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A Low-Volume Weight Training Protocol Reduces Abdominal Fat and Increases Muscle Strength in 12 Weeks

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ABSTRACT

Martins AP, Ceschini FL, Battazza R, Rodriguez D, João GA, Bocalini DS, Charro MA, Figueira Junior A. A Low-Volume Weight Training Protocol Reduces Abdominal Fat and Increases Muscle Strength in 12 Weeks. **JEPonline** 2016;19(1):96-106. This study evaluated the effect of a 12-wk low-volume weight training (WT) program on body composition and neuromotor fitness of WT practitioners. Fifteen men and women (28.2 ± 4.9 yrs old; body weight: 69.2 ± 13.4 kg; height: 170 ± 10 cm; BMI: 23.7 ± 2.7 kg·m^{-2}; with at least 1 yr of WT experience) were evaluated in a WT protocol (3 times·wk^{-1} for 12 wks). Training sessions included 9 exercises (45º leg press, bench press, trunk curl, stiff-leg deadlift, front pull-downs, adduction machine, lateral raises, triceps extensions, and bicep curls) of 3 sets of 8 reps at 85% (1RM) with 40-sec rest between sets and exercises. Body composition and maximum strength were analyzed with a one-way analysis ANOVA and Scheffe *post hoc* test (P<0.05). The 12-wk WT protocol slightly decreased body mass (−1.3%) and waist circumference (−2.4%) as skinfolds sum (5.6 cm = *Δ*% −19.40%) and abdominal fat (−10.31). Increases in lean body mass (3.4%) and lower limbs strength (63.4%) suggest that 12 wks of low-volume WT reduced abdominal fat and increased muscle strength.

Key Words: Strengths training, Adiposity, Muscle strength, Low-volume training

INTRODUCTION

Weight training (WT) is considered an effective stimulus to the neuromuscular system, providing positive adaptations in different components of physical fitness that result in increased muscle strength, hypertrophic responses, improved oxidative and glycolytic enzymatic function, stimulation of cardiovascular control, and improvement in body composition (8). Moreover, the effects of WT are directly associated with many aspects of the health of individuals. The excessive accumulation of body fat (particularly high levels of abdominal fat) is associated with increased risk of developing metabolic and cardiovascular diseases while the increase in fat-free mass is strongly associated with higher functional autonomy and a lower risk of morbidity and mortality due to all causes (4).

Personal history associated with lifestyle systematically influences the level of physical fitness, which influences the physiological adaptive capacity derived from training (2). In fact, in trained individuals, the speed for increased muscle strength and the reduction in adiposity differ considerably from untrained individuals (with a tendency of slower progression in the more experienced practitioners of WT). The American College of Sports Medicine (4) points out that muscle strength increases by ~40% in inexperienced individuals, 20% in moderately trained individuals, 16% in trained individuals, 10% in advanced-trained individuals, and 2% in elite athletes during periods ranging from 4 wks to 2 yrs.

The specific structure of a weight training program occurs with the manipulation of intensity, maximum shifted weight, contraction time (eccentric-concentric), and time interval between sets as well as the volume (i.e., number of exercises, number of sets, and weekly frequency) in a predetermined period. This combination is crucial in physiological adaptations both in the performance of athletes and of those who regularly participate in physical activities (1,20,26). Different physiological systems (nervous, endocrine, metabolic, and muscular) are sensitive to the training load (12,15,17). However, there is no consensus about the strength training response related to time-session frequency on metabolic and body composition changes (16).

Thus, the dose-response relationship between strength exercise and changes in physical fitness was examined by Peterson and colleagues (21) who demonstrated that in untrained individuals, the largest maximum strength gains were achieved at 60% of 1-repetition maximum (1RM), 3 d·wk^{-1}, and 4 sets per muscle group. In trained individuals (e.g., strength training practitioners), the most effective gains in strength occurred at 80% of 1RM, 2 d·wk^{-1}, and 4 sets. Meanwhile, in athletes, 85% of 1RM, 2 d·wk^{-1}, and a mean volume of 8 sets per muscle group were more effective. Thus, distinct dose-response trends may be considered possible for each population segment. Therefore, certain levels of appropriate exercise are needed to optimize the effects of WT.

Although the scientific literature identifies these dose-response trends related to WT, verification of prescriptions for programs that prioritize increasing the total volume of training as individuals gain experience in training is common in gyms. However, Kraemer and Ratamess (16) warned that this increased volume during a training period should be carefully monitored in order to reduce the risk of overtraining. They emphasized that low-volume programs might provide a strong variation during longer training cycles that are relevant when properly incorporated into a conditioning program. Considering the lack of current evidence that supports the effects of low volume on the physical fitness of body builders, the purpose of this study was to evaluate the effects of 12 wks of weight training with reduced workload volume on body composition and neuromotor fitness in intermediate-level bodybuilders.

METHODS

Subjects

The study sample consisted of 10 randomly selected, apparently healthy individuals who were bodybuilders for at least 1 yr prior to the study. Each subject agreed to participate in the study, which included 15 men and 15 women aged 28.2 ± 4.9 yrs (n = 30; mean ± SD). The inclusion criteria consisted of subjects: (a) between 22 and 34 yrs of age; (b) at least 1 yr of WT experience; (c) minimal of WT 3 $d \cdot wk^{-1}$ (given that the purpose of the study was to evaluate the effect of the protocol in people already trained and physiologically adapted to weight training); and (d) not using dietary supplements or anabolic steroids. The exclusion criteria consisted of any bodybuilder with: (a) chronic degenerative disease; (b) limitations on performance; (c) continuous medication use; and (d) less than 75% frequency in WT.

Procedures

The weight training program was conducted 3 $d \cdot wk^{-1}$ on alternate days (Monday, Wednesday, and Friday) for approximately 60 min during a 12-wks period. Each session consisted of 9 exercises with 3 sets of 8 reps at 85% (1RM) with a 40-sec rest between sets and exercises. The exercises were performed in the following order: 45º leg press, bench press, trunk curl, leg deadlift, front pull-downs, adduction machine, lateral raises, triceps extensions, and bicep curls.

Anthropometry

The pre-post intervention (6 wks and at 12-wks) anthropometry evaluation was based on body weight (kg), height (m) and body mass index (BMI, $kg \cdot m^{-2}$), abdominal circumference (cm), waist (cm) and hip (cm), right arm contracted (cm), and right thigh relaxed (cm). The skinfolds consisted of triceps, chest, and subscapular for men, and triceps, abdominal, and suprailiac for women. The sum of absolute skinfolds and mean values were assessed. Strength variables for the lower and upper limbs for the respective 1RM tests in 45º leg press and bench press were performed.

Assessment of Body Composition

In order to assess body composition, total body mass (kg) was determined in the subjects wearing bathing suits (women) or trunks (men) while standing erect with the back to the viewer scale. The circumferences of the abdomen, waist, hip, arm (contracting, with bent shoulders and elbows), and relaxed right thigh were determined by using a Sanny anthropometric metallic tape (Sanny, São Paulo – Brazil) with an accuracy of 0.1 cm.

To determine the chest, biceps, triceps, subscapular, suprailiac, abdominal, mid-axillary, thigh, and leg skin folds, a skinfold caliper with an accuracy of 0.1 mm was used. All evaluations were carried out in the morning on days when the subjects were not physically active.

Assessment of Muscular Strength

We determined the maximum strength (1RM) at the 45º leg press machine and the bench press with a 12-kg bar, free weights. Each subject warmed up with a 50% 1 RM, performing 3 sets of 10 reps each. Maximum load was determined through weight estimation. The maximum weight provided would be increased or decreased according to the correct movement. In the 45º leg press, the movement was executed with the feet placed parallel, with an average spacing (shoulder width) on the machine's platform. The subjects would breathe in while flexing the knees and hips and breathe out while pushing the platform until the knees were extended. Then, the subjects rested for 5 min between each attempt. During the bench press, the hands were placed on bar at a spacing such that when the movement was performed at the end of the eccentric phase and the beginning of the concentric phase, the angle between the subject's arm and forearm reached ~90°. The subjects breathed in once while flexing the elbows and horizontally abducting the arms, and breathed out while pushing the bar up until both elbow joints were fully extended. Then, the subjects rested for 5 min before the next set.

Statistical Analyses

All statistical analyses were performed using SPSS software (v 15.0; IBM, Armonk, NY, USA). We applied the D'Agostino–Pearson test to Gaussian distribution analysis. One-way ANOVA was used to compare periods over time, followed by Sheffe *post hoc* test when appropriate. The statistical significance was set at an alpha level of $P<0.05$ with the data expressed in means ± standard deviations.

RESULTS

The purpose of this study was to verify the effect of 12 wks of linear low-volume WT on body composition and neuromotor ability. Table 1 indicates that were no significant changes in the subjects' weight, height, and BMI among the three evaluation times.

Table 1. Mean Values and Standard Deviation in Weight, Height, and BMI before the Intervention and at 6 and 12 Weeks of Intervention.

Variables	Pre-Intervention	6 Weeks of Intervention	12 Weeks of Intervention
Weight (kg)	69.2 ± 13.4	68.9 ± 13.3	68.3 ± 7.9
Height (m)	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1
BMI ($kg·m^{-2}$)	23.7 ± 2.7	23.7 ± 2.8	23.4 ± 1.4

Comparison between pre-intervention and post-intervention values by using one-way analysis of variance with the Scheffe *post hoc* test

The same trend in anthropometric variables was observed (Table 2) at all 3 evaluation times, except for the subjects' waist variable, which showed a significant reduction at the end of the 12 wks of intervention versus the pre-intervention.

Table 2. Mean Values and Standard Deviations in the Anthropometric Variables before the Intervention and at 6 and 12 Weeks of Intervention.

Circumferences	Pre-Intervention	6 Weeks of Intervention	12 Weeks of Intervention
Abdomen (cm)	82.7 ± 7.5	81.9 ± 7.2	81.5 ± 0.0
Waist (cm)	77.6 ± 9.3	76.6 ± 8.7	75.7 ± 4.2*
Hip (cm)	97.0 ± 4.7	96.5 ± 4.6	95.9 ± 4.5
Right Arm (cm)	33.1 ± 5.1	32.8 ± 5.1	32.9 ± 4.0
Right Thigh (cm)	55.4 ± 4.0	54.2 ± 4.1	54.2 ± 0.2
Sum (cm)	345.8 ± 27.7	342.0 ± 26.8	340.2 ± 4.0
Mean (cm)	28.8 ± 2.3	28.5 ± 2.2	28.4 ± 0.3

*P<0.05, comparison between pre-intervention and post-intervention values by using the one-way analysis of variance with the Scheffe *post hoc* test.

Table 3 follows the previous trend of Table 2 with a statistically significant decrease of 10.31% in abdominal skinfolds, which was directly associated with the significant decrease in waist circumference (as indicated in Table 2). Therefore, the reduction in abdominal adiposity was demonstrated.

Table 3. Mean Values and Standard Deviation in the Skinfold Variables before the Intervention and at 6 and 12 Weeks of Intervention.

Skinfolds	Pre-Intervention	6 Weeks of Intervention	12 Weeks of Intervention
Thoracic (mm)	12.7 ± 5.3	11.6 ± 4.4	11.2 ± 2.1
Biceps (mm)	9.8 ± 4.8	8.6 ± 3.1	7.4 ± 4.2
Triceps (mm)	18.6 ± 5.7	15.3 ± 6.2	13.7 ± 9.0
Subscapularis (mm)	19.1 ± 5.9	16.2 ± 3.1	15.3 ± 1.6
Suprailiac (mm)	16.6 ± 4.2	15.3 ± 3.6	13.8 ± 5.2
Abdominal (mm)	22.3 ± 4.6	22.1 ± 4.8	20.0 ± 9.7*
Mid-axillary (mm)	16.5 ± 4.8	13.7 ± 2.8	13.3 ± 3.3
Thigh (mm)	23.6 ± 8.6	21.0 ± 8.8	20.2 ± 11.3
Leg (mm)	17.5 ± 7.4	16.5 ± 6.8	15.4 ± 9.9
Sum (mm)	156.7 ± 35.8	140.2 ± 34.2	130.3 ± 56.3
Mean (mm)	17.4 ± 4.0	15.6 ± 3.8	14.5 ± 6.3

*P<0.05, comparison between pre-intervention and post-intervention values by using one-way analysis of variance with the Scheffe post hoc test.

Regarding the body composition variables (% Fat, Lean Mass, and Fat Mass) presented in Table 4, there was a significant increase of 3.36% in lean mass between the pre-intervention and the post-intervention values. Table 5 indicates that there was a significant increase in maximum strength in the muscles of the lower limbs (71 kg to 116 kg). Table 6 shows that the WT program resulted in a statistically significant percentage change from 0 to 12 wks in waist circumference, abdominal skinfold, lean body mass, and leg press strength.

Table 4. Mean Values and Standard Deviation in the Body Composition Variables before the Intervention and at 6 and 12 Weeks of Intervention.

Variables of Body Composition	Pre-Intervention	6 Weeks of Intervention	12 Weeks of Intervention
% Fat	22.7 ± 5.7	20.4 ± 6.1	19.1 ± 9.8
Lean Body Mass (kg)	53.6 ± 11.4	55.1 ± 12.6	55.4 ± 12.4*
Fat Mass (kg)	15.6 ± 4.8	13.7 ± 4.1	12.9 ± 4.5

*P<0.05, comparison between pre-intervention and post-intervention values by using one-way analysis of variance with the Scheffe post hoc test

Table 5. Mean Values and Standard Deviation in the Maximum Strength Variables of the Upper and Lower Limbs before the Intervention and at 6 and 12 Weeks of Intervention.

Variables	Pre-Intervention	6 Weeks of Intervention	12 Weeks of Intervention
Bench Press (kg)	24.2 ± 16.2	26.2 ± 16.5	28.3 ± 17.7
Leg Press (kg)	71.0 ± 40.1	93.5 ± 44.2	116.0 ± 49.5*

*P<0.05, comparison between pre-intervention and post-intervention values by using one-way analysis of variance and Scheffe *post hoc* test

Table 6. Percentage Change (*Δ*%) in the Study Variables.

Skinfolds	Δ% 0–6 Weeks	Δ% 6–12 Weeks	Δ% 0–12 Weeks
Weight (kg)	−0.43	−0.87	−1.30
BMI ($kg \cdot m^{-2}$)	0	−1.27	−1.27
Waist Circumference	−1.29	−1.17	−2.45*
∑5 Circumference (cm)	−1.09	−0.52	−1.62
Abdominal Skinfold	−0.90	−9.50	−10.31*
∑1 Skinfolds	−10.50	−7.06	−16.85
% Body Fat	−10.13	−6.37	−15.86
Lean Body Mass (kg)	2.80	0.54	3.36*
Fat Body Mass (kg)	−12.17	−5.83	−17.31
(1RM) Bench Press (kg)	8.26	8.01	16.95
(1RM) Leg Press (kg)	31.69	24.06	63.38*

*P<0.05, comparison between pre-intervention and post-intervention values by using one-way analysis of variance and Scheffe *post hoc* test

DISCUSSION

This study examined body composition, anthropometric, and neuromotor fitness of WT practitioners who engaged in a 12-wk linear workload increase for each muscle group with one exercise for 3 sets with 8 repetitions. The findings indicate adjustments in all of the samples, independent of the previous methodology in training routines, given that the subjects had not engaged in WT for at least 12 months prior to the study.

Although the subjects were experienced in WT, this study found improvements in strength, lean muscle mass, and body fat with a low training volume at a total workload of 12-wk? Here, it is important to highlight that the WT volume in the present study reflected the subjects' training length (i.e., duration in minutes) that had an influence on the muscles and adjustments (9). All subjects reported training repetitions toward maximum voluntary contraction, which would make such an unlikely prospect. But, in general, the literature is consistent with self-selected WT intensities that are lower than recommended (e.g., 38% to 58% of 1RM) (9,10,22).

Although it is not clear yet what is the optimum number of sets per muscle group per session, several studies (15,17,14,23) indicate that programs with multiple sets present more efficacy than a single set WT program to increase strength in trained subjects. Peterson et al. (21) reported that ~8 sets produce larger effect sizes in athletes while 4 sets resulted in the higher effect sizes untrained and trained subjects. In the present study, the subjects were trained men and women who presented an increase in strength of the lower limbs (63.4%) with smaller number of sets (2). Gonzalez-Badillo and colleagues (11) reported that a moderate resistance training volume produced more favorable strength gains than high or low volumes during a short-term training cycle. The key factor may be the variance of the training volume and its interaction with training intensity rather than the absolute number of sets (26).

The number of repetitions may result in specific adaptations. Campos and colleagues (5), followed 32 untrained subjects in 4 groups: (a) the low repetition group (4 sets, 3 to 5RM, 3-min intervals); (b) the intermediate repetition group (3 sets, 9 to 11RM, 2-min intervals); (c) the high repetition group (2 sets, 20 to 28RM, 1-min intervals); and (d) no exercise group. The results indicate that the 3 trained groups showed significant increases in dynamic muscle strength (1RM) compared to pre-training. The comparison among groups, maximum relative and absolute leg press and squat strength were significantly higher in the low repetition group versus the intermediate repetition group and the high repetition group. The maximum strength improved in all groups, but the low repetition group had the greatest increase. The leg press increased 61% (1RM) in the low repetition group; 36% in the intermediate group and 32% in the high repetition group. The total work did not significantly differ among the training groups. We hypothesize that the training volume and intensity were high enough that it did not contribute to a change in functional and morphological components due to the lack of rest and excessive catabolism.

This hypothesis may be associated with the 3 $d \cdot wk^{-1}$ training that contributes to an optimal recovery period. Even at high volume and intensity, the training is reasonable with 72 hrs rest before the next stimulus. Longer rest periods and discontinued stimuli could permit an excessive recovery time, allowing the body to return to homeostasis, with overcompensation breakpoint. However, the peak of protein synthesis is reported to be around 24 hrs after exercise, resulting on anabolic environment for 36 to 48 hrs after exercise (18).

Training frequency may increase strength, but is associated with such factors as volume, intensity, conditioning level, recovery capacity, and the number of trained muscle groups per session. Several research studies (6,19,23) indicate that the progression from beginner to intermediate level with a frequency of 3 $d \cdot wk^{-1}$ is suggested for whole body exercises and large muscle groups.

According to Kraemer and Ratamess (16), an increase in training experience does not necessarily require changes in training frequency for each muscle group (but rather changes in exercise selection, volume, and intensity). Campos and colleagues (5) suggested that untrained individuals evaluated by muscle biopsy, presented a positive effect on muscle hypertrophy after 8 wks of training in the groups that trained with lower (3 to 5RM) and intermediate repetitions (9 to 11RM). They did not find a positive effect on hypertrophy (e.g., in cross sectional areas fiber types of I, IIa, and IIb) in the group that trained with high repetitions (i.e., 20 to 28 RM). Moreover, all the 3 training groups, the percent type IIb fibers decreased while there was a concomitant increase in fiber type IIa.

These data reinforce changes in relative proportions of myosin heavy chain isoforms. However it has been accepted that strength improvement is observed with high-intensity and low-volume training; whereas, lower-intensity and higher-volume training maximizes muscle hypertrophy (13). While body weight, BMI, and body fat percentage did not present changes after the intervention period, a decrease in waist circumference (−2.4%) is associated to reduction in abdominal skinfold (−10.3%). Although strength training has a smaller effect on weight loss, several health-related benefits are reported (such as increased fat-free mass and decreased fat body mass). These results are associated with a reduction in the risk factors for chronic diseases (2). Studies involving strength training aimed at weight loss should use an average number of repetitions between 9 and 12 (7).

CONCLUSIONS

The findings in this study indicate that the proposed methodology has a positive effect on maximal strength gains in lower limbs, which is associated with an increase in lean body mass. Also, there is a decrease in abdominal fat and waist circumference, suggesting that strength training programs with reduced-volume should contribute to an improve health status in trained men and women.

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