

INFLIGHT TREADMILL EXERCISE CAN SERVE AS A MULTI-DISCIPLINARY COUNTERMEASURE SYSTEM

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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. These data also support the concept that space flight may cause central adaptation of converging body-load somatosensory and vestibular input during gravitational transitions [1]. Therefore, we conclude that providing significant body-support loading during inflight treadmill along with balance training is necessary to mitigate decrements in critical mission tasks that require dynamic postural stability and mobility. Data obtained from space flight and bed rest support the notion that in-flight treadmill exercise, in addition to providing aerobic exercise and mechanical stimuli to the bone, also has a number of sensorimotor benefits by providing:

- A balance challenge during locomotion requiring segmental coordination in response to a downward force.
- Body-support loading during performance of a full-body active motor task.
- Oscillatory stimulation of the otoliths and synchronized periodic foot impacts that facilitate the coordination of gait motions and tune the full-body gaze control system.
- Appropriate sensory input (foot tactile input, muscle and tendon stretch input) to spinal locomotor central pattern generators required for the control of locomotion.

Forward work will focus on a follow-up bed rest study that incorporates aerobic and resistance exercise with a treadmill balance and gait training system that can serve as an integrated interdisciplinary countermeasure system for future exploration class missions.

[1] Mulavara A.P., Ruttley T., Cohen H.S., Peters B.T., Miller C., Brady R., Merkle L., Bloomberg J.J. (2012). Vestibular-somatosensory convergence in head movement control during locomotion after long-duration space flight. *Journal of Vestibular Research*. 22(2): 153-66.