RETROSPECTIVE ANALYSIS OF INFLIGHT EXERCISE LOADING AND PHYSIOLOGICAL OUTCOMES

L. L. Ploutz-Snyder[1], R. E. Buxton[2], J. K. De Witt[3], M.E. Guilliams[3], A.M. Hanson[4], B.T. Peters[3], M.M. Scott Pandorf[3], and J. D. Sibonga[4]
[1]Universities Space Research Association, Houston, TX, USA
[2]University of Houston, Houston, TX, USA
[3]Wyle Science, Technology & Engineering Group, Houston, TX, USA
[4]NASA Johnson Space Center, Houston, TX, USA

Astronauts perform exercise throughout their missions to counter the health declines that occur as a result of long-term exposure to weightlessness. Although all astronauts perform exercise during their missions, the specific prescriptions, and thus the mechanical loading, differs among individuals. For example, inflight ground reaction force data indicate that subject-specific differences exist in foot forces created when exercising on the second-generation treadmill (T2) [1]. The current exercise devices allow astronauts to complete prescriptions at higher intensities, resulting in greater benefits with increased efficiency. Although physiological outcomes have improved, the specific factors related to the increased benefits are unknown.

In-flight exercise hardware collect data that allows for exploratory analyses to determine if specific performance factors relate to physiological outcomes. These analyses are vital for understanding which components of exercise are most critical for optimal human health and performance. The relationship between exercise performance variables and physiological changes during flight has yet to be fully investigated. Identifying the critical performance variables that relate to improved physiological outcomes is vital for creating current and future exercise prescriptions to optimize astronaut health.

The specific aims of this project are: 1) To quantify the exercise-related mechanical loading experienced by crewmembers on T2 and ARED during their mission on ISS; 2) To explore relationships between exercise loading variables, bone, and muscle health changes during the mission; 3) To determine if specific mechanical loading variables are more critical than others in protecting physiology; 4) To develop methodology for operational use in monitoring accumulated training loads during crew exercise programs.

This retrospective analysis, which is currently in progress, is being conducted using data from astronauts that have flown long-duration missions onboard the ISS and have had access to exercise on the T2 and the Advanced Resistive Exercise Device (ARED). The specific exercise prescriptions vary for each astronaut. General exercise summary metrics will be developed to quantify exercise intensities, volumes, and durations for each subject. Where available, ground reaction force data will be used to quantify mechanical loading experienced by each astronaut. These inflight exercise metrics will be investigated relative to changes in pre- to post-flight bone and muscle health to identify which specific variables are related with improved or degraded physiological outcomes.

The information generated from this analysis will fill gaps related to typical bone loading characterization, exercise performance capability, exercise volume and efficiency, and importance of exercise hardware. In addition, methods for quantification of exercise loading for use in monitoring the exercise programs during future space missions will be explored with the intent to inform exercise scientists and trainers as to the critical aspects of inflight exercise prescriptions.

REFERENCES

[1] De Witt J.K. and Ploutz-Snyder L.L. (2014) *J Biomech* 47, 2339-2347.