The lack of a significant change in body weight as a result of the 12-wk training program is consistent with previous findings for college age woman (18, 20, 23, 30, 31) as well as for elderly women (7). There were changes in body composition for the weight training group, although these changes were not reflected in total body weight. When the subjects were compared according to age groups, decreases in body fat of 2.5% (UF) and 1.6% (OF) were demonstrated, along with increases in FFW of 1.6 kg (UF) and 1.1 kg (OF). These changes were similar in magnitude to those reported by Wilmore (30) for college women.

The results of the present study support the findings of Gettman et al. (14), who compared the effects of 12 wks of running and circuit weight training with a program of circuit weight training in middle-aged women and men. As in the present study, no changes
occurred in total body weight but there were decreases in % body fat of the women similar to those found herein.

The decreases in % fat, as determined by hydrostatic weighing, were accompanied by small but significant decreases in the triceps, abdominal, and thigh skinfolds, but no change in the suprailiac skinfolds. Wilmore (30) reported a decrease in % body fat that was associated with significant decreases in only two of eight skinfolds after a 10-wk weight training program in college women. The commonly used technique of estimating % body fat from skinfold equations may not be sensitive enough to ascertain the relatively small decreases found in % body fat with short-term weight training.

Although the total caloric cost of resistance exercise may not be as high as for cardiorespiratory training, Wilmore et al. (32) estimated the energy expenditure of participating in a circuit weight training program to be approximately 6 kcal per minute or about 130 kcal per session. Even if our subjects expended 130 kcal per session, it still would not be enough to account for the total decrease in their body fat, thus apparently other mechanisms are responsible. For example, it has been demonstrated that intramuscular triglyceride stores may be a major energy source during resistance exercise (11).

Furthermore, Chesley et al. (8) reported that the rate of protein synthesis was increased up to 24 hrs after resistance exercise. In addition, an increase in FFW as a result of the resistance training may have influenced our subjects’ general metabolism. These factors may have contributed to the body composition alterations they experienced.

Since there were no differences in the magnitude of changes in % body fat, FFW, and skinfold values between the UF and OF subgroups, it appears that the changes in body composition as a result of weight training are not limited to younger women. This should be encouraging to middle-aged and older women who are interested in this type of exercise as one element of a weight control program.

Muscular Endurance

Overall, the improvements in muscular endurance between pretest and posttest were quite dramatic, ranging from a low of 54% for the leg curl (hamstrings) to a high of 152% for the abdominal and the multi-curl (chest). Due to the extensive practice sessions (i.e., a minimum of three) required prior to initial data collection, the improvements at posttest should not be attributed to learning but rather to actual improvements in muscle function. Whether these increases in absolute muscular endurance were accompanied by gains in absolute strength cannot be ascertained from the present data. Anderson and Kearney (3) have presented limited data on males suggesting that strength gains do accompany endurance gains for the bench press.

Total percent improvements for all eight lifts were slightly higher for UF than for OF but the differences were not significant. This indicates that the gains in absolute muscular endurance occurred equally in both age groups. The largest percent increase for both groups occurred on the hip and back, abdominals, and multi-curl machines; the smallest increases were found for the leg curl and leg extension. Compared to men, women tend to be weakest in the chest, arms, and shoulders and strongest in the legs (19, 30).

Indirectly, the results of the present study support this conclusion since the smaller increases in muscular endurance occurred in the lifts involving the legs while the largest increases occurred in the chest. Assuming that the largest improvements, when expressed as percent increases, occur in the weakest areas, it would appear that the abdominals, hip, and back muscles are relatively weak in women also.

Practical Applications

Recognizing the limitations of this study (no control over diet, arbitrary age division, etc.), it appears that positive changes in body composition and muscular endurance occur equally in women under and over 40 as a result of participating in a 12-wk weight training program. This should be encouraging to all women regardless of age. However, when advocating weight training of this nature for women, one should stress that decreases in total body weight should not be expected. Since women often enter such programs to lose weight, this needs to be explained carefully so they will not become discouraged and drop out. Furthermore, the changes in body composition that do occur may not be discerned when using prediction equations to estimate percent body fat, and fitness directors should be aware of this when counseling potential participants.

References


