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 atrophy during spaceflight and a 4-month mission aboard the International Space Station (ISS) (Trappe, 2009). However, FW training is limited by microgravity-induced muscular weakness, decreased muscular force output, loss of muscle mass, and reduced muscular strength and power due to reduced limb volume. Advanced Resistive Exercise Device (ARED) was developed by NASA to address iRED’s limitations (variable loading, 600 lb load capacity, ARED likely will protect against muscle atrophy in microgravity. The interim Resistive Exercise Device (iRED) has been utilized since the first mission space flight (LeBlanc, 2000; Trappe, 2009).

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 prior to deploying ARED on the ISS. METHODS: Twenty subjects were assigned to either the ARED group (15 males, 6 females) or FW group (12 males, 5 females) and completed 16 weeks of training. 

**Abstract**

A RED and FW training elicited increases in muscle volume and strength that were not different from those elicited by FW training. 

**Overall Study Design**

- Twenty volunteers (14 men, 6 women) consented to participate in this study and were assigned to either a FW or ARED training group. The study protocol was reviewed and approved by the Johnson Space Center’s Committee for the Protection of Human Subjects. 
- Subjects performed squat, heel rise, and deadlift exercises 3 d/week for 16 weeks using a periodized resistive exercise training program. 
- Each group performed 3 repetitions maximum strength measurements (1RM) on both the ARED and FW. Training loads were prescribed from the HM on the training specific hardware for each exercise before and after 8 weeks of training. 
- FW & ARED 1RM were measured pre-, mid-, and post-training for all three exercises. 
- Magnetic Resonance images (MRI) were acquired pre- and post-training. 
- Data were analyzed using a training group x time repeated-measures ANOVA (p<0.05) and a muscle group x time ANOVA (p<0.05). 
- Training load was used to determine pair-wise differences when a significant F Score was found.

**MRI Methods**

- Subjects laid supine for 15 minutes to equilibrate fluid distribution. 
- 32 consecutive cross-sectional images (3 mm slices with a 2 mm gap) were acquired. 
- Images were analyzed using the GNU Image Manipulation Program (GIMP 2.6.6, Batcove, California) 
- Cross-sectional area (CSA) was calculated within each slice of the Rectus Femoris (RF), the Vastus lateralis group (VL), the Hamstring group (H), and the Adductor group (ADD) to the thigh and the Anterior Articular Compartment (ACL), Lateral Gastrocnemius (LG), Medial Gastrocnemius (MG), and the Deep Posterior group (DP) in the calf. 
- CSA (sq. mm) = FOV2·MRI Methods

**Conclusions**

- ARED trained elicited increases in muscle volume and strength that were not different from those elicited by FW training. 
- Some subjects during bed not utilized loads as high as 254 kg during their exercise training to prevent muscle atrophy and bone demineralization (Shackelford, 2004).

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