

Identification of cardiometabolic vulnerabilities caused by effects of synergistic stressors that are commonly encountered during space missions

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Microgravity is a physiologically challenging state even when at rest. Astronauts experience additional physical and mental stresses, such as prolonged exertion, sleep loss and circadian misalignment, that could impact cardiovascular function. The main goals of this four year NASA project are to characterize the independent and synergistic effects on cardiovascular and immune function of: (1) circadian misalignment; (2) sleep loss; and (3) varied physical and mental stressors, mimicking some of the synergistic stressors experienced by astronauts.

Sixteen healthy volunteers, aged 35-55 years, will be studied with standardized behavioral stressors occurring across all circadian phases, both with and without accruing sleep loss, achieved via two 11-day 'forced desynchrony' protocols performed in each subject (randomized, within-subject design), where wake periods are advanced 4-h each 'day' (i.e. recurring 20-h 'days'). One protocol permits 8.33 h sleep opportunity per 20-h 'day' (≡10 h sleep per 24-h), and the other permits 5 h sleep per 20-h 'day' (≡6 h sleep per 24-h; matching the reported sleep duration of astronauts). In both protocols, subjects will perform a standardized stress battery including a cognitively challenging task; bicycle exercise, and passive 60° head up tilt. Outcome variables include blood pressure, heart rate, arrhythmia frequency, cardiac vagal tone (from heart rate variability), sympathetic activity (catecholamines), and endothelial function. Additional measures of cardiac function (echocardiography), responses to a passive 80° head up tilt, maximal oxygen uptake, and immune function will be assessed at the beginning and at the end of each protocol (i.e., without and with sleep loss, and before and after circadian misalignment). We hope to identify the relative impact on cardiovascular risk markers of varied behavioural stressors while subjects experience circadian misalignment and sleep loss, mimicking some of the synergistic stressors experienced by astronauts. Supported by NASANNX1 OAR 1 OG.