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INVESTIGATION OF HEART RATE VARIABILITY CHANGES DURING A 5-DAY ALL-FEMALE DRY IMMERSION EXPERIMENT

Abstract

Human space exploration is rapidly advancing to habitats outside Low-Earth Orbit (LEO), including destinations such as the Moon and Mars. Spaceflight risks and challenges in LEO are well-understood, while they are expected to significantly amplify as humans travel outside of the Earth's magnetic field, where exposure to radiation, distance from Earth, isolation and confinement will be unlike any human experience known to-date. It will be further exacerbated by communication delays and limited feasibility of evacuation, should such need arise. As a result, there is an urgent need in the development of novel and comprehensive techniques to improve diagnostics, prognostics, and health management in-flight, to preserve health and wellbeing of the crew. Moreover, the female astronaut/cosmonaut population is beginning to gradually increase, while the spaceflight-induced effects on the biological female body are not well-understood. This study investigates cardiovascular changes, based on heart rate variability analysis, in response to simulated weightlessness, induced during a five-day all-female dry immersion experiment conducted at MEDES facility in France. Heart rate variability (HRV) analysis is one of the strongest predictors of physiological and mental state alternations in humans. It is a direct indicator of autonomous nervous system (ANS) activities, which are the driving agents for adaptational changes in bodily systems, such as peripheral resistance, temperature, and hormonal regulation. As such, this study leverages HRV analysis to assess the adaptation of the biological female body to conditions of simulated spaceflight, investigate the interplay of bodily systems and predict onset of functional or maladaptive changes. It incorporates time and frequency-domain features of the HRV to identify ANS specific responses, which can then be used to inform development of personalized resilience and mitigation strategies to alleviate deleterious effects of spaceflight environment. The results of our analysis on this all female study cohort are presented in this paper.