INPLASY

The Actual Effects of Blood Flow Restriction Combined with Resistance Training on Athletes: Does It Promote Muscle Hypertrophy? — A Systematic Review and Meta-Analysis

INPLASY202480002
doi: 10.37766/inplasy2024.8.0002
Received: 01 August 2024
Published: 01 August 2024

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ADMINISTRATIVE INFORMATION

Support - Innovative research on the construction of first-class course supported by the Open Online Course for Undergraduate Universities Steering Committee of Guangdong Province in 2022 (2022ZXKC262): The construction and application of Theory and Methods of Physical Training.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202480002

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 01 August 2024 and was last updated on 01 August 2024.

INTRODUCTION

Review question / Objective Using a systematic review and meta-analysis, evaluate the effects of blood flow restriction combined with resistance training on lower limb muscle hypertrophy, lower limb strength, jumping ability, and sprinting ability indicators of athletes compared to simple resistance training.

Condition being studied The study focuses on the effects of Blood Flow Restriction Training (BFRT) on athletic performance in athletes, specifically examining its impact on lower limb strength, muscle hypertrophy, explosive power, and sprint performance. BFRT involves the use of venous occlusion tourniquets to restrict blood flow during resistance training, creating a hypoxic environment that is believed to enhance muscular adaptations. This training method has been utilized since the 1970s, initially in the field of geriatric medicine in Japan, and is now being explored for its potential benefits in improving various aspects of athletic performance.

METHODS

Search strategy Search for "blood flow restriction", "Kaatsu", "BFRT Therapy", "BFRT Therapies", "BFRT", "Blood Flow Restriction Training", "Blood Flow Restriction Exercise", "resistance training", "resistance exercise", "players", "sportsman", "athlete", "sports person", "sportswomen" as English keywords in PubMed, Web of Science, Scopus, and EBSCO databases.

Participant or population Athletes of any age or gender, without injury, illness, or other clinical conditions.

Intervention The experimental group underwent resistance training under blood flow restriction.

Comparator The control group underwent resistance training.

Study designs to be included Randomized controlled trial.

Eligibility criteria Conference papers, review literature, book chapters and reviews; Unable to obtain the full text; Non sports science literature.

Information sources PubMed、Web of Science、Scopus、EBSCOA total of 1951 articles were retrieved through computer search, and two articles were traced back by reading relevant literature.

Main outcome(s) The main outcomes of this meta-analysis include:

Lower Limb Strength: Measured by the maximum force exerted by the lower limbs, assessed at baseline and after a training period of 6 weeks. Effect size (ES) and 95% confidence intervals (CIs) were calculated to determine the impact of BFRT compared to traditional resistance training (RT).

Muscle Hypertrophy: Evaluated by changes in muscle cross-sectional area or muscle volume, measured before and after the training intervention. The analysis considers studies with intervention durations ranging from 6 to 8 weeks.

Explosive Power: Assessed through performance metrics such as vertical jump height or power output in explosive exercises, with measurements taken at the beginning and end of the training program. ES and 95% CIs were used to compare the effects of BFRT and RT.

Sprint Performance: Measured by sprint times over distances such as 5m, 10m, or 20m, recorded before and after the intervention period. The review examines both short-term (up to 6 weeks) and longer-term (up to 8 weeks) training effects.

The outcomes highlight that BFRT significantly enhances lower limb strength (ES=0.57, 95% CI: 0.19-0.94, p=0.003) compared to RT. However, no significant differences were found in muscle hypertrophy (ES=0.18, 95% CI: -0.17-0.53, p=0.31), explosive power (ES=0.32, 95% CI: -0.01-0.65, p=0.06), or sprint performance (ES=-0.22, 95% CI: -0.59-0.16, p=0.26). Subgroup analyses indicate that a total training duration of 6 weeks (ES=0.71, 95% CI: 0.09-1.34, p=0.03) and a frequency of 2 times per week (ES=0.66, 95% CI: 0.06-1.27, p=0.03) are optimal for significant improvements in lower limb strength.

Data management Endnote X9.

Quality assessment / Risk of bias analysis This article used Review Manager 5.1 to evaluate the quality of the 12 included literature. The main finding of the bias risk assessment was that due to the specificity of the experiment, all studies were unable to implement blinding on the subjects. However, all included literature were randomized controlled trials, which to some extent alleviated the risk of bias caused by non blinded methods and provided important quality assurance basis for meta-analysis.

Strategy of data synthesis Using Review Manager 5.1 software for data analysis and meta-analysis, all indicators were uniformly converted in units. Therefore, in the final analysis, a weighted mean difference (WMD) with a 95% confidence interval was used. The ES calculated as a composite effect indicator was explained using the standardized mean difference convention outlined by Hopkins et al.22 (4.0=very large). The heterogeneity index I2 is used to evaluate the heterogeneity of the study. When I2 is less than 25%, the heterogeneity of the study is considered negligible; When I2 is between 25% and 75%, it is considered that there is moderate heterogeneity in the study; When I2 is greater than 75%, it is considered that there is high heterogeneity in the study. When the heterogeneity of the study is less than 25%, a fixed effects model is used for outcome indicator analysis; If the heterogeneity of the study is greater than 25%, a random effects model will be used for outcome indicator analysis. P<0.05 is considered statistically significant.

Subgroup analysis The subgroup analysis in this meta-analysis aims to explore the effects of different training durations, frequencies, and intensities on the outcomes of BFRT. The specific subgroups analyzed include:
1. Training Duration: Studies were categorized based on the total duration of the training interventions:
- ≤ 6 weeks: Studies with training programs lasting up to 6 weeks.
- > 6 weeks: Studies with training programs longer than 6 weeks.

2. Training Frequency: Studies were categorized based on the frequency of training sessions per week:
- 2 times per week: Studies with training sessions twice a week.
- More than 2 times per week: Studies with training sessions more than twice a week.

3. Training Intensity: Studies were categorized based on the intensity of the training:
- Low/Moderate-Intensity BFRT: Low to moderate-intensity blood flow restriction training.
- High-Intensity BFRT: High-intensity blood flow restriction training.

Sensitivity analysis Use Cochrane risk assessment tools to evaluate the quality of all included literature, with evaluation criteria including "Low risk", "Clear risk", and "High risk". The final results shall prevail as the basis for evaluating the quality of the literature. All studies included in this meta-analysis were independently assessed for quality by two researchers.

Country(ies) involved China.

Keywords Athletes, resistance training, lower limb strength, athletic performance.

Contributions of each author

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