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Comparisons between Low-Intensity Resistance Training with Blood Flow Restriction and High-Intensity Resistance Training on Back Muscles

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ABSTRACT

Seenuan C, Mitranun W. Comparisons between Low-Intensity Resistance Training with Blood Flow Restriction and High-Intensity Resistance Training on Back Muscles. **JEPonline** 2023;26(6):33-38. This study compared the effects of exercise with blood flow restriction (BFR) combined with low- and high-resistance training on the back muscles. Thirty 18 to 39 years of age men without a background in resistance training 6 months prior were randomly selected with systematic sampling into 3 Groups of 10 participants each: (a) BFR with low resistance training at 30% of one repetition maximum [1RM]; (b) high-intensity resistance training at 75% of 1RM; and (c) a Control Group. The two training groups performed pulldown exercises 3 days a week for 8 weeks. Before and after the 8-week training period, the participants were tested for 1RM of the lat pulldown, 1RM of the preacher curl, posterior scapular circumference, arm circumference, and body composition. The paired *t*-tests revealed that both Training Groups showed significant improvements in the 1RM of lat pulldown, 1RM of the preacher curl, posterior scapular circumference, and arm circumference after 8 weeks of training ($P < 0.05$). Analysis of covariance demonstrated that the high-intensity resistance training had significantly different 1RM in lat pulldown and posterior scapular circumference compared with the Control Group ($P < 0.05$). It was concluded that both types of training were similarly effective and could be incorporated into resistance training programs.

Key Words: Blood Flow Restriction Training, Circumference, High Intensity Resistance Training, One Repetition Maximum

INTRODUCTION

Resistance exercise is crucial for improving muscle strength. Traditional training methods often require training at approximately 70 to 80% of one repetition maximum (1RM) to achieve muscle development and increased strength (2). However, high-resistance training places a significant load on the muscles and joints, increasing the risk of injury with prolonged training at heavy loads. This poses a challenge for individuals undergoing injury rehabilitation who are unable to train at a high intensity.

Previous studies have explored exercise training methods that reduce the intensity of resistance training while promoting increased muscle strength. Blood Flow Restriction (BFR) training, which combines low-intensity resistance training (20 to 30% 1RM) with blood flow restriction has shown promising results (1). This type of training reduces stress exerted on the joints and can be beneficial for individuals recovering from injuries who cannot tolerate high-resistance training. BFR induces various mechanisms within the muscle cells that promote muscle development, which includes increased muscle protein synthesis and activation of fast-twitch muscle fibers (3-5,7).

A study conducted on the upper torso muscles examined the effects of BFR combined with low-resistance training during bench press exercise. The researchers measured muscle activity using electromyography and found increased muscle activity in the Experimental Group compared with the Control Group, particularly in the triceps brachii muscles that were subjected to blood flow restriction. They also observed increased muscle size in both restricted and non-restricted muscles, indicating the effectiveness of BFR in promoting muscle development (8).

Building on previous research, this study investigated whether applying BFR to the back muscles would yield similar results to training in the bench press position. Specifically, this study examined the interactions between the muscles that were directly restricted by blood flow and those that were not. This study hypothesized that BFR training combined with low-resistance exercises would result in improved back muscle strength and size.

METHODS

Subjects

Thirty working-age men between the ages of 18 and 39 years with no previous resistance training experience in the past 6 months were randomly selected with systematic sampling to 3 Groups of 10 subjects each: (a) BFR with low resistance (30% 1RM); (b) high-intensity resistance training (75% 1RM); and (c) a no training Control Group. The 2 Training Groups performed lat pulldown exercises 3 $d \cdot wk^{-1}$ for 8 weeks. Screening tests, including the Physical Activity Readiness Questionnaires, were conducted before the training program. This study was approved by the Ethics Committee of Srinakharinwirot University (No. SWUEC-G-321/2564E). Also, this study's protocol was registered at www.thaiclinicaltrials.org (Identifier: TCTR20230222011).

Familiarization Phase

The subjects in the 2 Training Groups were familiarized with the lat pulldown exercise machine and received instructions on back muscle exercises in the lat pulldown position. One week prior to the training program, the subjects underwent familiarization sessions to ensure the proper

techniques**.** The subjects in the BFR Group were also trained in the use of the BFR device during the lat pulldown exercise**.**

Exercise Training

The study followed a parallel design with all the subjects tested for 1RM of lat pulldown, 1RM of the preacher curl, posterior scapular circumference, arm circumference, and body composition before and after the 8-week training program. Both Training Groups performed pulldown exercises 3 $d \cdot wk^{-1}$ for a total of 8 weeks. Prior to each training session, all the subjects performed warm-up exercises. Group 1 underwent BFR combined with low-intensity training at 70% arterial occlusion pressure (AOP) and 30% 1RM for 75 repetitions (30 repetitions followed by 3 sets of 15 repetitions). Group 2 engaged in high-intensity training at 75% 1RM for 30 repetitions (3 sets of 10 repetitions with 2 to 3 min of rest between the sets) (9). Group 3 was the Control Group, which did not undergo any training. After completing the 8-week training program, the results were compared using statistical analyses.

Arterial Occlusion Pressure (AOP)

For the subjects in the BFR combined with low-resistance exercise Group, the AOP was determined to observe maximum strain-induced arterial occlusion. The subjects had a blood-oxygen-measuring device attached to their fingertips, and pressure was applied to the upper arm using a pressure-measuring device. Pressure at 70% AOP was calculated as the weight-limiting blood flow in the upper arm. Both arms of the participants in the BFR combined with low-resistance training Group performed the lat pulldown exercise.

Measurement

General Physical Characteristics

Body composition was measured using an electrical body composition analyzer (TANITA 720, Tanita, Japan). Posterior scapular and arm circumferences were assessed by the researcher using a tape measure.

One Repetition Maximum

1RM for lat pulldown and the preacher curl exercises was measured using a 9-step protocol, including warm-up with light resistance, rest periods, and progressively increasing loads until a near-maximal load was reached. The 1RM testing protocol followed established guidelines.

Statistical Analyses

The data are presented as mean and standard deviation. The Shapiro–Wilk Test was used to verify data normality. Analysis of variance was conducted to compare maximal capacities (1RM) in the lat pulldown, the preacher curl, posterior scapular circumference, arm circumference, muscle mass, and fat mass between: (a) the BFR with Low-Intensity Resistance Training Group; (b) the High-Intensity Resistance Training Group; and (c) the Control Group before and after the training period. The significance threshold was set at $P < 0.05$.

RESULTS

There were no significant Group differences in any of the subjects' characteristics before the exercise program (Table 1). Age, body mass, height, and BMI were comparable between the

Groups. After the 8-week training period, both the BFR with Low-Intensity Resistance Group and the High-Intensity Resistance Training Group showed significant improvements in the 1RM of the lat pulldown, the 1RM of the preacher curl, posterior scapular circumference, and arm circumference ($P < 0.05$) (Table 2). Analysis of covariance revealed that the high-intensity resistance training resulted in significantly different 1RM in lat pulldown and posterior scapular circumference compared with the Control Group ($P < 0.05$).

Table 1. Participant Characteristics.

Group	BFR-LI (N = 10)	HI (N = 10)	CONTROL (N = 10)
Age: $\bar{x} \pm SD$	29.60 ± 4.77	28.8 ± 3.12	31 ± 3.33
Weight: $\bar{x} \pm SD$	75.77 ± 8.97	75.22 ± 11.84	76.26 ± 12.94
Height: $\bar{x} \pm SD$	174.1 ± 5.99	172.2 ± 5.22	172.6 ± 5.27
BMI: $\bar{x} \pm SD$	24.97 ± 2.03	25.25 ± 2.79	25.54 ± 3.70

Table 2. Comparison of 1RM Lat Pulldown, Posterior Scapular Circumference, 1RM Preacher Curl, and Arm Circumference.

Group	BFR + LI (N = 10)		HI (N = 10)		Control (N = 10)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1RM Lat Pulldown	71.01±12.78	76.51±13.38*	69.82±11.49	81.77±10.86*#	70.93±10.35	70.52±12.09
Posterior Scapular Circumference	91.70±5.40	95±5.08*	92.50±3.47	96.80±3.65*#	91.60±2.67	91.40±3.10
1RM Preacher Curl	30.22±3.62	32.89±3.46*	30.40±3.18	32.95±3.88*	30.20±3.26	30.05±3.50
Arm Circumference (R)	27±2.0	28.50±2.1*	26.60±1.8	28.5±2.2*	28.3±1.5.	27.7±1.5
Arm Circumference (L)	26.5±1.9	27.90±1.8*	26.1±1.7	27.9±1.7*	27.6±1.3	27.3±1.6

* Different from Pre, $P < 0.05$; # Different from CON, $P < 0.05$. Abbreviations: **BFR** = Blood Flow Restriction, **LI** = Low Intensity, **HI** = High Intensity

DISCUSSION

The findings of this study support the hypothesis that BFR combined with low-intensity and high-intensity resistance training is effective in improving muscle strength. The observed increases in muscle size of the posterior scapular circumference and arm circumference were significant in both Training Groups.

Previous research demonstrated the efficacy of blood-flow restriction combined with low-resistance training in promoting muscle activation and strength gain. Studies on the upper torso muscles, such as the triceps brachii and the pectoralis major have shown an increase in muscle activity and size when BFR is applied during bench press exercises (8). The present study extends this research to the back muscles and explores the interaction between the muscles directly restricted and not directly restricted by blood flow.

These results indicate that BFR combined with low-intensity resistance and high-intensity resistance training can result in significant improvements in muscle strength and size. High-intensity resistance training showed greater improvements in the 1RM lat pulldown and the posterior scapular circumference than the Control Group, suggesting its effectiveness in eliciting muscle adaptations. However, BFR combined with low-resistance training yielded comparable results, making it a viable alternative for individuals who cannot tolerate high-resistance training because of injuries or other factors.

Remarkably, the muscle area subjected to occlusion in the BFR+ LI Group exhibited a comparable increase in circumference when compared to the HI Group. Despite the exercise program primarily targeting the back muscles, it is possible that hypertrophic enhancements could occur at a similar level. The combination of BFR training and low-resistance exercise provides an option for reducing joint stress and mitigating the risk of injury associated with high-resistance training. Also, it stimulates metabolic stress, which promotes the secretion of anabolic hormones and contributes to muscle development (4-6). This approach can be incorporated into resistance-training programs aimed at maintaining muscle strength and size without relying solely on high-resistance exercises.

Limitations in this study

This study has several limitations. First, it is advisable to employ the most precise measurement tools for circumference assessments. Second, while the research encouraged participants to maintain their regular calorie intake throughout the experiment, it would have been beneficial to collect nutritional information. Third, the study had a small number of participants.

CONCLUSIONS

BFR combined with low-resistance and high-intensity resistance training were similarly effective in improving back muscle strength and size. These findings suggest that BFR training can be incorporated into resistance training programs as an alternative approach to reduce joint stress and the risk of injury associated with high-resistance training. Further studies are warranted to explore the long-term effects and potential applications of BFR training in various populations.

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