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Effects of 8 Weeks Equal-Volume Resistance Training with Different Workout Frequency on Maximal Strength, Endurance and Body Composition

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Abstract. The purpose of this study was to determine the effects of short-term equal-volume resistance training with different workout frequency on maximal strength, endurance, and body composition in novice subjects. Thirty-nine healthy males comprised four groups; total-body resistance training (12 exercises for one session per week) (part I=10), total-body resistance training (12 exercises for two sessions per week) (part II=10), lower-body, upper-body, and upper-body resistance training (12 exercises for three sessions per week) (part III=9), and control group (CG=10). Assessments of body composition, leg and arm circumferences, body weight, strength (one repetition maximum in bench and leg press) and endurance (bench and leg press) were determined before and after 8 weeks of training. One repetition maximum in bench and leg press was improved significantly in all training groups ($P < 0.05$). All groups increased body weight, body composition, and bench and leg press endurance ($P < 0.05$), but PIII group showed a little improvement rather than other groups ($P > 0.05$). The PIII group not only increased thigh circumference but also improved arm circumference, whereas the PI and PII groups changed either arm circumference or thigh circumference ($P < 0.05$). It is concluded that in healthy young men, whole and split weight training routine produce similar results over the first 2 months of training, with minimal differences among groups.

Keywords: split routine, exercise performance, resistance training.

1. Introduction

Resistance training, also known as strength or weight training, has become one of the most popular forms of exercise for enhancing and individual's physical fitness as well as for conditioning athletes. Resistance training has been used extensively to increase fitness and sport performance. It has been demonstrated to augment maximum strength, power, and jumping ability (1,2,3). It is well known that a variety of resistance training programs can stimulate an increase in one repetition maximum (1RM) strength (4,5,6). However, only few studies have attempted to make direct comparisons of different styles of resistance training programs to determine adaptational differences. With short-term training, Marcinik et al. (7) compared high intensity (i.e., 70% of 1-RM) versus low intensity (i.e., 40% of 1-RM) aerobic/circuit resistance training in women who were U.S. Naval recruits. After 8 wk, 1-RM bench press performance was significantly greater in the high-intensity group, whereas no difference was observed between groups in 1-RM leg press performances. American College of Sports Medicine (ACSM) recommends split routines to maximize strength gains among intermediate-advanced resistance-trained individuals and athletes. With split routine training paradigm, individuals train different body parts on each training session within a week to allow proper muscle recovery and to maximize training loads. The ACSM expands this recommendation suggesting that split training routines should also require the periodization of the training load (8). This has been shown to be an effective initial frequency whereas 1-2 $d \cdot wk^{-1}$ appears to be an effective maintenance frequency for those individuals already engaged in a resistance training program (9). In a few studies: 4-5 $d \cdot wk^{-1}$ were superior to 3, 3 $d \cdot wk^{-1}$ superior to 1 and 2 d, and 2 $d \cdot wk^{-1}$ superior to 1 for increasing maximal strength (9,10). Performing upper/lower body split or muscle groups split routines during a workout are common at this level of training in addition to total-body workouts (5).

Hakkinen et al. (11) reported greater increases in muscle cross-sectional area and strength when training

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volume was divided into two sessions rather than one. Previous studies designed resistance training to upper-body, lower-body and or total-body workouts. They reported that upper-body and total-body resistance training resulted in similar improvements in performances and or total conditioning program directed at development of muscle tissue mass (12,13). In our knowledge, no study compared the effects of designing resistance training, which divided into three parts; total-body resistance training one session per week (part I), total-body resistance training two sessions per week (part II), and upper-body, lower-body, and upper-body resistance training three sessions per week (part III), together. No data are available to address this question that; Is resistance training for 1 session better than 2, or 3 sessions, and or 3 sessions is better than 1, or 2 sessions with equal-volume in novice subjects? Are important exercise sessions to design resistance training for novices and beginners? Are differences among exercise sessions for increasing physical fitness? Those are current questions that we want to answer in this study. Therefore, the purpose of this investigation was to examine the effect of three differences periodized resistance training programs (part I, part II, and part III) on strength, endurance, and body composition in novice subjects.

2. Methods

2.1. Subjects

Thirty-nine healthy males were volunteered to participate in this study. Subjects were randomly divided into four groups; part I group (PI; n=10), part II group (PII; n=10), part III group (PIII; n=9), and control group (CG; n=10). Subjects were informed as to the experimental procedures and signed informed consent statements and medical history forms in adherence with the human subjects' guidelines of the University of Guilan Health Sciences Center before any data collection. Subjects had been never involved any type of resistance training and had normal dietary intake during the study. There were no significant differences among groups in age, height, weight, and percent body fat at pre training (Table 1).

Table 1. Subjects characteristics. Data are mean ± SD.

	PI	PII	PIII	CG
Age (yr)	20.20±1.87	20.40±2.31	20.33±1.80	20.40±2.06
Height (cm)	173.60±3.80	174.20±5.18	175.67±5.29	174.40±5.05
Weight (kg)	70±4.49	72.15±8.28	73.33±7.63	74.15±5.61
Body fat (%)	13.54±2.72	13.74±2.92	14.13±2.86	13.20±3.49

2.2. Testing Procedures

The subjects were familiarized with the resistance training program about one week before the start of training period. During the familiarization session, subject initial characteristics such as; age, height, body weight, percent body fat, thigh and arm circumference, one repetition maximum (1RM) and endurance (60% 1RM) for bench press and leg press, were obtained.

Subjects were tested pre training and post training (8 weeks). The same researchers conducted all tests. Pre and post training anthropometric measures of weight, and percent body fat were taken. Height was measured to a nearest to 0.1 cm using height rod. Body weight with minimal clothing was measured to the nearest 0.1 kg on a lever-type balance in a fasted state after emptying the bladder. Subjects had 3 skin fold sites (chest, abdominal, and thigh) measured to determine body composition or percent body fat. The measurement was used the method of Jackson and Pollock (14). The circumference of mid thigh and mid upper arm of the dominant limbs was assessed.

A bilateral leg press test was selected to provide data on maximal strength through the full range of motion of the muscles involved. Maximal strength of the lower extremity muscles was assessed using concentric 1RM leg press action. Bilateral leg press tests were completed using standard leg press equipment (NIROO, KING BODY, IRAN), with the subjects assuming a sitting position and the weight sliding obliquely at 45˚. On command, the subjects performed a concentric leg extension (as fast as possible) starting from the flexed position to reach the full extension against the resistance determined by the weight. Warm-up consisted of a set of 10 repetitions at loads of 40-60% of the perceived maximum.

For the bench press, each participant lowered the bar until contact with the chest was achieved and subsequently lifted the bar back to the fully extended elbow position. Any trials failing to meet the standardized technique criteria were discarded. A warm-up consisting of 5-10 repetitions with approximately 40-60% of perceived maximum was performed. The rest period between the actions was always 2 minutes.

Subjects were allowed to perform maximum 8 repetitions during bench press and leg press, and were used equation of Brzycki (15) for the determine of 1RM.

$$1RM = \frac{weight(kg)}{1.0278 - (0.0278 \times number\ of\ \ repetitions)}$$

The local muscular endurance test was conducted 24 hours after maximal strength tests. The test was accomplished by execution of repetitions to exhaustion. After a short period of light aerobic warm-up, participants performed as many repetitions as possible without stopping or pausing between repetitions. The resistance comprised 60% of 1RM (16). The exercises selected for the application of this test were the bench and leg press.

2.3. Resistance Training

All workouts started with a general warm-up and included cool-down periods (i.e., low-intensity aerobic exercise, stretching, etc.) of approximately 5-10 min. A trainer supervised all subjects so that all essential program characteristics were strictly enforced. Specifically, trainers were responsible for seeing that exercise prescriptions were properly carried out and achieved during a workout (e.g., velocity of movement, appropriate spotting, appropriate safety considerations, prescribed rest periods, and proper hydration requirements). Also, it has been recently demonstrated that direct supervision of resistance training is vital to optimize strength performance adaptations (17). The 8 weeks program consisted of free weight and machine exercises. The part I group performed all upper- and lower-body exercises in one training session per week (Saturday) for 8 weeks. Resistance training program included; leg press, leg curl, leg extension, calf raise, lat pull-down, lat pull-row, bench press, pack fly, arm curl, dumbbell arm curl, triceps push-down, and dumbbell triceps extension (Table 2). The part II group performed upper- and lower-body exercises in two training sessions per week (Saturday and Tuesday) for 8 weeks. Resistance training program included; leg press, leg curl, lat pull-down, bench press, arm curl, and triceps push-down on Saturday; and leg extension, calf raise, lat pull-row, pack fly, dumbbell arm curl, and dumbbell triceps extension on Tuesday (Table 2). The part III group performed lower-body, upper-body and upper-body exercises in three training sessions per week (Saturday, Monday, and Wednesday) for 8 weeks. Resistance training program included; leg press, leg curl, leg extension, and calf raise on Saturday; lat pull-down, lat pull-row, triceps push-down, and dumbbell triceps extension on Monday; bench press, pack fly, arm curl, and dumbbell arm curl on Wednesday, (Table 2). Subjects were tested every 2 weeks, and resistance exercises were designed based on new 1RM for each exercise. Total training volume was not different among groups, yet training frequency was different among the three programs.

Table 2. Resistance training for PI, PII, PIII groups.

Group	Exercises	Week 1-2	Week 3-4	Week 5-6	Week 7-8	Rest periods
		Reps-intensity				
PI	I	12-60% 1RM	10-12-70% 1RM	8-10-75% 1RM	6-8-80%1RM	2-3 min
PII	II	12-60% 1RM	10-12-70% 1RM	8-10-75% 1RM	6-8-80%1RM	2-3 min
PIII	III	12-60% 1RM	10-12-70% 1RM	8-10-75% 1RM	6-8-80%1RM	2-3 min

I; 12 exercises on Saturday
II; 12 exercises on Saturday and Tuesday
III; 12 exercises on Saturday, Monday and Friday
1RM; one repetition maximum

2.4. Statistical Analysis

All data are presented as mean ± SD. A one-way analysis of variance (ANOVA) was used to determine significant differences among groups. In the event of a significant *F* ratio, Scheffe post hoc tests were used for pairwise comparisons. Paired *t*-tests were used to identify any significant differences between the groups at the pre and post tests for the dependent variables. A criterion α level of $P \leq 0.05$ was used to determine statistical significance.

3. Results

The results of this study are presented in figure 1. There were significant changes in the percent body fat, weight, 1RM bench press and 1RM leg press after a 8-week resistance training for all training groups ($P < 0.05$). The PII and PIII groups showed significant improvements rather than baseline in the thigh

circumference ($P < 0.05$). Whereas, The PI and PIII groups showed significantly increases rather than baseline in the arm circumference ($P < 0.05$). In the bench press and leg press endurance, all training groups increased significantly from corresponding pre training and control group (except bench press endurance for PI group) ($P < 0.05$). There were no significant differences among groups at pre and post training for the all variables ($P > 0.05$).

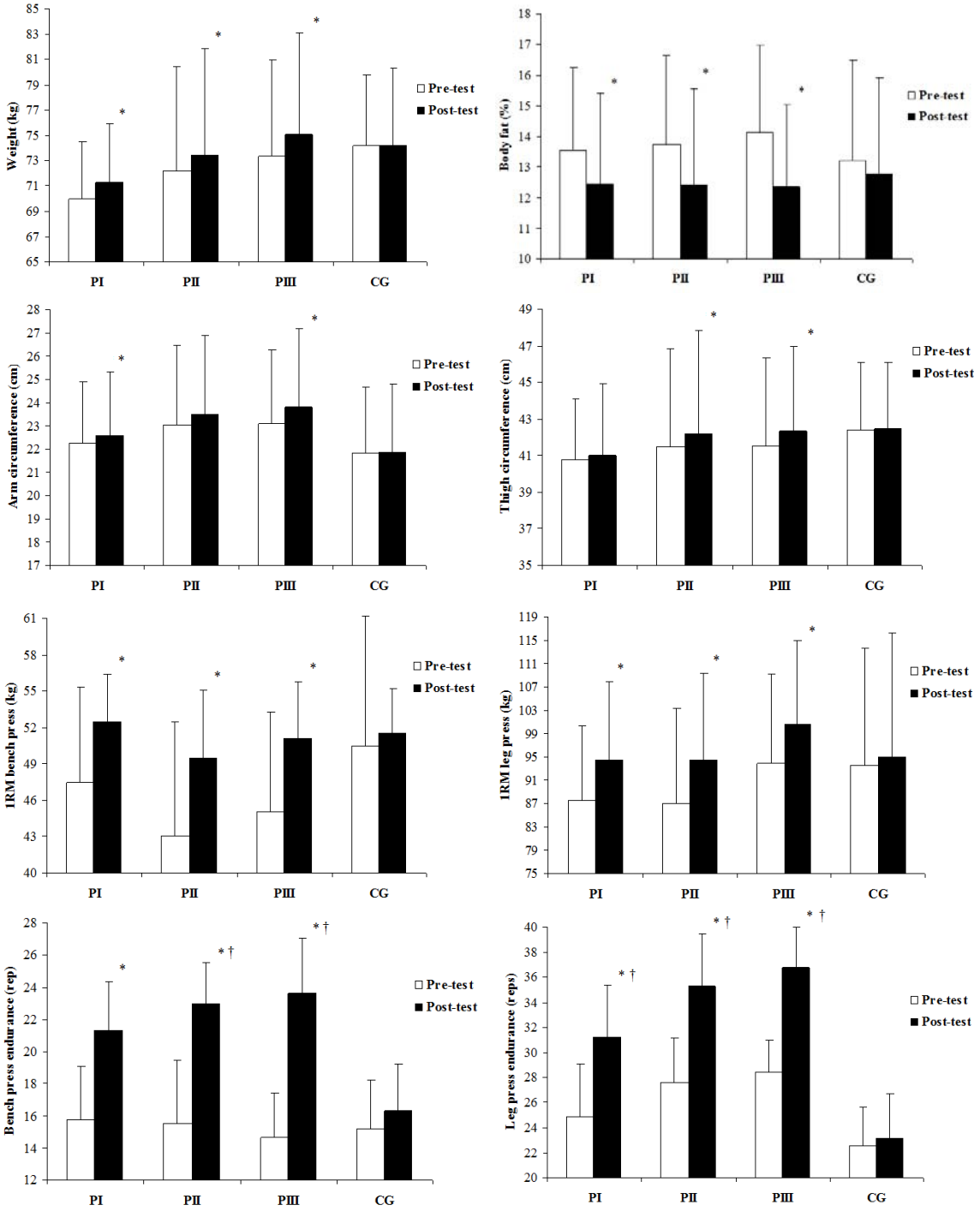

Fig 1. Differences in weight, percent body fat, arm and thigh circumference, one repetition maximum (1RM) at leg and bench press, and leg and bench press endurance (mean ± SD).

* Significant difference from corresponding pre-training

† Significant difference from corresponding CG

PI; part I, PII; part II, PIII; part III, CG; control group

4. Discussion

The purpose of the present study was to compare the effect of three equal-volume resistance training programs on physiological abilities in novice subjects. We hypothesized that, resistance training for 3 days are better than 1 or 2 days. The main finding of the present study was that, there were no significant differences among groups on 1RM bench and leg press, and leg and bench press endurance. Also, the PIII and PII groups showed significant improvements than pre training on arm circumference, and PIII and PI groups indicated significant increases from corresponding pre values on thigh circumference.

Upper and lower body strength increased significantly in all groups after a 8-week resistance training. In the contrast of our study, Berger (18) compared of one, two, and three sessions per week training the bench press or squat concluded that three sessions were superior to one or two sessions in bringing about strength increases. Another comparison of training frequency for the bench press also concluded that three sessions were superior to one or two sessions (19). The findings of the percent study are in line with Graves et al. (20) who reported that one session was equally as effective as two or three sessions per week when training for isolated lumbar extension strength. DeMichele et al. (21) found that two sessions per week was equivalent to three and superior to one session per week when training for torso rotation. These studies indicate that three sessions per week are superior to one or two sessions per week when training arm and leg musculature, whereas when training spine muscles, one or two sessions per week result in equivalent gains compared to three sessions per week. The training frequency of three sessions per week when training the arms and legs results in a 20 to 30% greater strength gain than a frequency of two sessions per week (22). Rhea et al. (23) determined the dose-response for strength development, reporting that untrained individuals see a consistent response as the training frequency increases up to 3 days/week. Strength coach and athletes believe that split routines allow individuals to train at a maximal effort level for given intensity, producing higher muscle strain on a specific session. These routines would facilitate recovery due to the alternation in the muscle group trained. But, it appears that split training routine were not more effective than whole body training routines used by other, irrespectively of the training status (24,25).

Only the PIII training group significantly increased in the arm and thigh circumference, whereas the PI and PII training groups increased either arm circumference or thigh circumference. All of the subjects improved their body weight and percent body fat (except CG). Increases in thigh CSA were only observed for the total body groups in the kraemer's et al study (13). Hakkkinen et al. (11) reported greater increases in muscle CSA when training volume was divided into two sessions per day rather than one. Huffman et al. (26) examined the effects of 10 weeks varying self-selected training frequencies among collegiate football players using different body-part training programs, and reported significant changes in the chest and thigh circumference, and sum of skinfold following four or five session-per-week training. Previous study reported increases in lean tissue mass after 10 weeks of training (27). Changes in muscle mass and CSA can be increases in; myofilaments, actin and myosin filaments, sarcoplasm, and connective tissue (28). A comparison of total body training routine and split system routine in young women who were previously not weight trained demonstrated no significant differences between groups in fat-free mass, or percent body fat changes (29). The results indicated that total-body and split-routine systems using the same total training volume produce similar results in healthy young women (29). Additionally, Carroll et al. (30) reported that when resistance training was equated for both time and number of sessions, 2 days/week resulted in a significant increase in the proportion of myosin heavy chain IIa compared with 3 days/week. The rest period between sessions must be sufficient to allow for muscular recuperation and development while alleviating the potential for overtraining (31). Split routine can allow performance of more assistance exercises and so many also be useful for enhancing physiological development.

All experimental groups improved significantly rather than pre training and control group in leg and bench press endurance (except bench press endurance for the PI group). Kraemer et al. (12) compared the effects of total-body and upper-body resistance training on endurance performance, and reported similar improvements in the squat endurance, push-ups, and sit-ups. A split routine system allows the training intensity for a particular body part or group of exercises to be higher than would be possible if the four to six sessions were combined into two or three long sessions of equivalent training volume. It is also possible to develop split routines in which the total training volume per body part is higher than that in a typical total body training session because in a split routine each training session is dedicated to a smaller number of body parts or muscle groups (5). In the present study, we not found any significant changes among groups, but part III showed minimal improvement rather than other groups. We think that, the lack of change in the anthropometric profiles suggests that neural factors may have been more important to the observed increases in strength and endurance than morphological adaptations. Moritani and DeVries (32) described that neural

adaptations would occur during the first weeks of training, it has been suggested that strength increments due to neural adaptations should also occur in highly trained athletes (33). Collectively, we recommend that, novice individuals had better use the split routine training for improving performance and promoting muscular adaptations.

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