A Qualitative Assessment of Preflight Fitness Training Strategies and Methods

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Summary

As the advent of private and commercial space travel opens the spaceflight experience to an increasing number of civilian "spaceflight participants" and industry/academic professionals at various levels of physical health and fitness, preflight fitness training strategies optimized to prepare trainees for the high-g and microgravity environments of spacecraft launch, free-flight/fall, and reentry/descent must be considered. Consequently, an assessment of preflight fitness training strategies and methods as they relate to the spaceflight environment is long overdue.

Historical Fitness Training

Conventional fitness training, which is frequently employed as preflight fitness training, is optimized for the terrestrial environment. This results in frequently neglected stabilizer and core muscle groups that are used during spaceflight but that ordinarily under-perform due to gravitational assistance (Jennings and Bagian 1996). Further and arguably counter-intuitively, it has been identified that those with an exceptional state of cardiovascular and physical fitness may recover more slowly post-flight and respond more poorly to hypodynamic conditions than do those with more average states of physical fitness (Frey 1987; Saiki et al. 1981). Fitness conditioning for NASA astronauts, meanwhile, has been identified as historically poorly tailored to the spaceflight environment (Jennings and Bagian 1996), centering too exclusively on running and "competitive athletics" while neglecting total body fitness training.

Points of Stability

Due to the unique, apparently weightless suborbital and orbital space environments, non-fulcrum "points of stability" earn special significance. Whereas humans in a terrestrial environment usually benefit from two or more such points of stability from which to initiate motion, (e.g., two legs in contact with the ground,) those in a microgravity environment regularly benefit from only one point of stability, (e.g., handhold,) or none at all (free-floating). This importance of stability points is intimated when Jennings and Bagian (1996) recommend the incorporation of lap pools in preflight total body fitness training, owing to the fact that "swimming provides conditioning to those muscle groups used during spaceflight." This is especially pertinent considering motive translation in microgravity is the leading cause of astronaut injury (Scheuring et al. 2009).

Recommendations

Fitness training that takes advantage of reduced points of stability will most effectively condition trainees for motive action in the spaceflight environment. While zero-stability-point training is ideal for microgravity fitness conditioning, (e.g., swimming, indoor skydiving,) infrastructural requirements (e.g., swimming pool, indoor turbine,) may be prohibitive and/or inconvenient. The development of more portable and versatile single-stability-point training systems, such as suspension training systems, may therefore be a preferred alternative for spaceflight participants and professionals eager to conveniently maximize their spaceflight experience.

References

Frey, M.A., 1987. Considerations in prescribing preflight aerobic exercise for astronauts. ASEM 58(10), 1014-1023.

Jennings, R.T., Bagian, J.P., 1996. Musculoskeletal injury review in the U.S. space program. ASEM 67(8), 762-766.

Saiki, H., Nakaya, M., Abe, M., Taketomi, Y., Oh'Ishi, K., Saiki, Y., Saiki, A., 1981. Effect of physical fitness and training on physiological responses to hypogravity. Acta Astronautica 8(9-10), 959-969.

Scheuring, R.A., Mathers, C.H., Jones J.A., Wear, M.L., 2009. Musculoskeletal injuries and minor trauma in space: incidence and injury mechanisms in U.S. astronauts. ASEM 80(2), 117-124.