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The Effect of 12-Week Resistance Training on Muscular Strength and Body Composition in Untrained Young Women: Implications of Exercise Frequency

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ABSTRACT

Lee H, Kim I.G, Sung C, Kim J.S. The Effect of 12-Week Resistance Training on Muscular Strength and Body Composition in Untrained Young Women: Implications of Exercise Frequency. **JEPonline** 2017;20(4):88-95. The purpose of this study was to evaluate the effect of resistance training with different workout frequency on muscular strength and body composition in untrained young women. Seventeen female college students without chronic diseases were recruited. Eight of the 17 students were engaged in comprehensive resistance training 3 times·wk^{-1} (3/wk, Moderate Frequency, MF) while 9 students were engaged in the same resistance training protocol but for only 1 time·wk^{-1} (1/wk, Less Frequency, LF). As compared to pre-training, post-training 1RM in bench press and lateral pulldown was increased significantly in both LF and MF groups, respectively (LF: 19.55 kg ± 0.85 vs. 24.33 kg ± 1.01, 20.0 kg ± 2.2 vs. 30.0 kg ± 1.62), (MF: 20.62 kg ± 0.32 vs. 23.62 kg ± 0.32, 23.12 kg ± 1.61 vs. 29.37 kg ± 0.77). Post-training 1RM in bench press and lateral pulldown in the LF group were not statistically different compared to the MF group. Body weight, muscle weight, percentage fat mass, and percentage abdominal fat mass were not different between the LF and the MF groups. The findings provide evidence that the strategy for reducing training frequency could be used as positive reinforcement for untrained female beginners with low self-efficacy for fitness and strength.

Key Words: Exercise Frequency, Resistance Training, Young Women

INTRODUCTION

The athletic and health benefits of resistance training are well documented and accepted in the fields of sports physiology and rehabilitation (18). Since the quantification of the dose-response relationship between training and the resultant strength gain is fundamental for the proper exercise prescription, a significant effort in finding the optimal training protocol was made though the adjustment of training intensity, frequency, and volume (19,20). Although high volumes of resistance training 3 times·wk^{-1} are considered to be among the most effective protocol for inducing skeletal muscle hypertrophy at an accelerated rate (2,10), the application of theses protocols to untrained beginners is limited. The primary reason is because the protocols might result in an increase in the dropout rate due mainly to the performer's low self-efficacy and the psychological pressure of training more frequently (16). This is true despite the health benefits in both sexes. Female adherence to a training program is reported to be significantly lower when compared to male adherence (8). Therefore, it is necessary to develop an effective method with modified training volume or frequency for the female novice to adhere to a training program.

Traditionally, the frequency for resistance training with 2 to 3 sets of repetitions at 60 to 80 RM is generally recommended to be 2 to 3 nonconsecutive days per week (6,9). These traditional training protocols have been proven to increase muscle mass and strength, as further supported by molecular signaling of hypertrophy such as training-induced mTOR activation and satellite cell activation (4,11). Although it is clear that the resistance training-induced hypertrophic response is evident (21), it is not well understood when muscle strength and mass occurs during training. As an example, Ikai and Fukunaga (12) found that isometric training induced a significant increase in cross sectional area (CSA) of the working skeletal muscles after 6 wks of training, but not after an additional 3 wks of training (12). In line with this, a time-course study demonstrated that a significant increase in 1 RM of chest press and knee extension occurred during an initial 6-wk program, which was followed by a non-significant increase during the remaining training protocol as compared to the 6-wk point (1). This finding suggests that once a certain level of muscle mass and strength is acquired, the rate of muscle acquisition enters a plateau stage.

In an effort to lower the psychological barrier to weight lifting for female beginners, the previous studies encouraged us to hypothesize that if a training duration is goes beyond the plateau stage, then, the effects of training with less frequency and lower volume would be comparable to those of traditional training. Therefore, the main purpose of this study was to compare the effects of a 12-wk-training program with a different workout frequency (1/wk vs. 3/wk) on muscle mass, muscular strength, and fat mass in untrained female college students.

METHODS

The subjects were 17 female college students. They were between 20 to 24 yrs of age who were enrolled in a university resistance training program. Eight of the 17 students were randomized into a resistance training group that trained 3 times·wk^{-1} (3/wk) while 9 students were randomized into a separate resistance training group that trained 1 time·wk^{-1} (1/wk). None of the subjects had a chronic disease, and none had participated in a resistance training program prior to the start of the study. All subjects understood the purpose of the study. Each subject provided a written informed consent prior to participate in the study.

Resistance Training

The subjects in the LF group (training with less frequency, 1 time·wk^{-1}) were subjected to a 150-min training session on a weekly basis. The subjects in the MF group (training with moderate frequency, 3 times·wk^{-1}) received the same training protocol 3 times·wk^{-1} non-consecutively. A 15-min preconditioning exercise that consisted of stretching and jumping jacks preceded the 2-hr strength training program. For each exercise, 3 sets of 10 repetitions were performed at 60% of the subjects' 1RM. During the training session, the subjects were rotated to 7 types of exercises that consisted of squat, bench press, arm curl, sit-up, lateral pulldown, shoulder press, and leg extension that was followed by a cool-down exercise for 15 min (such as slow walking and stretching).

Strength Measurement

Strength in the bench press and lateral pulldown exercises was assessed pre- and post-training. The subjects were scheduled for testing at a standard time of day similar to their training schedule. Each subject was supervised by a trained instructor. Before the determination of their 1RM, the subjects were instructed for proper posture and technique. Each subject initially performed a warm-up set of a couple of repetitions at a moderate weight selected by instructor. Following a brief rest for 2 min, the weight was gradually increased until only one repetition with which proper posture could be accomplished. The 1 RM testing on the bench press and lateral pulldown exercises was evaluated pre- and post-training.

BMI, Muscle Mass, Percentage Body Fat, and Percentage Abdominal Body Fat

For body mass index (BMI) calculation, body weight was divided by the square of the subject's height, which was expressed in units of kg·m^{-2}. Muscle mass and percentage body fat were measured using a 4-point bioelectrical impedance analysis (InBody).

Statistical Analyses

The results were presented as mean ± SD. Groups were compared using factorial mixed model ANOVA 2X2 (Group x Time). When appropriate, multiple comparisons by the Fisher's least significant difference test were used for *post hoc* testing. The statistical significance was set at $P<0.05$ and statistical analysis was performed using SPSS 12.0 software.

RESULTS

Post-training 1 RM in bench press and lateral pulldown was increased significantly in both the LF group (1 time·wk^{-1}) and the MF group (3 times·wk^{-1}), respectively, as compared to pre-training (Bench press; P=0.01, P=.001, Lat pulldown, P=.003, P=0.01). Post-training 1RM in the bench press and the lateral pulldown in the LT group were not statistically different compared to the MF group. Body weight, muscle weight, percentage fat mass, and percentage abdominal fat mass were not different between the LF and MF groups.

DISCUSSION

A relatively low percentage (17.5%) of female adherence to resistance training has been observed (8) despite U.S. governmental efforts to increase the proportion of adults who engage in regular resistance training to 30% (23). In an effort to tackle this problem, several lines of studies have been conducted in regards to psychology and epidemiology (3,14,16). A reason for the low adherence rate to exercise appears to be a function of the performer's low self-efficacy and psychological pressure to lift weights (16). Therefore, the main purpose of this study was to see if training with less workout frequency per week would be sufficient to promote positive health benefits in untrained young women.

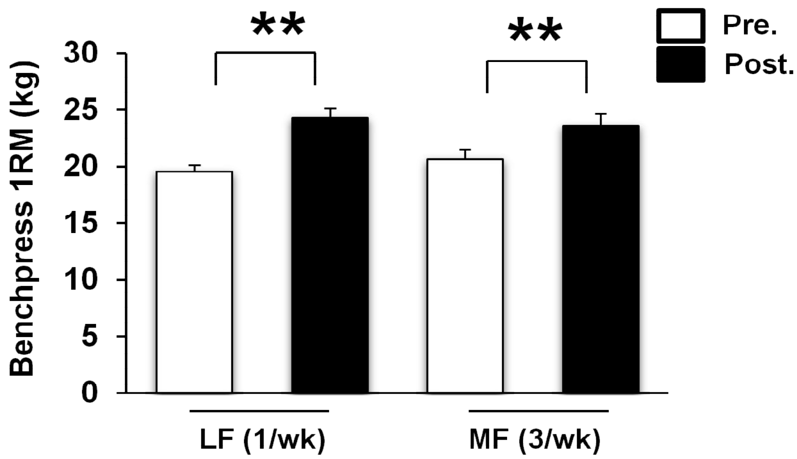

Figure 1. The Effect of Resistance Training with Low and Aoderate Frequency on 1RM of Bench Press. The statistical significance was set at *P<0.05 and **P<0.01

The primary finding was that a 12-wk-resistance training program with 3 sets of 10 repetitions at 60% RM performed once a week resulted in an increase in the strength of previously untrained subjects, which was comparable to the increase in strength previously untrained subjects using the same training protocol performed 3 times·wk^{-1}. This finding indicates that a frequency of just 1 time·wk^{-1} is sufficient for young untrained females. This is an interesting finding, particularly since a previous study demonstrated that male weightlifters who trained 1 time·wk^{-1} acquired only 62% of the strength when compared with male weightlifters who trained 3 times·wk^{-1} (15). The discrepant results between our findings and their results might be related to the differences in methodology. Specifically, differences in training status and sex may explain theses inconsistent findings. In line with this, Candow and Burke (5) reported that a 6-wk resistance program of 2 d·wk^{-1} of training increased muscle mass similarly to 3 d·wk^{-1} in untrained women. Also, they suggested that the strategy for the modulation of frequency could be adopted for untrained female novice initiating a resistance training program without a loss of training effects. In fact, the reason for the present study was to provide physiological evidence not only to encourage participation rate but to increase adherence to resistance training because a less frequent resistance training protocol that induces health benefits appears to also provide positive psychological reinforcement in inexperienced individuals with low self-efficacy for strength training.

It is interesting that both training programs did not induce a significant increase in muscle mass. While this finding is not in line with the expectation of strength training, it is generally understood that the early phase of muscle strength acquisition originates from neuromuscular adaptation in the absence of a concomitant increase in skeletal muscle mass (7). The theory is further supported by a time-dependent study with young women that over 20 wks of resistance training, an increase in muscle mass was delayed until 10 wks and significant from

10 to 20 wks, suggesting a possibility that if our 12-wk-training protocol was extended over 20 wks, a hypertrophic response would also be observed.

In the study by Kwon et al. (13), percentage fat mass in whole body and abdominal region was not changed by any of the two training methods. While resistance training alone has been shown to be an effective method to reduce fat mass in old women with type 2 diabetes, the effects in young female subjects was not reported. This finding warrants future study to see if resistance training alone can influence fat mass in young women without metabolic diseases.

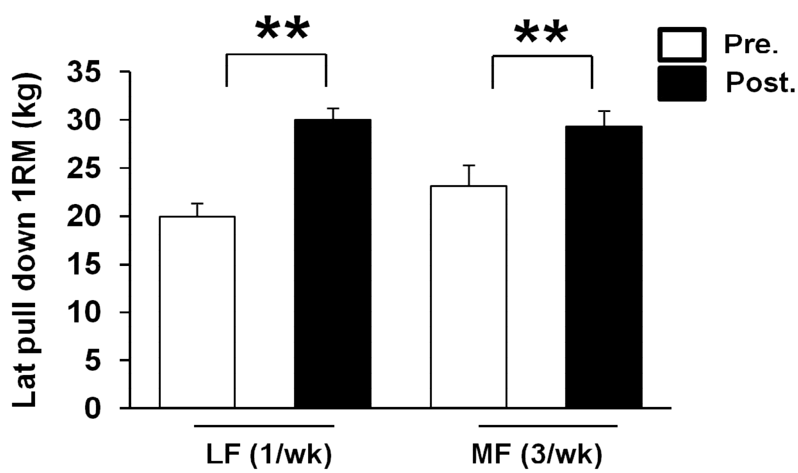

Figure 2. The Effect of Resistance Rraining with Low and Moderate Frequency on 1RM of Lateral Pulldown. The statistical significance was set at *P<0.05 and **P<0.01

Table 1. The Body weight, Fat mass, and Muscle Mass Before and After Training.

Conditions	Pre-LF	Post-LF	Pre-MF	Post-MF
Body Weight (%)	51.33 ± 1.68	51.32 ± 1.39	53.56 ± 2.41	52.93 ± 1.99
Body Fat Mass (%)	26.63 ± 1.03	25.62 ± 1.27	27.75 ± 0.88	27.37 ± 1.17
Abdominal Fat Mass (%)	0.79 ± 0.009	0.78 ± 0.009	0.79 ± 0.012	0.78 ± 0.013
Muscle Mass (kg)	33.82 ± 2.31	35.8 ± 1.09	34.21 ± 1.73	36.22 ± 1.39

No statistical difference was detected across all groups tested.

The Limitations of the Study

Due to limited resources, we were not able to measure strength and muscle mass in a time-dependent manner, which induce a limitation to provide trends and changes in strength gain over the training period. Secondly, muscle mass and fat mass were measured with the use of a 4-point bioelectrical impedance analysis of which the results are reported to be affected by factors such as the environment, ethnicity, and phase of menstrual cycle (22). Therefore, it is recommended that more accurate methodology such as dual x-ray absorptiometry (DEXA) and magnetic resonance imaging (MRI) be adopted in future studies.

CONCLUSIONS

It is concluded that resistance training performed 1 time·wk^{-1} induced an increase in strength as comparable to the same training protocol of 3 times·wk^{-1} in untrained young female subjects. Therefore, it is considered that the strategy for reducing training frequency could be used as positive reinforcement for untrained female subjects with low self-efficacy for fitness and strength.

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