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

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Background


  – 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

Time to complete (sec)

Strength/body weight

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Supine egress & walk

Power / body weight

Time to complete (sec)
Ladder Climb

![Graph showing the relationship between time to complete (sec) and power/body weight. The x-axis represents 'Time to complete (sec)' ranging from 0.00 to 60.00, and the y-axis represents 'Power/body weight' ranging from 0.00 to 30.00. The data points are scattered across the graph, indicating a possible correlation between the two variables.](image-url)
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.