Eliciting Post-Activation Potentiation Using Blood Flow Restriction Technique: A Preliminary Look

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Table of Contents

Preface

Post-activation potentiation (PAP) and blood flow restriction (BFR) are both heavily used techniques among the field of exercise science. They both emerged into the field with each their own purpose. However, mechanisms underlying them may overlap, warranting the consideration of how they may work together. These techniques have not yet been combined with the intent of inducing PAP solely from BFR. The field of exercise science is consistently investigating methods to achieve optimal human movement. With knowledge of BFR and PAP, it is purposeful to determine if these techniques are able to complement one another. This document explores BFR and PAP through their history and traditional uses. Moreover, it describes an original research approach to integrate these two techniques.

History of Post-Activation Potentiation (PAP)

Post-Activation Potentiation (PAP) is a phenomenon that has been studied extensively in the field of exercise science. It is becoming more and more popular as a concept to enhance performance in athletes (NSCA, 2016). PAP is commonly known as the aftereffect that makes complex training beneficial for performance enhancement. Complex training involves pairing a heavy resistance exercise with a power exercise that is biomechanically similar within the same set (NSCA, 2016). Power exercises or plyometrics that involve a rapid change between eccentric and concentric contraction involve the concept of stretch shortening cycle (SSC). The SSC explains how the elastic components of the muscles and tendons are lengthened during the eccentric action, increasing elastic energy, and then rapidly shortened during the concentric action that immediately follows, causing an explosive movement (NSCA, 2016). A common example that portrays this concept is a countermovement jump (CMJ). During the CMJ the quadriceps, glutes, and calf muscles, as well as the achilles tendon are stretched during the preparatory movement for the jump, when completing about a half squat. Then as the upward phase of the jump begins, these muscles and tendons are rapidly transitioned into a concentric contraction, allowing explosive movement off of the ground as the stretched components "spring" back. During complex training, the heavy resistance exercise is fundamentally different from the power exercise and therefore requires a different stretch shortening task (NSCA, 2016). Higher force with slower velocity is required during the heavy resistance exercise, whereas low force with high movement velocity is required during the power exercise (McCann & Flanagan, 2010). Development of PAP has been explained as this change in the force-velocity relationship between these two exercises (McCann & Flanagan, 2010). Physiological components within the muscle are altered during the heavy resistance exercise, priming it for the subsequent movement, as long as adequate time is allowed for fatigue to dissipate between the two (Tillin & Bishop, 2009). Consequently, more force can be produced during the power exercise, enhancing performance, such as by increasing CMJ height.

History of Blood Flow Restriction (BFR)

What is BFR?

Blood flow restriction (BFR) is an exercise modality that has been studied extensively (Patterson et. al., 2019). It involves the use of a pressurized cuff that is placed at the proximal end of a limb. When the cuff is inflated, blood flow to the corresponding limb is restricted. When restricting arterial flow and venous return, physiological processes are affected. For instance, the muscles of the occluded limb are less able to receive oxygen and glucose. These altered physiological processes cause BFR to have the effect that it does (Pope et. al., 2013). It is well established that using BFR during low load exercise (about 20% 1 Repetition Maximum [RM]) produces muscle hypertrophy and strength gains similar to that of high load resistance training (about 80% 1 RM) when similar exercise volumes are used (Abe et. al. 2006; Biazon et. al., 2019; Vechin et. al., 2015). The proposed mechanisms underlying exercise with BFR include promoting higher order muscle fiber recruitment, stimulating muscle protein synthesis, metabolic accumulation, and cell swelling (Loenneke et. al., 2012).

Kaatsu Master

Restricting blood flow during exercise has been accomplished with the use of multiple tools. Researchers have used simplistic devices such as tourniquets (Shinohara et. al., 1997) and elastic knee wraps tightly wrapped around the limb (Scott et al. 2017) to obtain blood flow restriction. However, more commonly pressurized cuffs (Loenneke et. al., 2015) or a device called the Kaatsu Master (Karabulut et. al., 2010) have been utilized. The Kaatsu master has been extensively used among BFR research to the point where vascular restriction training has earned the name Kaatsu training, when this device is used (Abe et. al., 2005; Abe et. al. 2006; Karabulut et. al., 2010). The Kaatsu master uses a repeated pressure sequence that allows for customizable and precise pressure occlusion (KAATSU Global, Inc, 2022). The Kaatsu master has been used for recovery, rehabilitation, and performance improvement (KAATSU Global, Inc, 2022).

Pressure Selection and Cuff Width

Two common considerations of BFR training include the width of the pressurized cuff and the pressure setting of the cuff. When training intensities are low, occlusion pressure has been shown to have an effect on the muscle hypertrophy response (Lixandrão et. al., 2015). A higher occlusion pressure (approximately 80%) may produce a more desirable effect for low intensity training (Lixandrão et. al., 2015). However, if the width of the cuff is wider, less pressure is required to acquire a desired percentage of blood flow restriction (Pope et. al., 2013). The size of an individual's limb also affects the pressure setting. A larger limb will require a higher pressure to restrict arterial blood flow (Patterson et. al., 2019). A commonly accepted technique to find the exercise occlusion pressure is to inflate the pressurized cuff to the point where blood flow ceases (100% occlusion), and then multiply that by the desired pressure for exercise (Patterson, et. al. 2019). An arterial occlusion pressure between 40-80% occlusion is generally used, depending on the intensity of the exercise protocol (Patterson et. al., 2019).

Original Research

Abstract

Post-activation potentiation (PAP) describes a phenomenon that occurs in muscles that is commonly used to achieve maximum performance of a power-based movement, such as a vertical jump. PAP is traditionally achieved through physiological mechanisms that occur from high load, biomechanically similar exercise, completed before the power movement intended to be maximized. Blood flow restriction (BFR) is a training method wherein a pressure cuff is used to occlude blood flow to a limb during exercise. PAP has been studied extensively, though limited research has introduced a convenient way to make PAP accessible to athletes for immediate performance improvement. BFR resistance training with low-load has been shown to mimic the training effects of high-load resistance exercise. Current research combining the use of BFR to elicit PAP is very limited and needs to be examined further. It is theorized that BFR may be able to induce PAP by means of its simulation of high-load resistance exercise. Recreationally trained individuals may also benefit from this for personal use and may display a different PAP response. **Methods**: The proposed study investigates PAP effects on vertical jump height, following the completion of body weight (BW) squats with BFR among recreationally and competitively trained individuals. In two separate sessions participants completed BW squats with and without BFR, allowing participant characteristics to be controlled. Vertical jump height (VJH) was measured before and after each condition using a Vertical Challenger Jump Unit. Jump gain (JG) was calculated by subtracting the pre-squat VJH from the post-squat VJH and compared using a 2-factor with replication ANOVA. **Results:** No significant differences in jump gain were found. **Conclusion:** The results indicate less promising ability of BFR to elicit PAP, however, further investigation is needed.

Introduction

Vertical jump is a key aspect of human performance. A common technique used to increase vertical jump height (VJH) is the muscular phenomenon post-activation potentiation (PAP). PAP is traditionally recognized as the performance enhancing aspect of complex training (McCann & Flanagan, 2010). Complex training involves completing a heavy resistance exercise prior to a biomechanically similar power exercise. A common example involves performing the back squat exercise prior to a vertical jump (Cleary, et. al., 2020). Greatest PAP effects have been noticed after preloading events of 1-3 sets with 1-5 repetitions of 80% or greater of one's 1 repetition maximum (RM) (Villalon-Gasch et. al., 2020). The heavy preload establishes a "readied" state within the worked muscles, allowing improvement of the subsequent power exercise (Robbins, 2005). The mechanisms responsible for this "readied" state of the muscle are the phosphorylation of regulatory light myosin chains, which increase the sensitivity of the muscles contractile components to calcium, and greater recruitment of type II muscle fibers (Gołaś et. al., 2016; Sale, 2002; Tillin & Bishop, 2009).

A consideration of PAP is that fatigue could coexist with potentiation (Jo et. al., 2010). However, fatigue dissipates more quickly (Tillin & Bishop, 2009). Therefore, a recovery period after the preloading event may reduce fatigue effects allowing potentiation to be recognized (Tillin & Bishop, 2009). Studies suggest that PAP effect is best experienced two to ten minutes after the high-load exercise (Gołaś et. al., 2016; Nibali et. al., 2015; Tillin & Bishop, 2009). Due to the time constraint and heavy equipment needed to utilize PAP performance effects, it is not a feasible technique for athletes prior to a competition.

Blood flow restriction (BFR), which uses a pressure cuff to occlude limbs during exercise, is a popular method to simulate high load. Resistance exercise with BFR is commonly performed at low loads (about 20% 1 RM) with high repetitions (~15-30) (Yamanaka et. al., 2012; Fatela et. al. 2016; Karabulut et. al., 2010; Pope et. al., 2013). Short rest periods are often used (Pope et. al., 2013). Additionally, such protocols benefit from utilization of high occlusion pressures (~80% occlusion) (Lixandrão et. al., 2015). When compared to traditional high load resistance exercise (~80% 1 RM), low load exercise with BFR has shown to produce similar muscular strength and hypertrophy gains (Doma et. al., 2020; Karabulut et. al., 2010; Lixandrão et. al., 2015). Furthermore, BFR training with only bodyweight elicits increased muscle cross-sectional area (Jakobsgaard, et. al., 2018). The proposed mechanisms underlying BFR, including increased recruitment of type II muscle fibers, increased metabolic stress, and enhanced intramuscular signaling, may be the cause of these adaptations (Pope et. al., 2013; Wilk, et. al., 2020).

Since training with BFR has shown to simulate the effects created by high load resistance training, it is theorized that BFR with low load, such as bodyweight (BW), may be able to induce PAP through this mechanism. In a study by Doma et. al. (2020), BFR was used in conjunction with BW lunges and five drop jump heights were measured in three minute intervals after the protocol. The BFR group showed a significant increase of five centimeters in drop jump height on the fifth drop jump, while the non-BFR group had no significant height increase (Doma et. al., 2020). Additionally, significant power increases of the subsequent jump were observed after the addition of BFR to BW exercise (Doma, et. al., 2020).

The current knowledge about whether BFR can induce PAP is very limited. There is no research investigating the use of BFR during BW squats to elicit PAP and increase VJH during a single event. Huge possibilities for PAP utilization in the athletic world may result from research in this area. Vertical jump is a key performance aspect for sports like basketball, where the player who can jump the highest wins the tipoff at the beginning of the game, and volleyball, where vertical jumps are used to block and spike the ball in many instances. Increasing VJH, beyond achieved improvements from athletic training, immediately before performance, would be a desirable effect for such sports. If BW BFR elicits PAP, utilization of PAP by athletes to obtain such an effect may become considerably more practical. Additionally, this discovery would be beneficial to recreationally trained individuals to achieve personal training goals or aid in performance enhancement for intramural or club sports. PAP response may differ among the groups due to their discrepancies in training.

Therefore, the purpose of this study was to investigate whether BW squats with inflated BFR (BFR-ON) elicits PAP, evident by an increase in VJH, when compared to the control condition of BW squats with deflated BFR (BFR-OFF). It was hypothesized that the vertical jump gain (JG) would be greater after the BFR-ON condition when compared to the BFR-OFF condition. Furthermore, due to their more advanced training status, it was hypothesized that competitively trained individuals would experience a greater PAP effect than recreationally trained individuals.

Methods

Experimental Approach to the Problem

A within subjects design was used as each subject completed three sessions: familiarization, and two experimental sessions. All sessions were completed one week apart from the previous. All subjects completed the familiarization session first. Then, for the two experimental sessions, the order of the BFR-ON and BFR-OFF conditions were randomized among participants. Pre-squat and post-squat VJH was measured. PAP effect was measured by calculating the jump gain (JG) as the difference between post-squat VJH and pre-squat VJH for each condition.

Subjects

Healthy competitively and recreationally trained individuals, ages 18-28, were recruited from the local campus community. There were 8 participants total. Both the competitively and recreationally trained groups consisted of 2 females and 2 males. Participant characteristics are presented in Table 1. The competitively trained group consisted of collegiate varsity athletes including a volleyball player, soccer player, wrestler, and track and field. On top of resistance training, the competitively trained subjects reported having sport specific training 5-6 days per week and have all been training for greater than 2 years. The recreationally trained subjects reported training for at least the prior six months, most for greater than 2 years. Three competitively trained and one recreationally trained participant reported having previous experience with BFR. All participants completed informed consent via Qualtrics that was approved by Oakland University's Institutional Review Board before testing.

Subjects also completed a health history questionnaire via Qualtrics to confirm they were at low risk for use of BFR, which excluded those with any musculoskeletal injuries, underlying conditions such as diabetes, or uncontrolled hypertension, and use of blood thinning medication. Subjects were instructed to keep their normal exercise and practice routines, but avoid exercise the day of, prior to their session, consume a similar meal prior to each session, and avoid caffeine 4 hours prior to each session. Prior to the start of each exercise session it was verified via yes or no questions that the subjects complied to the requests.

Group	*N*	Age	Height (inches)	Weight (lbs)	Resistance Training Days/Week
Competitively Trained	4	20.5 ± 0.58	68 ± 4.69	156.25 ± 21.75	2.25 ± 1.26
Recreationally Trained	4	22.75 ± 3.20	67.75 ± 3.50	175.5 ± 26.66	3.75 ± 0.96

Table 1: Participant Characteristics (mean ± SD)

Procedures

Familiarization session. Subjects completed the health history questionnaire via Qualtrics to confirm low risk for use of BFR. Self reports of height and weight were collected during the health history process. Subjects were then familiarized with the Vertical Challenger jump unit (Tandem Sport, Louisville, KY), used to measure vertical jump height. They were instructed to try a countermovement jump (CMJ) starting on an AMTI force plate and hitting the highest vane on the Vertical Challenger jump unit they could. Subjects were then familiarized with BFR. Figure 1 shows the AirBands BFR cuffs (AirBands International) that were used. Placement of the cuffs was instructed to be high up on the thigh in similar placement of a rock climbing harness with a snug, but not restrictive fit. With the BFR cuff on but not inflated, subjects were instructed to walk around and try a couple BW squats. Once the subject felt comfortable with the BFR not inflated, they were asked to try it inflated. The cuff was calibrated to determine full occlusion pressure, and then inflated to 80% occlusion. Subjects were informed about the possible discomfort from BFR and were told they could inform the researcher or remove the cuff by unstrapping it, if it became too uncomfortable at any time. With the cuff inflated, subjects were again asked to walk around and try a couple BW squats.

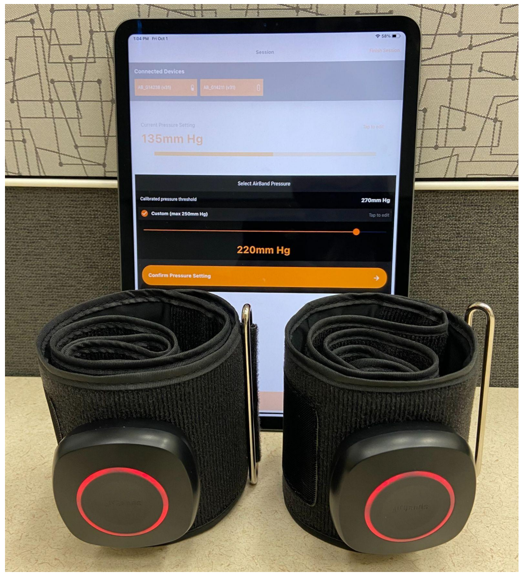

Figure 1: AirBands BFR cuffs with bluetooth application.

Experimental Session. Subjects returned for the first exercise session one week after the familiarization session. The order of the BFR-ON and BFR-OFF conditions were randomized. Both groups completed a warm-up consisting of walking on the treadmill (Precor, TRM 885) for 5 minutes at 3 mph. Subjects were then brought to the Vertical Challenger jump unit. The height of the unit was adjusted according to the Vertical Challenger guidelines. The reach height of the subjects was measured by having the subject reach their right arm straight up and walking forward displacing as many markers on the jump unit they could. The jump unit was then raised accordingly to ensure the subject could not jump above the highest vane. The subject was instructed to complete one CMJ with an arm swing, starting on the force plate and jumping as high as they could. Immediately after, for both conditions the subject put on the BFR cuffs. Placement was instructed to be high up on the thigh in similar placement of a rock climbing harness with a snug but not restrictive fit. The BFR-ON group had the cuff calibrated and then inflated to 80% occlusion. The subject was informed that if at any time the BFR became too uncomfortable they could tell the researcher or unstrap the cuff. None of the participants did so.

The cuffs were kept deflated for the BFR-OFF group. During both conditions, the subject completed 1 set of 12 BW squats to parallel depth (90 degree angle). After completion of the last squat, the BFR cuff was immediately deflated (BFR-ON) and the cuff was removed (BFR-ON and BFR-OFF). The subject then recovered for two minutes. During recovery, the subject was instructed to not sit down. The subject then completed another vertical jump test, completing one CMJ, starting on the force plate and jumping as high as they could. This protocol is outlined in Figure 2.

Figure 2: Experimental sessions protocol.

Statistical analysis

Jump gain (JG) was calculated by subtracting the pre-squat VJH from the post-squat VJH collected in each session. A 2-factor with replication ANOVA (Group, recreational vs competitive; BFR, BFR-ON and BFR-OFF) was used to compare the JG scores, with follow-up pairwise comparisons where indicated. Statistical significance was determined against *alpha* = 0.05, with marginal significance noted against *alpha* < 0.1.

Results

The results of the 2-factor ANOVA reveal no significant differences between the main effects of Group ($p = 0.51$) or BFR ($p = 0.28$), nor an interaction effect between Group and BFR ($p = 0.51$).

	Group	
Condition	**Competitively Trained**	**Recreationally Trained**
JG BFR-OFF	0	0.25
JG BFR-ON	0	1

Table 2: Average jump gain (JG) for BFR-ON and BFR-OFF compared by Group (Competitively vs Recreationally Trained).

Discussion

This study investigated the effects of BW squats with BFR on VJH among competitively and recreationally trained individuals. It was anticipated that BFR would lead to greater jump height gains and that competitively trained individuals would have greater jump gains than recreationally trained individuals, indicating a better PAP effect.

The data does not support the proposed hypotheses. It was determined that the competitively trained individuals did not experience any JG from BFR. The recreationally trained group also did not experience any statistically significant jump gain from BFR. These results indicate that PAP was not elicited from this BFR protocol. However, this lack of statistical significance may be due to the extremely small sample size, since this was a preliminary investigation.

There is the possibility of BW BFR not being an appropriate stimulus to evoke PAP. Traditional PAP protocols often include completing 5 repetitions of 80% or higher of 1 to 5 RM (McCann & Flanagan, 2010; Villalon-Gasch et. al., 2020; Weber et. al., 2008). This traditional method is said to increase motor unit recruitment, synchronization, and generate greater cross-bridge attachments within the muscle to increase force production. Although BFR resistance training is said to increase recruitment of type II muscle fibers (Pope et. al., 2013), a primary mechanism underlying PAP (Tillin & Bishop, 2009), these other variables that lead to PAP development may not be well enough addressed.

The results are in line with a study by Cleary et. al. (2020), that didn't achieve PAP from a BFR preloading condition. Their study investigated a complex training session with a BFR squat condition using 30% 1 RM and BFR at 60% of arterial occlusion pressure for 30 repetitions. Dissimilarly, the researchers concluded that their results may be due to the protocol being too intense and producing an onset of fatigue (Cleary et. al., 2020). When using BFR for traditional resistance training sessions, 15-30 repetitions is commonly used (Pope et. al., 2013). The 12 BW squats in the current study may not have been an intense enough stimulus to induce PAP, whereas the condition in the study from Cleary et. al. (2020) was too intense. Therefore, an intensity less than what was used in the study by Cleary et. al., (2020) and more that what was used in the present study should be examined.

Since one of the goals of the present study was to determine a protocol that used solely BW and BFR (no additional weight) to make it a more feasible technique, future research should examine if completing more BW squats would be sufficient. BW exercise with BFR has been shown to increase muscle cross-sectional area (Jakobsgaard et. al., 2018). However, there is no clear training volume recommendation for BW exercise with BFR (Jakobsgaard et. al., 2018). Further investigation on BW exercise with BFR in general may help produce a more appropriate complex training protocol. Doma et. al. (2020) utilized a complex training session of 3 sets of 8 repetitions of single-leg lunges and found significant PAP stimulus among subsequent drop jump performance. The researchers reported confirmed increased utilization of type II muscle fibers, evident by an increase in blood lactate values from greater reliance on anaerobic metabolism (Doma et. al., 2020). The one set of 12 repetitions of BW squats in the current study took no longer than thirty seconds to complete and BFR was immediately deflated and removed after the twelfth repetition. Thus, the time under BFR may not have allowed the body to experience a long enough hypoxic state to shift to anaerobic metabolism and increase type II fiber recruitment for consequential PAP. Further investigation should consider increasing sets of the preloading BFR event or keeping the limbs occluded during all or part or all of the rest period.

Another consideration includes the fact that only one vertical jump was completed for each pre and post- squat measurement. This was in hopes of better practical application. For example, in the event of a tipoff at the start of a basketball game, the athlete hopes to exhibit PAP effect in that single instance. However, the single jump event during the study may not have been representative of the participant's best performance. Other studies that have examined complex training have used averages of multiple repetitions of pre and post vertical jump performances (McCann &Flannagan, 2010; Weber et. al., 2008). Doma et. al. (2020) investigated 5 drop jump repetitions after the BW PAP protocol in 3 minute increments. They found that significant power increases occurred from the BFR condition on the second, third, and fifth drop jumps, which were completed 6 minutes, 9 minutes, and 15 minutes, respectively, after the PAP protocol (Doma et. al., 2020). This leads to concern regarding the rest interval of 2 minutes used during the current study. For traditional PAP elicitation, multiple studies have recommended two to ten minutes of rest between the PAP protocol and the subsequent power performance (Gołaś et. al., 2016; Nibali et. al., 2015; Tillin & Bishop, 2009). A rest interval on the shorter end of the spectrum was used in the current study because pilot testing produced expectations that the PAP protocol would be fairly low intensity compared to traditional high load PAP protocols. Thus, requiring less rest time for potentiation to overcome fatigue. However, occlusion may alter fatigue experience within the muscles (Fatela et. al., 2016). Doma et. al. (2020) theorized that a longer recovery period might have been necessary after the BFR PAP protocol since the anaerobically trained participants were not regularly participating in BFR training. Therefore, it is possible that a longer recovery period was needed after the PAP protocol in the current study.

Separately, insignificant results from the study may be attributed to the Vertical Challenger jump device that was used for measurement of vertical jump height. Among other studies, the commonly used device to measure vertical jump height is the Vertec (Cleary et. al., 2020; McCann & Flanagan, 2010). The Vertec device has markers at half-inch increments (Sports Imports, Hilliard, OH). Whereas the Vertical Challenger device has markers at one-inch increments (Tandem Sport, Louisville, KY). Consequently, if the participant's jump height was in between markers, but only the lower marker was displaced, this may have resulted in jump gains that were not able to be accounted for.

In regards to training status, the results from the current study differed from that of Chiu et. al., (2003) that found that athletically trained individuals experienced better PAP effect than recreationally trained individuals. Their study included athletes that were all involved in explosive sports. On the other hand, the current study involved athletes from a variety of different sports, all of which may include explosive components, but it is difficult to determine how these athletes compare with those included in the study of Chiu et. al. (2003). PAP inducement has been shown to be dependent on previous training adaptations (Hamada et. al., 2000). Therefore, the discrepancy between the current study and that of Chiu et. al. (2003) could be due to the type of athletes included in the study.

Studies have shown BFR training to produce significant muscular adaptations in recreationally trained individuals (Loenneke et. al., 2015; Yasuda et. al., 2011). In the present study, although not statistically significant, the recreationally trained group demonstrated an average of 0.75 more inches in JG after BFR than without. This is after a gain of 0.25 inches in the BFR-OFF condition. This finding should be investigated further utilizing a larger sample to examine if this trend is true for other recreationally trained individuals, possibly suggesting that BFR elicits PAP effects in recreationally trained individuals more than competitively trained individuals.

Projected Limitations

Due to the limited research concerning this topic, a limitation of this study included determining the exact number of repetitions of BW squats with BFR that is sufficient enough to mimic high-load response, without fatiguing the muscles, to be able produce PAP effects. Given that this was a preliminary study, another limitation includes the small sample size of the study. Furthermore, the Vertical Challenger may have caused unaccounted for jump gains. AMTI force plate data was also collected during the CMJ and should be analyzed to determine inconsistencies. Lastly, this study only looked at jump gains and not other biomechanical aspects of a CMJ. AMTI force plate data should also be analyzed for peak force and take-off velocity data to provide deeper understanding of the effect of BFR on CMJ.

Conclusion

In conclusion, previous literature and prior practice propose that BFR may affect vertical jump gain in a compelling manner. However, results from the current study are less promising. Future studies should further examine the role of BFR in PAP protocols, how BFR may affect the rest period required, the discrepancies experienced with BFR across training status, as well as how BFR may alter other biomechanical mechanisms during the subsequent vertical jump performance.

Practical Application

BW squats with BFR did not produce significant vertical jump gains in recreationally or competitively trained individuals. However, this could possibly be due to the limited knowledge concerning set, repetition, and rest requirements of BW BFR for producing PAP effect. Therefore, coaches and practitioners should further investigate different experimental protocols to determine the role BFR may have in acute performance enhancement.

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Conflict of Interest

The authors report no conflict of interest. Authors of this study are not affiliated with, nor were endorsed by AirBands.

Epilogue

Given the prevalence of PAP and BFR, it is compelling to determine how these two techniques may have a role together.

This original research has contributed a first effort to test the role of BFR as a PAP elicitation method.

Of course, only one protocol could be vetted in this work, but we hope to have opened the door to future research to further explore other set/rep/load protocols to better understand the relationship.

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