National Aeronautics and Space Administration

On-Orbit Evaluation of a New Treadmill Harness for Improved Crewmember Comfort and Load Distribution

Results From International Space Station Increments 21 Through 25

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The current design of the International Space Station (ISS) Treadmill Harness has been reported to cause pain and discomfort to crewmembers during exercise. The Harness Station Development Test Objective (SDTO) provided participating crewmembers (n = 6) with a new harness design, the "Glenn Harness," to evaluate for comfort and loading as compared to the current Treadmill Harness. A novel suite of load-sensing instrumentation was developed to noninvasively measure load distribution and provided a first-ever quantification of actual dynamic loads during treadmill exercise. In addition, crew debriefs provided feedback on harness preference and overall impressions.

Purpose

- Evaluate the new treadmill harness (Glenn Harness) design for comfort during exercise and measure the loads in the harness straps for direct comparison with the current Treadmill Harness
- More comfortable harnessing may allow crewmembers to set higher loads into harness
- Greater loading during treadmill running may improve the health benefit of exercise (e.g., bone mass)

Features of the Glenn Harness

- "S"-shaped padded shoulder straps that avoid sensitive regions of the neck and shoulder while minimizing chest compression and better load distribution
- Biocidal fabric on inside surfaces eliminates odor buildup
- Waist belt with cupped and canted regions to apply load to the iliac crests and lumbar shelf; split padding feature, stiff outer shell, and removable lumbar padding
- Precurved and padded waist belt for customized fit (S, M, L, male/female)
  —No complicated adjustment for size differences
- Load attached to multiple points and transferred over the semirigid shell of the waist belt for better load distribution

Glenn Harness designed to improve comfort and load distribution.

ISS flight engineer wearing the Glenn Harness during ISS Expedition 21.

Glenn Harness.

Treadmill Harness.

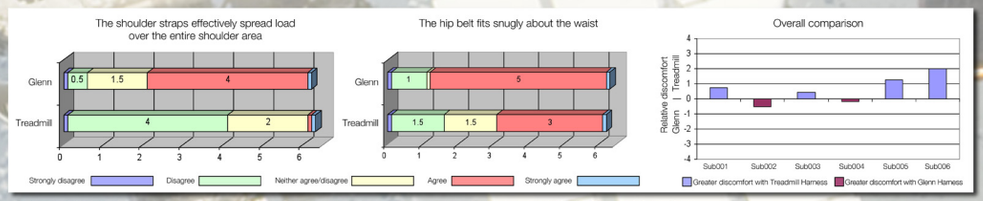
Methods

- Six crewmembers (five male, 5 ft 11 in. ± 2 in., 199 lb ± 19 lb, and one female 5 ft 6 in., 130 lb) ran an approved protocol using normal exercise time at 60 and 90 percent body weight loading and compared "side by side"
  Note: 100 percent body weight loading was not achievable for all crewmembers due to flight surgeon rule allowing only one bungee be used per side
  – Load data captured on both the Glenn and Treadmill harnesses to provide hip:shoulder loading ratio and total load into harness
  – First month on-orbit used normal Treadmill Harness, then four data collection sessions with Glenn (or Treadmill); four data collection sessions with Treadmill (or Glenn)—remainder of mission wore harness of choice
  – Crewmembers provided qualitative comfort/fit/function feedback via a questionnaire after selected sessions for both harness types (Borg Scale and Likert Scale)

SDTO Results

All crewmembers completed questionnaires after select sessions (typically every third or fourth exercise session), which included a modified Borg scale for pain (0 to 10 scale) for each harness in specific body areas (neck, shoulders, back, hips, waist, and overall), perceived load ratio (percent load at hip versus percent load at shoulders), perceived total load, narrative responses relating to harness fit and comfort, and questions relating to harness performance and effectiveness.

Questionnaire responses and crew debriefs confirmed that overall, one crewmember preferred the Treadmill Harness, one crewmember expressed no preference, and four crewmembers preferred the Glenn Harness. Load data were captured for three of six crewmembers and analysis is underway.



Data highlights from the Likert and Borg Scale responses comparing Harness comfort, fit, and function.

Conclusions

- Post-flight analysis in returned Glenn Harnesses (n = 3) showed minimal wear and tear
- Four of the six subjects found the Glenn Harness to be more comfortable in this on-orbit, side-by-side comparison as measured by the crew comfort questionnaire and crew debriefs
- Specific areas for improvement have been identified, and forward recommendations will be provided to the Human Research Program
- The protocol developed for the SDTO provided valuable insight into crew comfort issues, design improvements, and loading preferences for exercise harnessing, which lays the groundwork for better harnessing systems and training protocols

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