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The effects of blood flow restriction on fatigue and metabolic stress

Submission date
20/09/2024

Recruitment status
No longer recruiting

Registration date
23/09/2024

Overall study status
Completed

Last Edited
08/10/2026

Condition category
Nutritional, Metabolic, Endocrine

[_] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[X] Results
[_] Individual participant data

Plain English summary of protocol

Background and study aims
This study's purpose is to examine acute responses to low-load resistance exercise while using blood flow restriction (BFR). As a type of training in which resistance or aerobic exercise is performed using an occlusive cuff on a proximal muscle, the intent of occluding venous blood flow (not arterial) is to induce an anabolic response without the requirement of higher loads. There are 3 primary mechanisms through which BFR, when used in conjunction with resistance training, is thought to stimulate anabolic responses: increased cellular swelling, enhanced metabolic stress, and increased muscle fiber recruitment. This technique has primarily been used in performance settings to promote muscle hypertrophy while utilizing lighter loads (30% of 1 repetition maximum) compared to the traditional recommendation of 70% of 1 repetition maximum, often required to induce a hypertrophic response to training. Additionally, BFR is used in clinical settings to aid in muscle recovery following immobilization or injury as a way to stimulate an anabolic response without the requirement of heavy loads. Currently, it is unknown how the physiological response of using BFR during low-load resistance training may compare to high-load resistance training without BFR. The results of this study will indicate how low-load resistance training with BFR compares to high-load resistance training without BFR in regards to the physiological response to exercise. These findings will help guide programming decisions when choosing to incorporate BFR into resistance training programs while also identifying the physiological response to this type of activity.

Who can participate?
Recreationally active male or female healthy volunteers aged between 18 and 27 years old

What does the study involve?
Participants will be randomly assigned to one of two exercise routines:
1. Low weight (30% of their maximum lift) with blood flow restriction (BFR).
2. High weight (65% of their maximum lift) without BFR.
They will be assigned using an online tool. At the start, the researchers will measure how much pressure is needed to restrict blood flow in their limbs using an automated cuff. Then, they will estimate the participants' maximum squat weight from a test using a Smith machine.

In both routines, participants will do one set of 30 repetitions at the assigned weight, followed by three sets where they can do up to 15 repetitions, with a 2-minute rest between sets. For the BFR routine, the cuff will be inflated to 50% of the pressure needed to restrict blood flow and kept on throughout the exercise and rest periods.

What are the possible benefits and risks of participating?
The potential benefits of participating are strictly for educational purposes and to better understand how blood flow restriction influences short-term physiological responses, lower body power, and perceptions of effort. The risks are physical discomfort from the challenging strength training protocol along with the discomfort of partially occluding blood flow during exercise.

Where is the study run from?
University of Wisconsin–La Crosse

When is the study starting and how long is it expected to run for?
August 2021 and May 2022

Who is funding the study?
University of Wisconsin–La Crosse

Who is the main contact?
Dr Andrew Jagim, jagim.andrew@mayo.edu

Contact information

Type(s)
Public, Scientific, Principal investigator

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Additional identifiers

Study information

Scientific Title

The physiological response of low-load resistance exercise with blood flow restriction

Study objectives
Blood flow restriction will increase metabolic stress and lead to increases in neuromuscular fatigue.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 29/07/2021, Institutional Review Board (IRB) for the Protection of Human Subjects, University of Wisconsin - La Crosse (1725 State Street, La Crosse, 54601, United States of America; +1 608-785-8044; irb@uwlax.edu), ref: JS-57-21

Primary study design
Interventional

Study design
Randomized controlled within-subject cross-over trial

Study type(s)
Other

Health condition(s) or problem(s) studied
Impact of blood flow restriction on metabolic stress neuromuscular fatigue

Interventions
Using a randomized, cross-over design, participants completed one of two experimental conditions: Low load (30% of 1 repetition maximum) + Blood flow restriction (BFR; or High load (65% of 1 repetition maximum [1RM]) + non-BFR. Participants were randomized using a free online randomization tool. During baseline testing, participants had limb occlusion pressure (50%) determined using an automated, self-inflating cuff system (SmartCuffs©, Smart Tools Plus, LLC, Strongsville, OH, USA) for each limb. Following limb occlusion determination, 1RM back squat was estimated from a 3RM test using a Smith machine (Plyometric Power System; Norsearch, Australia). In both conditions, participants completed 1 set of 30 repetitions in their respective resistance training protocol, at the assigned load, and then 3 sets with a maximum number of 15 repetitions allowed in sets 2-4, with a 2-minute rest in between sets. During the BFR condition, the cuff was inflated to the determined leg-specific pressure (set at 50% of total limb occlusion pressure) and left on for the duration of the protocol including rest periods.

Intervention Type
Device

Phase
Not Applicable

Drug/device/biological/vaccine name(s)
Automated blood flow restriction cuff

Primary outcome(s)

1. Blood lactate measured using a Lactate Scout (Sports Resource Group, USA) handheld analysis device at baseline and following the 4th (final) set of back squat exercises
2. Vertical jump height measured using a 27” x 27” jump mat (Just Jump System, Probotics, AL, USA) at baseline and following the 4th (final) set of back squat exercises

Key secondary outcome(s)
1. Ratings of perceived exertion measured using Borg’s 10-point ratings of perceived exertion (0-10) scale at baseline and immediately following each set of the back squat exercise
2. Hemodynamic responses measured using a mercurial sphygmomanometer (American Diagnostic Corporation, model #AD-720) before and after the back squat exercise, in addition to post-inflation of the BFR cuffs for the BFR condition only

Completion date
15/05/2022

Eligibility

Key inclusion criteria
1. Recreationally active male or female
2. Aged between 18 and 27 years old

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
No

Age group
Adult

Lower age limit
18 Years

Upper age limit
27 Years

Sex
All

Total final enrolment
13

Key exclusion criteria
1. Neuromuscular conditions
2. Risk factors for cardiovascular disease
3. Prior history of stroke or blood clots

Date of first enrolment
01/09/2021

Date of final enrolment
01/10/2021

Locations

Countries of recruitment
United States of America

Study participating centre
University of Wisconsin - La Crosse
1725 State Street
La Crosse
United States of America
54601

Sponsor information

Organisation
University of Wisconsin–La Crosse

ROR
https://ror.org/00x8ccz20

Funder(s)

Funder type
University/education

Funder Name
University of Wisconsin-La Crosse

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study are/will be available upon request from Dr Andrew Jagim, jagim.andrew@mayo.edu. De-identified participant-level data will be available upon request at any time after publication. Written consent was required and obtained before study participation.

IPD sharing plan summary

Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Results article		04/12/2024	08/10/2026	Yes	No