ABSTRACT
Existing models (such as bed rest) of muscle deconditioning are cumbersome and expensive. We propose a new model utilizing a weighted suit to manipulate strength, power, or endurance relative to body weight (BW).
Methods: 20 subjects performed 7 occupational tasks while wearing a suit weighted with 0–120% of BW. Models of the full relationship between muscle function/BW and task completion time were developed using fractional polynomial regression and verified by the addition of pre- and postflight astronaut performance data for the same tasks. Spline regression was used to identify muscle function thresholds below which task performance was impaired.
Results: Thresholds of performance decline were identified for each task. Seated egress & walk (most difficult task) showed thresholds of leg press (LP) isometric peak force/BW of 18 N/kg, LP power/BW of 18 W/kg, LP work/BW of 79 J/kg, isokinetic knee extension (KE)/BW of 6 Nm/kg, and KE torque/BW of 1.9 Nm/kg.
Conclusions: Laboratory manipulation of relative strength has promise as an appropriate analog for spaceflight-induced loss of muscle function, for predicting occupational task performance and establishing operationally relevant strength thresholds.

INTRODUCTION AND PURPOSE
• Lower body muscle strength and power is related to performance of ambulatory tasks of daily living in older adults (1–4).
• Minimal strength / power requirements to perform ambulatory activities of daily living are related to body mass (4).
• Greater body mass requires more strength / power
• Develop and validate a methodology for evaluation leg strength / power requirements of occupational astronaut tasks.

RESULTS
Weighted suit used to manipulate strength or power/bdy weight ratio

STATISTICAL MODELING

Spline Regression
• Extension of OLS regression that estimates the relationship between outcome and predictor as a piecewise linear function composed of two or more linear segments.
• Used to model a single-knot/two-slope linear association between all strength/body weight predictors and the time to completion for each task.
• Modeled a two-slope association, where the intersection of the two segments (knot) represents the threshold where the association between strength/body and performance changes. Separate models were estimated varying the knot location by percentile increments throughout the range of X including a no-spline (linear) model. The model of best-fit was chosen based on the highest multiple R² coefficient of determination.

Fractional Polynomial Regression
• Generalization of polynomial regression that allows fractional powers and/or powers of the natural log of X in the estimation of a curvilinear relationship.
• Used to estimate the full curvilinear association between individual strength/body weight predictors and time to completion.
• Consistent with our threshold-hypothesis we restricted our models to include, at most, three terms including the Y-intercept.

DISCUSSION
• Laboratory manipulation of relative strength has promise as an appropriate analog for spaceflight-induced loss of muscle function, for predicting occupational task performance and establishing operationally relevant strength thresholds.
• Addition of astronaut data appears to confirm the models established using the weighted suit.
• Future work should focus on optimization of both predictors and tasks.

REFERENCES