Impact of Blood Flow Restriction Therapy on VO_2max in Elite Athletes: A Systematic Review and Meta-Analysis

Eric Bartlett, SPT
Brendan Betti, SPT
Lucas Hackett, SPT
Michael McGuire, SPT
Peter Leininger, PT, DPT, PhD, OCS
Joshua Prall, PT, DPT, EdD, OCS

Overview

- Purpose/Hypothesis
- Introduction
- Databases
- Search Terms
- PEDro Scores
- PRISMA
- Results
- Discussion
- Clinical Relevance

Objectives

1. Understand the basic principles of BFRT
2. Learn the potential benefits of BFRT in elite athletes
3. Understand where literature lacks
4. Carry over findings into clinical practice

Introduction

- Blood flow restriction therapy (BFRT) involves the use of a pressure cuff, tourniquet, or elastic banding to occlude the outflow of venous blood from exercising muscle to enhance training while maintaining relatively low loading of the joints.[1]

- Elite athletes stress their joints regularly through training and competition in order to achieve or maintain peak performance.

- Elite athletes are defined as collegiate to professional athletes or having a VO_2max of 50 mL/min/kg.

Introduction

- BFRT allows for the use of loads as low as 20-30% of 1 repetition maximum (1-RM) to produce beneficial results.
    - This is compared to historically successful training programs, which typically use 75-80% of 1RM to produce results.[3]

- Research has shown the positive effects of BFRT across different populations and with respect to cross sectional area, but is limited when examining the effects on VO_2max for elite level athletes.

Purpose

The purpose of this systematic review was to determine the impact of blood flow restriction therapy (BFRT) on VO_2max in comparison to traditional training in elite athletes.

Methods

Search Engines

- PubMed, Proquest Central, Cochrane Library, EBSCOHost

Search Limits

- Peer-reviewed, Human population, 10-year range, English language, Adults (18+)

Methods

Search Terms

("Blood flow restriction" **OR** "Blood flow occlusion" **OR** Kaatsu **OR** "vascular occlusion" **OR** Ischemia **OR** "restricted blood flow" **OR** "occlusion training" **OR** "ischemic preconditioning")

AND

(athlete **OR** "student athlete" **OR** "elite athlete" **OR** "well-trained") AND (VO_2max **OR** "VO_2 max")

Methods

Study Design

- All RCTs

Inclusion Criteria

- Healthy, well-trained, male and female athletes above the age of 18 years old who participate in organized sports

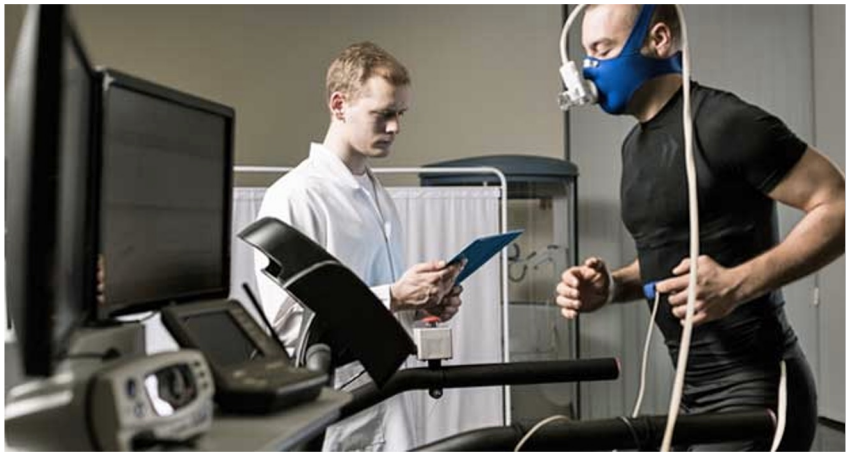
Methods

- Healthy = non-smokers who lack orthopedic injury and chronic illness
- Well-trained = collegiate to professional athletes OR VO_2max ≥ 50 mL/min/kg
- Traditional training = exercises for improving endurance capacity involving prolonged, repetitive aerobic exercises that elevate heart rate such as running, squatting, cycling, and rowing training without BFRT with the primary objective of improving VO_2max and metabolic demand

Outcome Measures

Primary

1. **VO_2max**

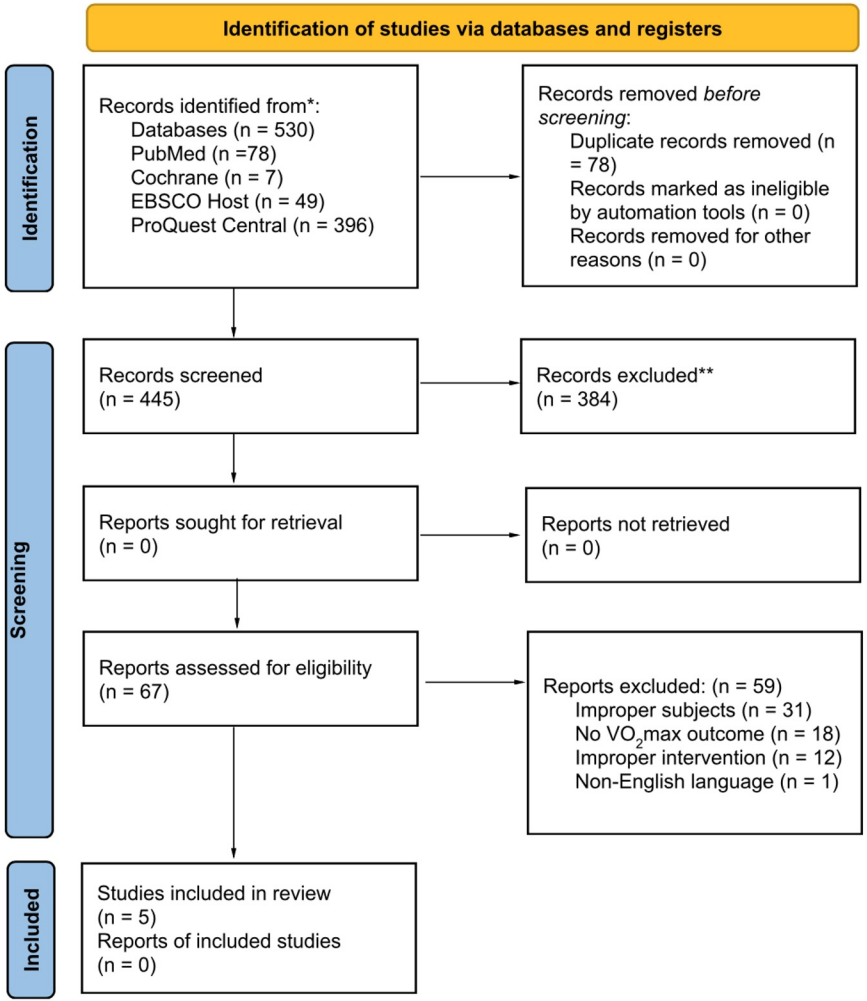


https://www.teachpe.com/anatomy-physiology/vo2-max

Secondary

1. **1-RM test**
2. **Peak running velocity**
3. **Running economy**
4. **Time to exhaustion**
5. **Onset of blood lactate accumulation**

Study	Random Allocation	Concealed Allocation	Base-line Compar-ison	Blinding of subject-(s)	Blinding of therapist-(s)	Blinding of assess-or(s)	Adequate Follow up	Intention to treat	Between group comparison	Measure ment of variability	PEDro Score
Paull EJ et al. (2019)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	**8/10**
Taylor CW, et al. (2016)	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Slysz JT et al. (2019)	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Held S, et al (2020)	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Tangchaisuriya P, et al. (2021)	Y	Y	Y	N	N	N	Y	Y	Y	Y	**7/10**
Average											**7.2/10**


Identification of studies via databases and registers
Identification
Records identified from*:
Databases (n = 530)
PubMed (n =78)
Cochrane (n = 7)
EBSCO Host (n = 49)
ProQuest Central (n = 396)
Records removed *before screening*:
Duplicate records removed (n = 78)
Records marked as ineligible by automation tools (n = 0)
Records removed for other reasons (n = 0)
Screening
Records screened
(n = 445)
Records excluded**
(n = 384)
Reports sought for retrieval
(n = 0)
Reports not retrieved
(n = 0)
Reports assessed for eligibility
(n = 67)
Reports excluded: (n = 59)
Improper subjects (n = 31)
No VO_2max outcome (n = 18)
Improper intervention (n = 12)
Non-English language (n = 1)
Included
Studies included in review
(n = 5)
Reports of included studies
(n = 0)

Results

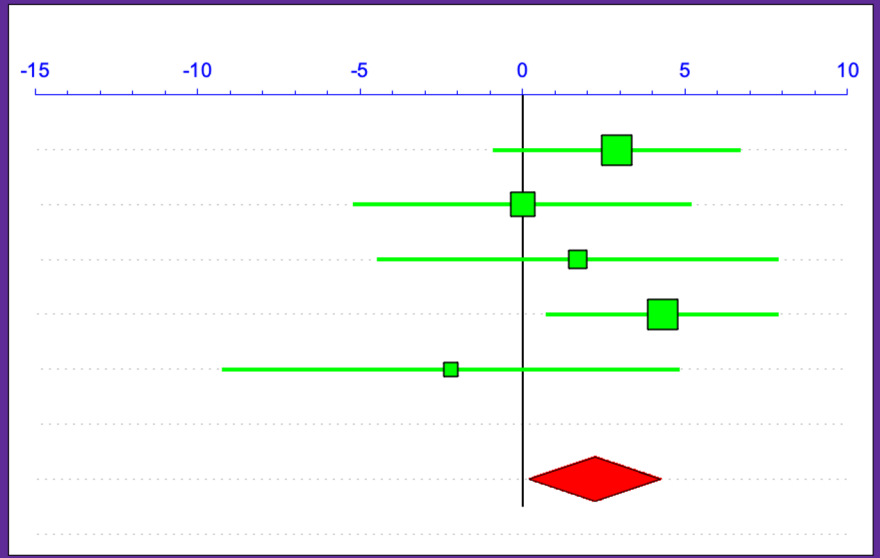
- Two out of five studies found statistically significant increase in VO_2max with BFRT.
  - One use BFRT during rowing ergometer and in a boat.
  - Second study used BFRT with cycle ergometer.

Results

- Meta-analysis of the data showed BFRT improved overall mean difference from pre to post-training 2.23, 95% CI [0.22, 4.24].

- There was an added benefit combining BFRT with HIIT training.

Meta-Analysis Results



Discussion

- BFRT has been used throughout research to analyze the effects of low load, high volume training on strength and muscle mass, but little has been done on VO_2max.
- When done correctly, BFRT is an easy and safe way to increase metabolic demand on tissues while remaining at a lower level of intensity.
- Additional benefit was also found when combining BFRT with HIIT.

Discussion

- Elite athletes are constantly looking for an edge over the competition. At the highest level, even a slight increase in VO_2max can mean the difference between gold and silver.

- More research is needed with generalized protocols to determine how effective BFRT might be at increasing VO_2max.

Clinical Relevance

- **Elite athletes are always searching for ways to refine their training in order to optimally enhance performance.**

- Existing evidence supports BFRT to improve performance outcomes such as time to exhaustion, time-trial performance, running economy, as well as cross-sectional area associated with hypertrophy. [1, 2, 4]

- Clinicians, such as Physical Therapists, who work closely with elite athletes, may consider the use of BFRT to enhance performance in elite athletes, although the benefits for VO_2max require further research.

Limitations

- Widely variable BFRT protocols and outcomes across each study.
- Small sample sizes.
- Our research was confined to the databases we searched.

Future Research

- Although an overall positive MD change in VO_2max of 2.23 mL/kg/min was found across BFRT groups, the clinical significance of this aerobic capacity outcome remains unclear.
- Future research is necessary to determine BFRT protocols for best results (specific to either endurance training or 1RM).

References

1. Paull EJ, Van Guilder GP. Remote ischemic preconditioning increases accumulated oxygen deficit in middle-distance runners. *J Appl Physiol (1985)*. 2019;126(5):1193-1203. doi:10.1152/japplphysiol.00585.2018.
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5. Tangchaisuriya P, Chuensiri N, Tanaka H, Suksom D. Physiological adaptations to high-intensity interval training combined with blood flow restriction in masters road cyclists. *Med Sci Sports Exerc*. 2021 Dec 29. doi: 10.1249/MSS.0000000000002857.

Questions?