**Effects of Blood Flow Restriction Training on Skeletal Muscle Hypertrophy in Various Populations**

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**RESEARCH QUESTION**

Is blood flow restriction training (BFR) more efficacious in producing muscle hypertrophy when compared to hypertrophy training without the use of blood flow restriction?

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**BACKGROUND**

BFR consists of low intensity weight training with high repetitions while wearing a tourniquet on either the upper extremity (UE) or lower extremity (LE). This can result in significant increases in skeletal muscle hypertrophy and strength. Ocluing the blood flow of an extremity reduces the amount of arterial blood flow and venous return to muscles, which demonstrates an increase in type II skeletal muscle fiber recruitment. Safety has been a major concern in BFR with respect to blood flow occlusion; however, personalized occlusion pressures have been shown to be beneficial. Personalized occlusion pressures decrease the adverse effects that are seen with complete arterial occlusion and consistent levels of occlusion limits the variability in BFR intensities. Intensity levels with BFR can be as low as 20% of the 1 repetition maximum (1 RM), which can be beneficial in various populations with the considerations of injury and recovery time in mind. BFR has been found to be successful in both healthy and unhealthy individuals. There is evidence to support the use of BFR in athletes and rehabilitation due to the decreased force on the musculoskeletal tissues, joints, and ligaments as well as the reduction in muscle damage and inflammation.

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**PURPOSE**

The purpose of this literature analysis is to review the efficacy of blood flow restriction training in comparison to traditional hypertrophy training. Effectiveness in various populations is also reviewed in this literature analysis.

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**MATERIALS AND METHODS**

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<th>Authors</th>
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<td>Dankel et al. 1</td>
<td>Studies included were required to apply BFR to the UE before exercise and was left on until completion. Participants also needed to be enrolled in chronic training of at least 5 sessions where pre and post measure of muscle size and/or strength were taken.</td>
<td>A collection of peer-reviewed studies was reviewed and evaluated the adaptation of muscle hypertrophy that occurred in various populations. Outcomes compared included strength and size of the muscles in the UE.</td>
<td>Maximum benefits of BFR in the UE were seen in single joint exercises at 30% load. Increases in muscle size and strength in various muscle groups in the UE were not with the presence of BFR. Targeting muscles beyond the restricted area may require more repetitions.</td>
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<td>Yamakata et al. 2</td>
<td>Studies included football athletes with an average age of 19.2 ± 1.8 years were randomly assigned to two groups (BFR and control). Time of training was kept consistent for each participant. Pre and post tests included blood pressure, grip of upper and lower chest, upper and lower arm, and thigh, height, body mass index, and IRM of bench press and squat. The exercise protocol included 1 set of 5 reps at 20% IRM followed by 3 sets of 20 reps with a 45 second rest period. Pace of concentric and eccentric contractions were guided with a metronome with the eccentric phase lasting twice as long as the concentric phase. Participants trained 3x/week for 4 weeks.</td>
<td>After 1 month, BFR group demonstrated a 7% increase in bench press (p&lt;0.05) and 8% increase in squat (p&lt;0.05) when compared to the control group (3.2% and 4.9% respectively). Improvements in chest girth measurements were statistically significant for the BFR group (p&lt;0.05).</td>
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<td>Luebbers et al. 3</td>
<td>Study: The effects of a 7-week practical blood flow restriction program on well-trained collegiate athletes 62 male NCAA Division II football athletes were divided into 4 groups. Subjects had a mean age of 20.3 ± 1.1 years, mean weight of 99.2 ± 19.7 kg, and 6 ± 2.2 years of weightlifting experience. Pre-test day 1 included UE and LE girth measurements and IRM bench press, completed after 48 hours of rest; day 2 included IRM squat. The program lasted 7 weeks. Group 1 consisted of a high intensity traditional training protocol (H) with 1RM supplemental training (S) and BFR (SR). Group 2 completed H/S protocol. Group 3 completed H/R protocol. Group 4 completed a modified training program/S/R protocol. Training protocol consisted of training UE and LE 2x's each week.</td>
<td>Group 1 experienced larger increases in IRM squat than the other training groups (p&lt;0.05). The addition of the S protocol, with or without BFR, made no difference in the extent of gains during bench press as well as thigh and arm size.</td>
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<td>Leomke et al. 4</td>
<td>Study: Low intensity blood flow restriction training: a meta-analysis Inclusion criteria required the primary focus of the study to compare effects of low intensity (LI) endurance/ resistance training to LI-BFR. Outcome measures were required to include at least one measure of muscle hypertrophy, only studies measuring outcomes of UE were analyzed. A collection of 11 studies were analyzed. Participants must have been collegiate or professional athletes in the study. Pre- and post- effect sizes (ES) were calculated and adjusted for sample size bias. Descriptive statistics were calculated and univariate analysis of variance by groups. Paired comparisons were performed using Bonferroni post hoc procedure.</td>
<td>Significant differences were found between LI-BFR training and LI training when comparing the mean ES for muscle hypertrophy (p&lt;0.05). Untrained groups gained more strength than recreationally active groups (p&lt;0.05). Significant differences were found between training 2-3 days/week and 4-5 days, as well as 4.5-days and 6-days.</td>
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**ANALYSIS**

Overall, BFR demonstrates an increase in strength gains and muscle hypertrophy in both UE and LE training. 1,4 Yamakata et al and Leubbers et al evaluated the effects of BFR on football athletes and found increases in strength and size of the muscles being trained. It can be inferred that the effects of BFR are still applicable to resistance trained athletes. It is also noted that untrained individuals experience increased strength gains compared to those who are recreationally active before BFR training. As a result, it can be stated that BFR training can be beneficial for increasing strength and hypertrophy across different populations. BFR also demonstrates a cross transfer effect where gains were also noted proximal to the occlusion site, although may require more repetitions. Therefore, BFR can be efficacious in more than the targeted muscle groups.

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**REFERENCES**


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**Figure 1: Group x Time interaction of 1 RM Squat**

**Figure 2: Effect size x Weeks of Training for LI-BFR**

**Figure 2**: By 10 weeks, muscle hypertrophy remains fairly constant while strength significantly increases (p<0.01). It is known that neural adaptations increase strength within the first couple of weeks and hypertrophy comes later; however, LI-BFR tends to demonstrate opposite effects by 10 weeks.

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**CONCLUSIONS**

BFR training requires several variables to be manipulated such as frequency, intensity, and volume of training. Based on the current research, BFR training proves to be an efficacious method to increase overall strength/hypertrophy for the muscle groups being trained in both UE and LE. It was found that BFR training is still efficacious in resistance trained athletes even though they achieved a high level of muscular adaptation to traditional resistance training. BFR training has also been shown to be a safer alternative when compared to traditional resistance training with respect to musculotendinous tissue. The results of these studies warrant further investigation on the effects of BFR with appropriate and objective measurements of BFR occlusion pressures.