Impact of Respiratory Muscle Training and Dietary Nitrate Supplementation on Exercise Performance at Sea Level and at Simulated Altitudes

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Abstract

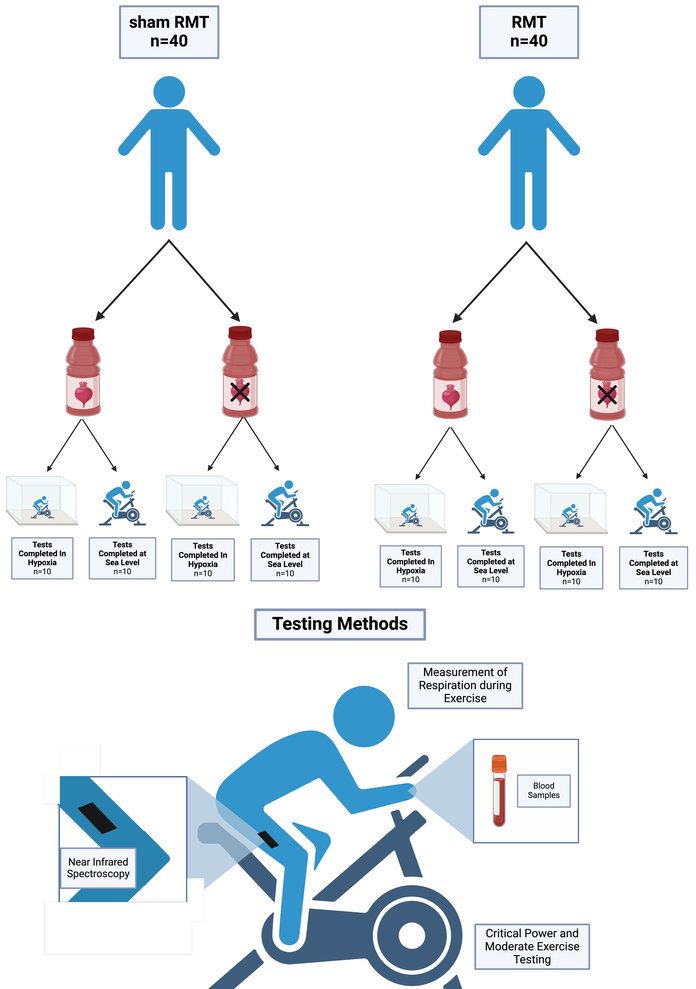
This project addresses the connection between oxygen uptake and exercise tolerance at sea level and extreme altitudes. This will be done by measuring the effects of Respiratory Muscle Training (RMT) and dietary nitrate supplementation interventions. We hypothesize that these interventions will improve exercise performance at sea level and extreme altitudes by increasing respiratory muscle fitness and therefore improving the ability of the body to distribute oxygen during maximal exercise. The project will be conducted by having study participants complete Critical Power Tests (CPT) to examine changes in their maximum exercise tolerance throughout a 5-week trial, with a goal of having 40 participants in the study. The success of the interventions will be further evaluated by measuring oxygen saturation in the muscles using Near-Infrared Spectroscopy and measuring the thickness of the diaphragm using a Doppler Ultrasound. Participants will also complete the CPT in a hypobaric chamber set to 16,000 feet to simulate the altitude at which supplemental oxygen is recommended in order to counteract the adverse effects of low oxygen content. The results of this study will highlight the relationship between respiratory muscle fitness and exercise tolerance at sea level and extreme altitudes.

Background

•High-intensity exercise increases the metabolic demand for oxygen in the muscles and cardiovascular system, leading to an increased load on the pulmonary system.
•In hypoxic conditions, the pulmonary muscles ‘steal’ blood flow from the muscles, causing a decrease in exercise tolerance.
•Respiratory Muscle Training (RMT) can strengthen the pulmonary muscles and decrease pulmonary muscle fatigue.
•Dietary nitrate supplementation can increase the amount of nitrite in the cardiovascular system, therefore increasing the amount of oxyhemoglobin in the system.
•This study aims to investigate the effects of RMT and nitrate supplementation on muscle tissue oxygenation, vascular endothelial function, and exercise tolerance.

Methodology

- Aim 1 involves two groups: one undergoing Respiratory Muscle Training (RMT) at sea level and the other at altitude.
- Aim 2 combines nitrate supplementation with RMT at altitude. All participants undergo a 3-minute all-out cycle ergometer test and near-infrared spectroscopy (NIRS) assessments.
- Subjects are randomly assigned to sham or RMT-trained groups, followed by nitrate-rich beetroot juice or a placebo for 5 weeks.
- Measurements include NIRS assessments, diaphragm measurements via ultrasound and blood sample collections before and after the RMT period.



Hypothesis

•RMT alone will enhance the oxygen tissue saturation in the Vastus Lateralis muscle during severe-intensity exercise, improving exercise tolerance.
•RMT combined with Dietary Nitrate will greatly improve vascular endothelial function as well as increase exercise tolerance and muscle tissue oxygen saturation.

Expected Outcomes

- Increase understanding of the complex interplay between respiratory muscle fitness and exercise tolerance.
- Determine the efficacy of respiratory muscle training and nitrate supplementation on oxygen efficiency and utilization to develop countermeasures for not only healthy but patient populations.
- Increase knowledge of the correlation between exercise tolerance, acute mountain sickness, and the redistribution of blood flow from skeletal muscles to respiratory muscles during high-intensity exercises and at high altitudes.
- Develop a safe and effective protocol for VO2 max and critical power determination at sea level and simulated increased altitude.
- Explore the intersection between blood lactate measurement, non-invasive gastrocnemius mitochondrial oxidative capacity, plasma, and nitrate levels in comparison to cardiovascular performance.

References

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