Optimizing Exercise in Space: Utilizing Blood-Flow Restriction, High-Intensity, and Concurrent Training

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ABSTRACT

Prolonged exposure to a microgravity environments leads to degenerative effects on the musculoskeletal and cardiovascular systems. Therefore, it is essential to address the importance of exercise in space as astronauts are required to be physically equipped to adapt to the extraterrestrial environment. Previous space missions such as the Apollo Program have failed to effectively utilize exercise to manage deconditioning due to their program inconsistency in frequency and intensity. As a result, the purpose of this literature review was to provide a comprehensive and critical review of six empirical studies that introduce a new exercise protocol incorporating a blood-flow restriction (BFR) training method, high-intensity training (HIT), and strategically incorporating concurrent training. As a result, this literature review confirms that utilizing these training techniques will induce muscle growth, increase maximum rate of oxygen consumption (VO_{2max}), increase bone mass, and prevent suboptimal training adaptations.

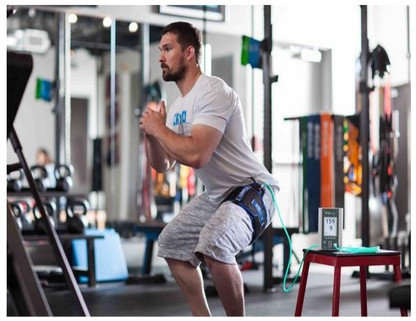
INTRODUCTION

•Prolonged exposure to microgravity environments leads to degenerative effects on muscular growth, strength, and endurance.[1,2]

•Blood-flow restriction elicits muscle growth by increasing the tension within the muscles.[3,4]

•Strategically incorporating concurrent training (i.e. aerobic and resistance training combined) will prevent decrements in strength, which is referred to as the interference effect.[5]

•HIT can simultaneously improve muscular strength and endurance.[6]



PURPOSE

The purpose of this literature review is to determine the effectiveness of BFR, HIT and concurrent training techniques to improve the musculoskeletal and cardiovascular systems in a microgravity environment.

METHODS

- PubMed database was used to find the Frontier Journal Series of Optimization of Exercise Countermeasures For Human Space Flight – Lessons From Terrestrial Physiology and Operational Implementation.
- Out of the 14 review articles in the journal ,6 articles were selected by using the following key words: Blood-Flow Restriction Training, High-Intensity Training, and Concurrent Training.

RESULTS

Figure 1: LI-BFR on Muscle Strength and Hypertrophy

Figure 2: HIT on VO_{2max} and Stroke Volume

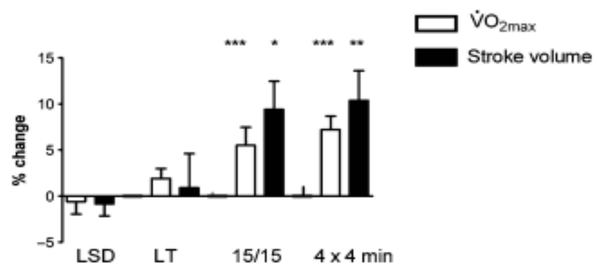
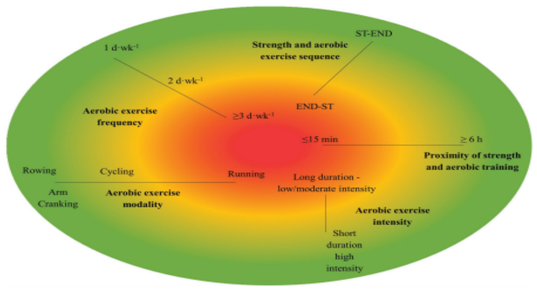


Figure 3: Interference Effect on Concurrent Training



Low Intensity Blood Flow Restriction Training (LI-BFR)

•Significant increase in muscular strength after 10 weeks of utilizing low-intensity blood-flow restriction training.

•Slight decrease in muscle hypertrophy, however, not significant.

High-Intensity Training

•Subject were placed in four exercise groups with each group varying in intensity levels based on percentage of maximum heart rate (HR_{max})

•Subject who exercised with greater intensity showed a significant increase in VO_{2max} and stroke volume.

Concurrent Training

•Green area indicates interference effect will unlikely to result, however, the likeliness increases from yellow to red.

•Strength training must be performed first before endurance training (ST-END)

•≥6 hour rest period between strength and endurance training

CONCLUSION

•BFR training induce an increase in muscular strength and is favorable than resistance training because it reduces risk of injury.

•HIT significantly improves cardiorespiratory fitness and is time efficient.

•Aerobic exercises should be performed after resistance training with at least a 6 hour rest period to prevent interference effect.

FUTURE WORK

•Future research is needed to determine the potential health related risk factors that BFR has on individuals with high/low blood pressure.

• More research is needed to determine whether the benefits of HIT would occur in a microgravity environment.

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