Paper ID: 62675
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IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medicine in Space and Extreme Environments (4)

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BRIDGING THE KNOWLEDGE GAP IN BIOLOGICAL SEX DIFFERENCES OF HUMAN CARDIOVASCULAR DECONDITIONING DURING A 5-DAY DRY IMMERSION EXPERIMENT

Abstract

The humankind has entered the Artemis Generation, which through sustainable presence in Low-Earth Orbit has paved the way for return to the Moon and catalyze human efforts for Mars exploration. The revolutionary advancements in science and technology have pushed the bounds of humanity, expanding our understanding of human body systems in space and their interplay with social and physical environments, and the impact it has on individual health, wellness, and performance. Despite decades of research and manned space exploration, a significant knowledge gap persists in biological sex differences, as it pertains to adaptation to conditions of the spaceflight environment. Males continue to dominate the field of space research and data on female effects associated with conditions of weightlessness remain a limiting factor in the current body of literature. Most of the knowledge on human deconditioning during spaceflight, cardiovascular deconditioning in particular, has been reported for male astronauts and cosmonauts, while the differences and specifics of female adaptation are not well understood. To bridge the knowledge gap in biological sex differences of adaptation to conditions of the spaceflight environment, the European Space Agency has organized the first-of-a-kind all female dry immersion experiment, which will be conducted in the MEDES facility in France. It will provide insights into the female effects associated with adaptation to a simulated spaceflight environment. In prior research, we proposed a prototype of a wholistic framework for assessment of adaptation and resilience during spaceflight, based on heart rate variability features extracted from the electrocardiogram (ECG) signal. The wholistic framework is based on big data and stream computing approaches, which enable provision of health analytics-as-a-service in real-time, to enhance autonomy, prognostics, diagnostics and health management capacity in-flight. This framework will further be validated within the context of a 5-day female dry immersion experiment, the findings of which will be synthesized with our prior 5-day all-male dry immersion study results to better understand the differences in cardiovascular deconditioning. It will offer valuable insights into the biological sex-based differences that exist and begin to inform mitigation strategies that can be introduced to minimize the deleterious effects associated with spaceflight environment for each biological sex, while preserving health, wellness, and optimal performance of the crew.