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Effects of blood flow restriction combined with moderate/high-intensity resistance training on hypertrophy adaptations

Submission date 05/12/2025	**Recruitment status** Recruiting	[_] Prospectively registered [X] Protocol
Registration date 16/01/2026	**Overall study status** Ongoing	[_] Statistical analysis plan [_] Results
Last Edited 16/01/2026	**Condition category** Other	[_] Individual participant data [X] Record updated in last year

Plain English summary of protocol

Background and study aims
Resistance training is the most effective method for increasing muscle size (hypertrophy) and strength. Blood Flow Restriction (BFR) is a technique that uses pressurized cuffs to partially reduce blood flow to muscles during exercise, and has been shown to potentiate muscle growth. The main aim of this study is to determine if adding the BFR technique to a high-intensity, velocity-based resistance training program produces greater gains in muscle size and strength than performing the same training without BFR.

Who can participate?
Healthy men aged 18 and 35 years old with a minimum of one year of experience in hypertrophy training. They must also be capable of performing a squat 1RM with a weight equivalent to at least 1.2 times their body weight.

What does the study involve?
Participants will be randomly assigned to one of three training groups. The intervention lasts 15 weeks in total, including: 12 weeks of supervised training and three measurement weeks (Weeks 1, 8, and 15).

Training: Two supervised sessions per week, focused on the leg (Smith machine squat and leg extension) at a high intensity (70% of estimated 1RM).

Groups: Participants will be assigned to the BFR Group (with cuffs), or to one of two control groups that train without cuffs (one matches velocity loss and the other matches total volume).

Measurements: Muscle size (hypertrophy), strength (maximum, endurance), and power will be measured at weeks 1, 8, and 15.

What are the possible benefits and risks of participating?
Benefits: Participants will receive a high-quality supervised training program for 12 weeks. They will receive detailed, free measurements of their muscle size, strength, and power using high-precision equipment (ultrasound and linear encoder).

Risks: The main risks are associated with the use of BFR cuffs (slight pain or discomfort during exercise, or small temporary bruises) and the normal risks associated with high-intensity training (post-exercise muscle soreness, risk of muscle strain). All risks are mitigated by direct professional supervision.

Where is the study run from?
The study is promoted and directed by the Facultat de Psicologia, Ciències de l'Educació i de l' Esport Blanquerna of the Ramon Llull University (URL). The training intervention will be carried out at the Complex Esportiu Municipal L'Hospitalet Nord in L'Hospitalet de Llobregat.

When is the study starting and how long is it expected to run for?
January 2026 to July 2031. The project began its elaboration in 2024 within the framework of the PhD Program. The interventions with the three study groups are scheduled to be completed by 2028. Although the intervention phase ends in 2028, the final project completion (analysis, thesis defense, and dissemination) is expected to be before 2031, which is the absolute deadline. The individual participation of each subject has a total duration of 15 weeks.

Who is funding the study?
The study is carried out within the framework of the PhD Program in Physical Activity and Sport Sciences of the Universitat Ramon Llull, without specific external funding from a research or industry agency.

Who is the main contact?
The main contact for inquiries about the study is the researcher in training, under the supervision of his thesis directors:
Guillermo Seijas Albir (Researcher in training), guillermosa@blanquerna.url.edu

Contact information

Type(s)
Public, Scientific, Principal investigator

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Additional identifiers

Protocol serial number
2425019D

Study information

Scientific Title
A randomized controlled trial to evaluate the effects of blood flow restriction combined with moderate or high-intensity resistance training versus moderate or high-intensity resistance training alone on muscular hypertrophy and strength adaptations in healthy resistance-trained adults

Acronym
BFR-HIGH

Study objectives
Blood Flow Restriction (BFR) combined with moderate or high-intensity resistance training will result in greater increases in muscular hypertrophy (cross-sectional area and muscle thickness), maximum muscular strength, strength endurance, and lower-body power (Countermovement Jump) compared to moderate or high-intensity resistance training alone in healthy resistance-trained adults.

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 02/09/2025, Ethics and Research Committee of the Faculty of Psychology, Education and Sport Sciences Blanquerna of the Ramon Llull University (Carrer del Císter, Barcelona, 08022, Spain; +34 932 533 118; montsecr@blanquerna.edu), ref: 2425019D

Primary study design
Interventional

Allocation
Randomized controlled trial

Masking
Open (masking not used)

Control
Placebo

Assignment
Parallel

Purpose
Treatment

Study type(s)

Efficacy, Treatment

Health condition(s) or problem(s) studied
The study addresses the domain of exercise physiology, focusing on optimizing resistance training methodologies for maximizing muscular hypertrophy and strength in healthy resistance-trained adults.

Interventions
This study will be conducted as a single-centre interventional randomized controlled trial comprising three sequential groups, to which participants will be randomly assigned prior to the start of their individual training phase. The total duration of the study intervention for each participant is 15 weeks. This period includes 12 weeks of training and three specific measurement and deload weeks (weeks 1, 8, and 15), during which no training of the target muscle group is performed.

The training protocol focuses on the lower body (cuádriceps) and involves two supervised sessions per week. The total workload consists of 7 effective sets per session for the target muscle group: 4 sets of parallel squat on a Smith machine (Salter) and 3 sets of leg extension (TechnoGym).

All groups will perform the exercises using a load equivalent to 70% of the estimated one-repetition maximum (1RM), which is monitored and adjusted via the load-velocity test using a linear encoder.

The three randomized arms are defined as follows:

Blood Flow Restriction Group (BFR V35): Participants perform the protocol with the Blood Flow Restriction (BFR) technique applied. Sets are terminated when the propulsive velocity loss reaches 35% (V35). The BFR pressure is set at 70% of total arterial occlusion (TAO), and the pressure is not relieved between sets. This group's data determines the volume for the FF Vol group.

Velocity-Matched Control Group (FF V35): Participants perform the training without BFR, stopping the set when the propulsive velocity loss reaches 35%. This group controls for the effects of the velocity-based termination criterion.

Volume-Matched Control Group (FF Vol): Participants perform the training without BFR. This group must match the mean number of repetitions (volume) achieved by the BFR V35 group for each set and exercise, based on the volume data accumulated during the BFR V35 intervention phase. This controls for the effects del volumen total.

The overall effective training volume is 14 sets per week for the target muscle group.

Method of randomisation
The study consists of three sequential waves (cohorts), each assigned to a different experimental condition. For methodological reasons, the BFR V35 condition must be conducted first, as its results are required to determine the training volume for the FF Vol condition. After completing the first wave, the FF Vol and FF V35 conditions will be assigned to the second and third waves using a computer-generated randomisation procedure, as the order between these two conditions is not subject to methodological constraints.

The research team is aware of the final order of the waves from the beginning of the intervention to ensure appropriate planning of the protocol. However, participants will not be informed of the condition corresponding to their wave during the recruitment process.

Intervention Type
Behavioural

Primary outcome(s)
1. Muscle thickness and Muscle Cross-Sectional Area (CSA) measured using B-mode ultrasound at baseline (Week 1), mid-intervention (Week 8), and post-intervention (Week 15)

Key secondary outcome(s))
1. Maximum muscular strength (1RM estimation) measured using a linear position transducer (encoder) with load-velocity profiling at baseline (Week 1), mid-intervention (Week 8), and post-intervention (Week 15)

2. Strength endurance measured using repetitions to mechanical failure at 70% of 1RM at baseline (Week 1), mid-intervention (Week 8), and post-intervention (Week 15)

3. Lower-body power (jump height and power output) measured using a Countermovement Jump (CMJ) test with the Optojump system at baseline (Week 1), mid-intervention (Week 8), and post-intervention (Week 15)

Completion date
31/07/2031

Eligibility

Key inclusion criteria
1. Sex: Participants must be men.
2. Age Range: Individuals between 18 and 35 years old.
3. Training Experience: Minimum of one year of consistent hypertrophy training (2–3 sessions per week per muscle group).
4. Confirmed Strength Level: Capable of performing a 1-repetition maximum (1RM) squat with a weight equivalent to 1.2 times their body mass.
5. Health Status: No history of cardiovascular or metabolic diseases, including venous thrombosis, coagulation disorders, heart disease, hypertension, varicose veins, or obesity.
6. Injury Status: No musculoskeletal injuries in the trained muscles within the last six months.
7. Substance Use: No use of anabolic steroids or other performance-enhancing drugs in the last year.

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit

18 years

Upper age limit
35 years

Sex
Male

Total final enrolment
0

Key exclusion criteria
1. Failure to Meet Inclusion Criteria: Individuals who do not meet any of the specified inclusion criteria (e.g., age range, male sex, minimum training experience, or baseline strength level).
1. Medical Contraindications: Presence of any cardiovascular, metabolic, or chronic disease (e.g., uncontrolled hypertension, coagulation disorders, deep vein thrombosis, or severe varicose veins) that contraindicates the safe use of Blood Flow Restriction (BFR).
3. Active Injury: Presence of any active or recent (last six months) musculoskeletal injury in the lower limbs or trunk that prevents the safe and correct execution of the training exercises.
4. Substance Use: Use of anabolic steroids or other performance-enhancing drugs within the last year.
5. Lack of Compliance Commitment: Inability or unwillingness to commit to the required two supervised training sessions per week for the full 15-week intervention period.
6. Lifestyle Interference: Inability or unwillingness to maintain stable daily routines regarding physical activity (outside the protocol), sleep patterns, and nutritional intake for the duration of the study, as assessed through the initial anamnesis.
7. Concurrent Participation: Simultaneous participation in any other exercise intervention study or any study involving performance-affecting supplementation.

Date of first enrolment
15/01/2026

Date of final enrolment
15/02/2031

Locations

Countries of recruitment
Spain

Study participating centre
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Study participating centre
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Sponsor information

Organisation
Universitat Ramon Llull

ROR
https://ror.org/04p9k2z50

Funder(s)

Funder type
Not defined

Funder Name
Education, Audiovisual and Culture Executive Agency

Alternative Name(s)
The Education, Audiovisual and Culture Executive Agency, Education, Audiovisual & Culture Executive Agency, EACEA, l'EACEA

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary

Data sharing statement to be made available at a later date

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Protocol file		24/03/2025	17/12/2025	No	No