

TREADMILL EXERCISE WITH INCREASED BODY LOADING ENHANCES POSTFLIGHT FUNCTIONAL PERFORMANCE

J.J. Bloomberg¹, C.D. Batson², R.E. Buxton³, A.H. Feiveson¹, I.S. Kofman⁴, S. Laurie⁴, S.M.C. Lee⁴, C.A. Miller⁴,
A.P. Mulavara⁵, B.T. Peters⁴, T. Phillips⁴, S.H. Platts¹, L.L. Ploutz-Snyder⁵, M.F. Reschke¹, J.W. Ryder⁵, M.B.
Stenger⁴, L.C. Taylor⁴, and S.J. Wood⁶

¹NASA-Johnson Space Center, Houston, TX, ²MEI Technology, Houston, TX, ³University of Houston, Houston, TX,
⁴Wyle Science, Technology, & Engineering Group, Houston, TX, ⁵Universities Space Research Association,
Houston, TX, ⁶Azusa Pacific University, Azusa, CA

The goals of the Functional Task Test (FTT) study were to determine the effects of space flight on functional tests that are representative of high priority exploration mission tasks and to identify the key underlying physiological factors that contribute to decrements in performance. Ultimately this information will be used to assess performance risks and inform the design of countermeasures for exploration class missions. We have previously shown that for Shuttle, ISS and bed rest subjects functional tasks requiring a greater demand for dynamic control of postural equilibrium (i.e. fall recovery, seat egress/obstacle avoidance during walking, object translation, jump down) showed the greatest decrement in performance. Functional tests with reduced requirements for postural stability (i.e. hatch opening, ladder climb, manual manipulation of objects and tool use) showed little reduction in performance. These changes in functional performance were paralleled by similar decrements in sensorimotor tests designed to specifically assess postural equilibrium and dynamic gait control. The bed rest analog allows us to investigate the impact of axial body unloading in isolation on both functional tasks and on the underlying physiological factors that lead to decrements in performance and then compare them with the results obtained in our space flight study. These results indicate that body support unloading experienced during space flight plays a central role in postflight alteration of functional task performance. Given the importance of body-support loading we set out to determine if there is a relationship between the load experienced during inflight treadmill exercise (produced by a harness and bungee system) and postflight functional performance.

ISS crewmembers (n=13) were tested using the FTT protocol before and after 6 months in space. Crewmembers were tested three times before flight, and on 1, 6, and 30 days after landing. To determine how differences in body-support loading experienced during inflight treadmill exercise impacts postflight functional performance, the loading history for each subject during inflight treadmill (T2) exercise was correlated with postflight measures of performance. Crewmembers who walked on the treadmill with higher pull-down loads had less decrement in postflight postural stability and dynamic locomotor control than those subjects who exercised with lighter loads.

These data point to the importance of providing significant body loading during inflight treadmill exercise. This and the addition of specific balance training may further mitigate decrements in critical mission tasks that require dynamic postural stability and mobility. Inflight treadmill exercise provides a multi-disciplinary platform to provide sensorimotor, aerobic and bone mechanical stimuli benefits. Forward work will focus on the development of an inflight training system that will integrate aerobic, resistive and balance training modalities into a single interdisciplinary countermeasure system for exploration class missions.