THE INTEGRATED IMPACT OF DIET ON HUMAN IMMUNE RESPONSE, THE GUT MICROBIOTA, AND NUTRITIONAL STATUS DURING ADAPTATION TO A SPACEFLIGHT ANALOG

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Spaceflight impacts human physiology, including well documented immune system dysregulation. Diet, immune function, and the microbiome are interlinked, but diet is the only one of these factors that we have the ability to easily, and significantly, alter on Earth or during flight. As we understand dietary impacts on physiology more thoroughly, we may then improve the spaceflight diet to improve crew health and potentially reduce spaceflight-associated physiological alterations. It is expected that increasing the consumption of fruits and vegetables and bioactive compounds (e.g., omega-3 fatty acids, lycopene, flavonoids) and therefore enhancing overall nutritional intake from the nominal shelf-stable, fully-processed space food system could serve as a countermeasure to improve human immunological profiles, the taxonomic profile of the gut microbiota, and nutritional status, especially where currently dysregulated during spaceflight.

This interdisciplinary study will determine the effect of the current shelf-stable spaceflight diet compared to an "enhanced" shelf-stable spaceflight diet (25% more foods rich in omega-3 fatty acids, lycopene, flavonoids, and more fruits, and vegetables in general). The NASA Human Exploration Research Analog (HERA) 2017 missions, consisting of four 45-day missions with closed chamber confinement and realistic mission simulation in a high-fidelity mock space vehicle, will serve as a platform to replicate mission stressors and the effects on crew biochemistry, immunology, and the gut microbiome. Bio sampling of crewmembers is scheduled for selected intervals pre- and in-mission. Data collection also includes dietary intake recording. Outcome measures will include immune markers (e.g., peripheral leukocyte distribution, inflammatory cytokine profiles, T cell function), the taxonomic and metatranscriptomic profile of the gut microbiome, and nutritional status biomarkers and metabolites. Statistical evaluations will determine physiological and biochemical shifts in relation to nutrient intake and study phase.

To date, sample collection has been completed for 2 crewmembers from the first mission, aka Campaign 4 Mission 1. Mission 2 was terminated after 22 days due to effects of Hurricane Harvey, and sample collection was not completed. Sample collection will continue for Campaign 4 Mission 3 and 4 prior to comprehensive sample analysis.

Beneficial improvements will provide evidence of the impact of diet on crew health and adaptation to this spaceflight analog, and will aid in the design and development of more-efficient targeted dietary interventions for exploration missions.