**Abstract**

Space flight-induced muscle atrophy, particularly in the postural and locomotory muscles, may impair task performance during long-duration space missions and planetary exploration. High intensity free weight (FW) resistive exercise training has been shown to prevent alterations in bone and muscle strength during a space mission (Shackelford et al., 2004). However, FW exercises are limited to traditional, fixed weight machines, and equipment costs can be prohibitive during long-duration missions. NASA is interested in developing a flexible, modular, and easy-to-use exercise system with a high patient load capacity that may have decreased its efficacy. ARED was developed by NASA to address this limitation (variable loading, assistance of the Exercise Physiology Laboratory members for their hard work and dedication to this project. A special thank you to the test subjects in this research). This study was supported by NASA Johnson Space Center's Exercise Countermeasures Project. The authors gratefully acknowledge the assistance of the Exercise Physiology Laboratory members for their hard work and dedication to this project. A special thank you to the test subjects in this research.

**Introduction**

- Muscle atrophy and reduced muscle strength have been observed following long-duration space flight (Liu, 2000, Tropp, 2009).
- Decreased muscle performance is considered a human health and performance risk by the Human Research Project at the Johnson Space Center, National Aeronautics and Space Administration (NASA). Decreased muscle function may impact space mission performance and mission success during long duration missions and planetary exploration.
- The interim Resistive Exercise Device (tRED) has been utilized since the first International Space Station (ISS) mission as a countermeasure to stress losses and muscle atrophy, but did not prove to be completely protective (Lee, 2004).
- ARED was developed by NASA to address tRED's limitations in loading variables, 1.3 kg of maximum resistance, limited range of motion, and lower eccentric forces (that may have decreased in efficacy).
- ARED, recently deployed on ISS during Expedition 18, provides up to 272 kg of resistance using 2 vacuum cylinders (constant load), 20-channel to simulate the inertial component of free weight (FW) exercise, and provides an eccentric load of greater than 90% for loads greater than 45 kg.

**Purpose**

The purpose of this study was to compare the efficacy of ARED and FW training to induce hypertrophy in specific muscle groups in ambulatory subjects.

**Methods**

- **Subjects:** Twenty volunteers (14 men, 6 women) consisted of 11 FW (主体) and 12 ARED ([^1]主体) training groups. The study protocol was reviewed and approved by the Johnson Space Center’s Institutional Review Board.
- **Exercise Program:** Subjects performed squat, heel raise, and deadlift exercises 3 d/ wk for 16 weeks using a periodized resistance exercise training program.
- **MRI Measurements:** Changes in the CSA of muscle groups in ambulatory subjects prior to employing ARED in FW training significant F Score was found.

**Conclusions**

- **ARED training elicited increases in muscle volume and strength that were not different than those elicited by FW training.** With the training effort similar to FW and a 50 lb load capacity, ARED likely will protect against muscle atrophy, in microgravity.

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**References**

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**Overall Study Design**

- **Subjects:** Twenty volunteers (14 men, 6 women) consisted of 11 FW (主体) and 12 ARED ([^1]主体) training groups. The study protocol was reviewed and approved by the Johnson Space Center’s Institutional Review Board.
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