**The Impact of Lower Body Blood Flow Restriction During Warm-Up Protocols on Strength, Power, and Speed**

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**Abstract**

**Introduction**

What is BFR?

Potential uses/Ischemic pre-conditioning summary

Intro to Hytro – more practical than traditional BFR methods?

Previous research using Hytro (LOP studies)

Aim of study

**Experimental Approach to the Problem**

**COMPLETE THIS WHEN RESULTS ARE DONE**

# Method

## Participants

A convenience sample of 20 (thirteen males and seven females) university sports students (mean ± SD; age: 19.90 ± 2.25 years; mass: 71.36 ± 12.38 kg; stature: 1.75 ± 0.10 m) participated in the study. Before commencing testing, all participants were fully informed about the procedures, possible risks, and purpose of the study. All participants also completed a PAR-Q form and provided written informed consent. The Solent University Ethics Committee approved this study.

## 

## Procedures

*Session 1 Familiarisation*

During the 1st visit to the laboratory, the participants completed a PAR-Q form and had the opportunity to ask any questions about the study before providing written informed consent. The participant’s mass (Seca 875, Seca, Hamburg, Germany) and stature (Seca portable stadiometer, Seca, Hamburg, Germany) were then recorded before the participants were fitted for the Hytro BFR shorts as per the manufacturer’s recommendations ([Hytro sizing guide](https://hytro.com/size-charts/)). The subjects then completed the warm-up that would be used in the experimental trials. This started with four minutes of cycling on a Wattbike (Wattbike Pro, Wattbike, Nottingham, UK) at 85 rpm and 100 W. Upon completing the cycling, the participants completed the same dynamic warm-up (see Table 1 for exercises) that would be completed during the subsequent experimental trials. During the warm-up, the participants wore the Hytro BFR shorts on setting three (BFR strap pressure = 118.9 ± 11.2 mmHg) to familiarise themselves with the shorts and exercise with BFR. After the warm-up, the participants removed the Hytro BFR shorts and rested for five minutes. They then completed a series of isometric mid-thigh pull (IMTP) efforts to familiarise themselves with this test. Initially, the participants were sized in the IMTP rack (Perform Better, Southam, UK) to ensure the fixed bar was at the correct height (knee [125 – 145 degrees] and hip [140-150 degrees]). This was noted to ensure consistency across future trials. The force plates (FDLite, ForceDecks, Vald, Brisbane, Australia) were zeroed (sampling at 1000 Hz), and the participants were weighed on the force plates. The participants were then fitted with lifting straps to ensure no loss of grip during the trials. They then completed 3 x 5-second trials at 50, 75 and 95% of their perceived maximum effort (15 seconds between reps and 1 minute between sets). After a further three-minute rest, the participants completed 3 x 5-second maximal efforts with a one-minute rest period between repetitions. During all the trials, the participants were initially instructed to grip the bar and remove slack from the system before being instructed to pull “hard and fast”.

*Experimental Trials*

On the subsequent visits to the laboratory, the participants were randomly allocated to the three experimental conditions (control, low BFR and high BFR) so that each participant completed all three conditions with 48 hours of recovery between each testing session. Participants were asked to refrain from any lower body exercise 24 hours before each testing session and to refrain from drinking caffeine before testing. All testing took place at the same time of the day for all participants (± 1 hour).

When arriving at the laboratory, the participants were initially fitted with a heart rate monitor (Polar H7, Polar, Finland), had a resting capillary (0.3μl from the finger) blood lactate sample collected (Lactate Pro 2, Arkay Factory Inc, Japan), and completed three sit-and-reach trials (30 seconds between repetitions). They then put the Hytro BFR shorts on for the BFR trials or wore their own shorts during the control condition. During the low BFR trials, the participants wore the Hytro shorts on setting one (BFR strap pressure = 60.4 ± 9.6 mmHg) and setting four for the high BFR trials (BFR strap pressure = 158 ± 14.0 mmHg). Once fitted with the shorts, the participants complete the same warm-up as outlined previously. During the warm-up, heart rate (beats.min-1) was monitored via the Polar Team application and recorded every minute.

Upon completion of the warm-up, the participants removed the Hytro shorts and had a three-minute rest period. During this period, their rating of perceived exertion (NEED THE BORG 6-20 SCALE REFERENCE), blood lactate and sit and reach (cm) scores (3 trials, 30 seconds rest between trials) were recorded. Following this rest period, the subjects completed countermovement jump (CMJ), 30m sprint and IMTP trials in a randomised, counterbalanced order (3 minutes rest between each test).

*Countermovement Jump, Sprint and Isometric Mid-Thigh Pull Trials*

All CMJ trials took place using the FDLite force plates (ForceDecks, Vald, Brisbane, Australia) sampling at 1000 Hz. Before jumping, the force plates were zeroed, and the participants were weighed on the force plates. After a period of quiet standing (~2 seconds), the participants squatted to a self-selected depth with their hands placed akimbo and were then instructed to jump as high as possible. The participants completed three trials with 30 seconds of rest between them. Jump height (cm) calculated by the impulse-momentum relationship was the variable of interest in these trials. For the sprint trials, timing gates (SmartSpeedPlus, Vald, Brisbane, Australia) were set up at the start line, 10, 20, and 30m. Participants started 30cm before the first gate to ensure it was not triggered prematurely. When instructed, the participants sprinted maximally through each of the timing gates. Between each trial, they were given a three-minute rest period. The timing splits (seconds) at each gate were the variables of interest during this testing. During the IMTP, the participants completed three maximal trials as described previously, with 30 seconds of rest between trials. The peak force (N) during these trials was the variable of interest.

# *Statistical Analysis*

# Results

# Discussion

## Limitations

## Conclusion

**Practical Applications**