Relationships Among Lower Body Strength, Power, and Performance of Functional Tasks

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Background

- Lower body muscle strength and power is related to performance of ambulatory tasks of daily living in older adults. Ploutz-Snyder, et al, *J Gerontol*, 2002; Chandler et al, Arch Phys Med Rehabil, 1998; Hughes et al, J Biomech, 1996; Bassey et al, Clin Sci, 1992.
- Minimal strength / power requirements to perform ambulatory activities of daily living are related to body mass. Ploutz-Snyder, et al, *J Gerontol*, 2002.
  - Greater body mass requires more strength / power
- What are the leg strength / power requirements of occupational astronaut tasks?

Research Design

- 17 subjects with similar QF isokinetic strength / body weight ratio as USOS crew members.
- Performed lower body strength / power testing
- Performed occupational astronaut tasks with varying levels of added body weight in attempt to vary the strength/body weight and power/body weight ratios.

Strength & Power Testing

- **Leg Press**
  - **Maximal Isometric Force**: Push against fixed footplate.
  - **Power/Endurance**: Push weight away as fast as possible (40% max. force, 21 repetitions). Concentric only - weight caught by a braking system.

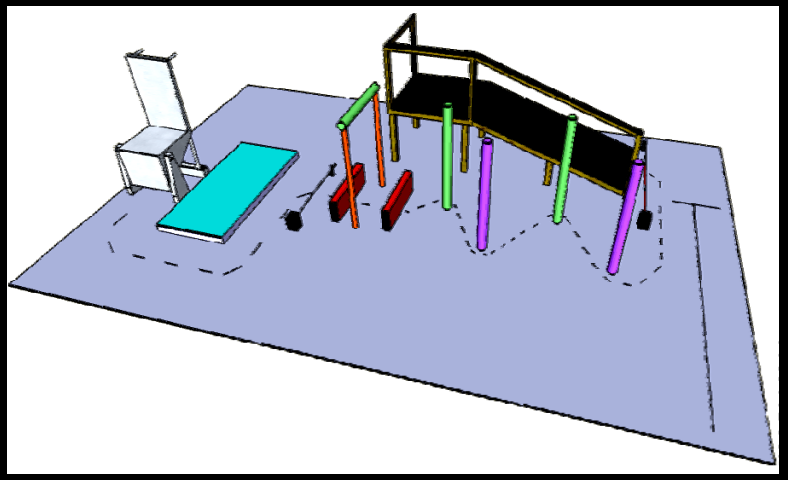
Weighted Suit

- Subjects performed tasks while wearing additional load distributed on torso and limbs distributed according to average limb segment weight.

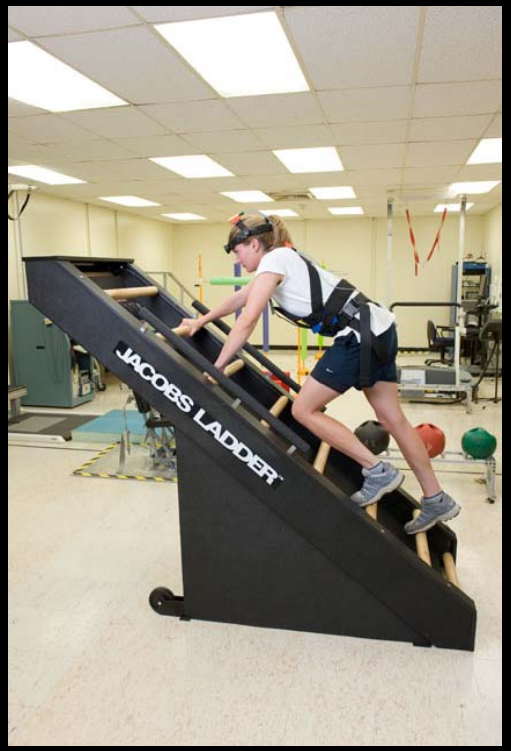
- 0, 20, 40, 60, 80, 100, 120% body weight added to the suit

Functional Tasks

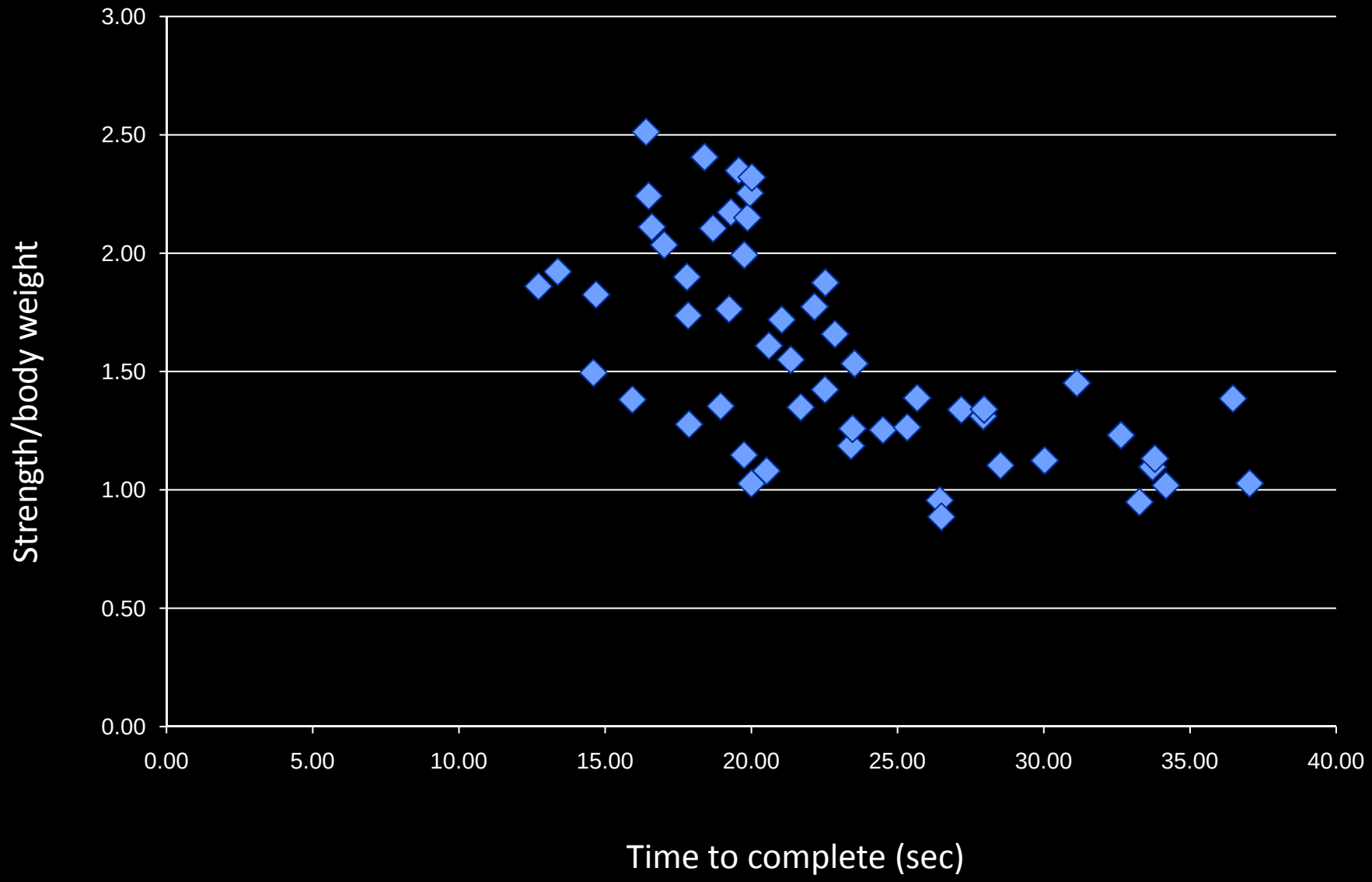
- Supine egress and walk
  - Rise from supine position and complete obstacle course.



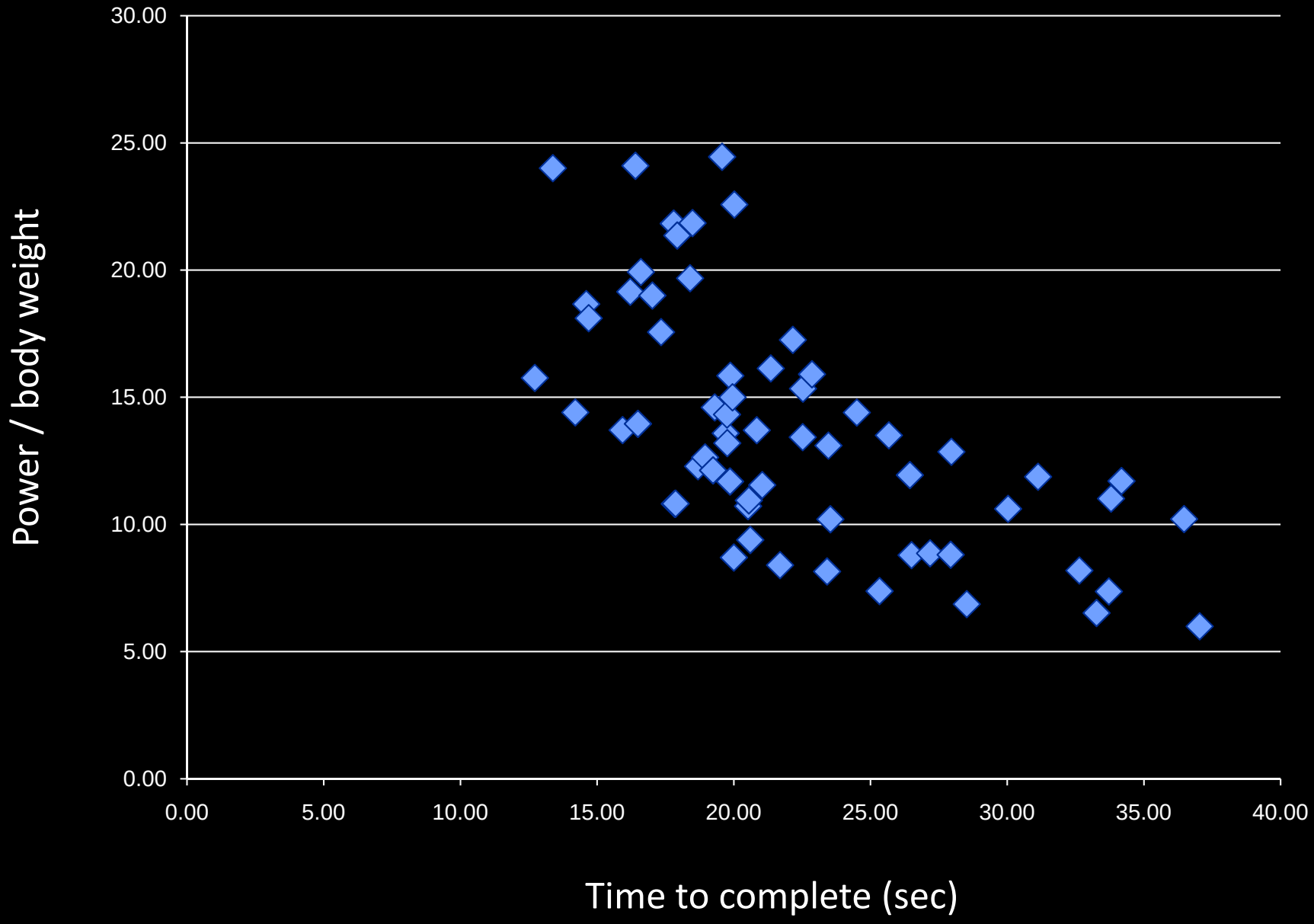
- Ladder climb
  - Climb 40 rungs of a ladder treadmill



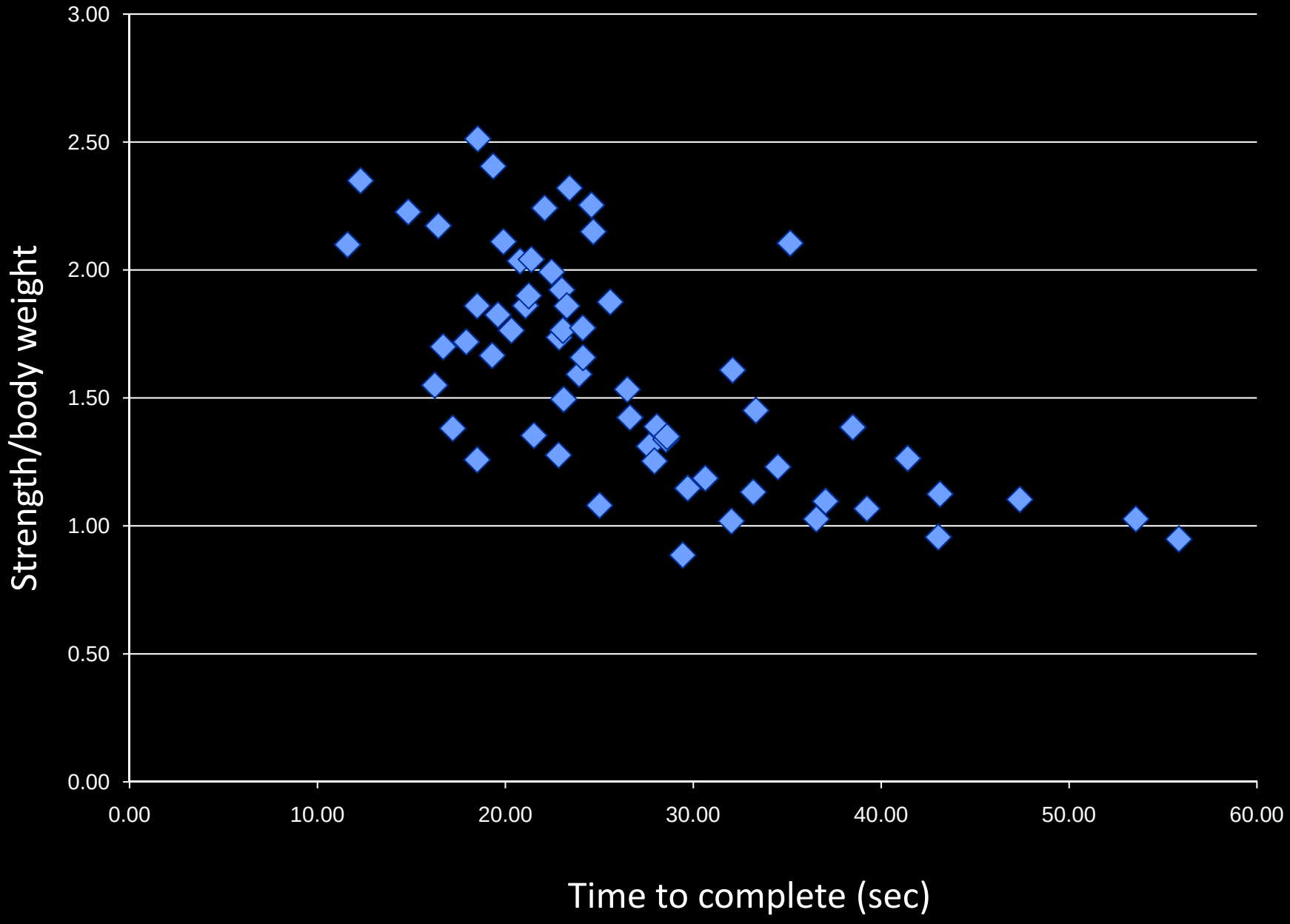
Supine egress & walk



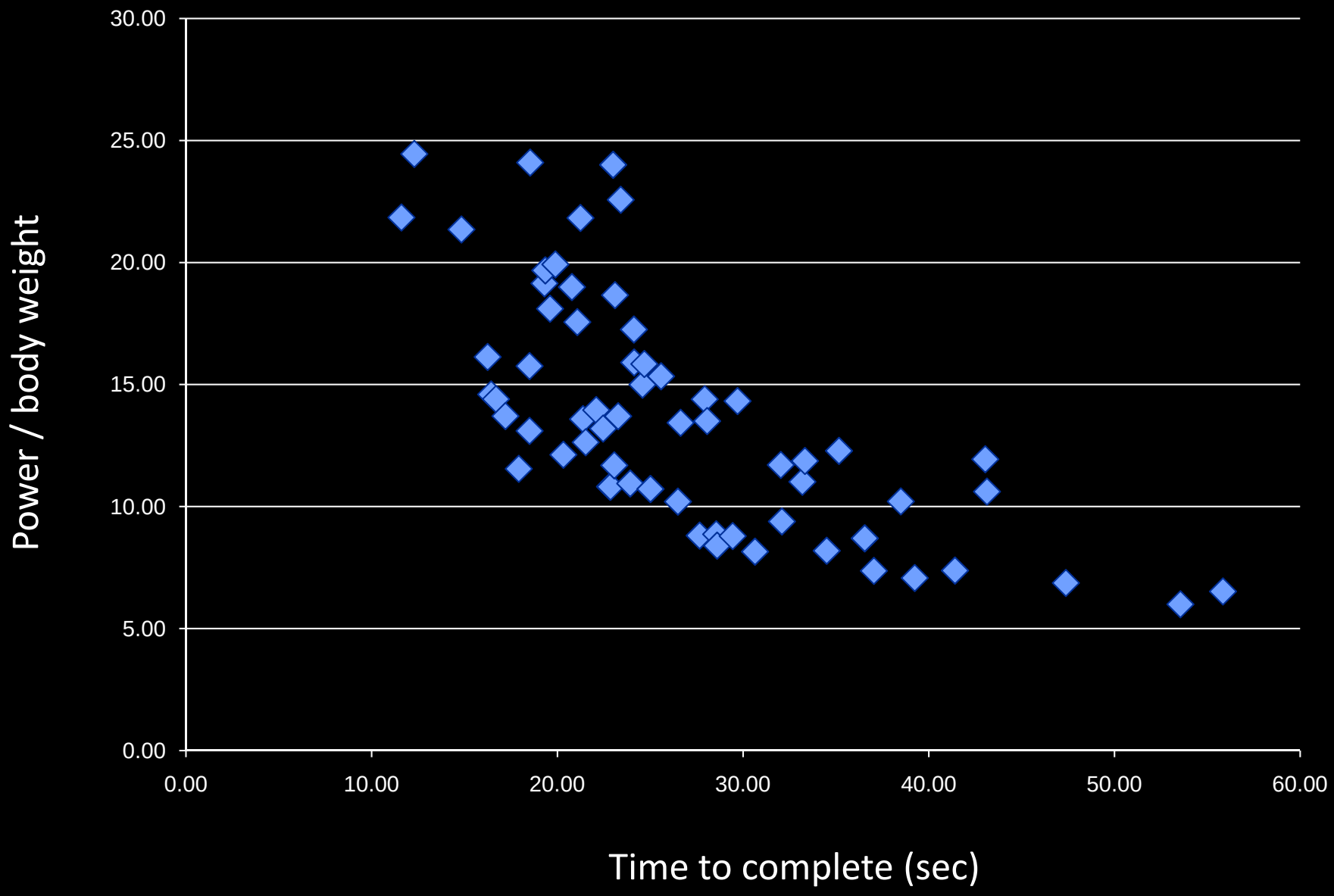
Supine egress & walk



Ladder Climb



Ladder Climb



Conclusions

- A 20% reduction in power / body weight from 18 to 14 W/kg
  - Increased ladder climb time 70% from 14 to 24 seconds.
  - Increased supine egress & walk time 50% from 14 to 21 seconds

- A 20% reduction in strength / body weight from 2.1 to 1.7 Nm/kg
  - Increased ladder climb time 128% from 10.5 to 24 seconds
  - Increased supine egress & walk time 82% from 11 to 20 seconds

Conclusions

- Considerable task slowing occurs with decrements in strength and power often associated with long duration spaceflight.
- There is a relatively linear relationship between strength/power and task time across the spectrum of typical crew strengths.
- The operational impact of this relationship should be evaluated.