Fiscal Year:	FY 2022	**Task Last Updated:**	FY 06/30/2023
PI Name:	Crucian, Brian Ph.D.		
Project Title:	Validation of Multisystem Countermeasures Protocol for Spaceflight during Antarctica Winter-over at Palmer Station		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	03/03/2021	**End Date:**	03/02/2026
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No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	Dr. Crucian: Added Douglass Diak, Cody Gutierrez, Jay Luna. Removed Georg Makedonas and Stephanie Krieger (both have departed out lab) (Ed., 9/15/23).		
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Task Description:	Low-Earth orbital spaceflight perturbs the human immune system persistently, characterized by reductions in T and NK cell function, altered cytokine profiles, and the reactivation of latent herpesviruses. While these alterations have not caused widespread clinical issues, some crewmembers experience immune-related adverse events, including manifestations of herpes virus reactivation, other infectious diseases, and atopic dermatitis. Because future deep-space exploration missions will be of unprecedented duration, it is reasonable to hypothesize that the immune perturbations observed aboard the International Space Station (ISS) will intensify during longer missions in deep space, thereby placing crewmembers at elevated clinical risk. Thus, it is imperative to preserve the immunocompetence of astronauts by developing a countermeasure strategy operationally compatible (mass, power, crew time, etc.) with implementation during deep space missions of exploration. An international team of interdisciplinary scientists has developed a candidate multisystem immune countermeasure protocol ready to test for efficacy, consisting of diet modification, nutritional supplementation, prescribed aerobic and resistive exercise, and a set of stress-relieving exercises implemented using a virtual reality headset. The isolation, extreme environment, prolonged duration, and various mission-associated stressors suggest the best Earth analog for spaceflight-induced immune dysregulation is likely to be Antarctica winter-over. Amongst the various Antarctic stations, one with small (ISS-like) crew size and normoxic (coastal) conditions would be superior to evaluate the NASA countermeasure. The United States maintains three primary stations on Antarctica: Amundsen-Scott South Pole Station, McMurdo Station, and Palmer Station, of which only Palmer possesses and induces the desired characteristics that are most similar to the ISS. In this study, we will implement the countermeasure protocol to a cohort of subjects for three consecutive Antarctica winter-over sessions (2 countermeasure, 1 control session) at Palmer. Hypothesis: Implementation of a ‘suite’ of interdisciplinary biomedical countermeasures will positively rectify any immune dysregulation induced by the Palmer Antarctica spaceflight analog. This study will therefore validate the countermeasures suite prior to a potential flight validation aboard the ISS, and utilization during upcoming deep space missions. Aims: (1) To determine if the complete immune countermeasure protocol developed for spaceflight ameliorates the detrimental effect of coastal Antarctica winter-over, as a relevant ground analog for deep space missions, on a variety of physiological biomarkers. The primary aim involves the quantification of the association between immunologic/virologic biomarkers and usage of the countermeasure protocol. (2) To analyze the specific components of the protocol (e.g., nutrition, innate immunity, stress, etc.) and other biomarkers of interest. The experimental assays will consist of the previously validated measures that define immune dysregulation in astronauts.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research. 1) Time to Implementation: Winter-over missions on Antarctica are yearlong deployments, which means opportunities to implement science there occur once a year. Initiating this project, concurrent with the planned NASA Johnson Space Center (JSC) Research and Clinical Advisory Panel/Technical Interchange Meeting (RCAP/TIM), will expedite our ability to meet the Production Readiness Review (PRR) schedule for upcoming ground and flight validation of immune countermeasures. External solicitations would introduce unnecessary cost and delay study implementation, potentially by two years. 2) Technical homology: The same measurements that have been used to define immune dysregulation during long-duration spaceflight will be used in this study to assess the efficacy of the countermeasure protocol. Furthermore, this constant set of parameters will be a valuable dataset against which to compare additional, cutting-edge means of immune surveillance. Without the consistency across studies, the result will be independent datasets, from which it will be impossible to formulate conclusions about the biological mechanisms at play. Many of the immune assays and endpoints included here have been validated during previous flight studies. To solicit for assays externally would invite technical differences from the flight studies that have defined immune dysregulation among astronauts in space, and produce a negative effect on data correlation. 3) Validated sample processing protocols: The research teams listed in this proposal have already optimized and validated the protocols to ensure proper biological sample collection, stability, and storage under the operational constraints of fieldwork in Antarctica. 4) Established collaborations: The NASA JSC investigators have a documented work relationship with the American and international partner immunologists listed in the protocol, which will expedite the execution of the study and ensure rapid and open communication between the teams. 5) Implementation Aspects: For a complicated medical study with unique sampling constraints, it is advantageous to have an in-house investigator lead the study to success. Examples of this notion include central coordination of sample storage and sharing; facilitation of data collection, storage, analyses, and sharing; and physical proximity of interdisciplinary laboratories (Nutrition, Food, Exercise, and Microbiology), which promotes communication.
Research Impact/Earth Benefits:	

Task Progress:	With the completion of the Antarctica Winter-Over (WO) 2022, samples have been successfully returned from Antarctica to NASA/JSC for further processing and distribution to Co-Investigators. WO 2023 has also commenced with 11 subjects consenting and performing their baseline data collections (BDCs) held in Chile. Another 5 subjects, who were already stationed at Palmer Station, Antarctica, asked to participate in the investigation. These 5 subjects were consented, but no BDC was able to be collected on them due to them joining in-mission. Therefore, there will now be a total of 16 subjects participating in Antarctica's 2023 Winter-Over, with a potential for 4 more participants to join if available.
Bibliography Type:	Description: (Last Updated: 09/15/2023)
Articles in Peer-reviewed Journals	Feuerecker M, Strewe C, Aumayr M, Heitland T, Limper U, Crucian B, Baatout S, Choukér A. "One year in the extreme isolation of Antarctica-Is this enough to modulate an "allergic" sensitization?" Biomedicines. 2022 Feb 15;10(2):448. https://doi.org/10.3390/biomedicines10020448 ; PubMed PMID: 35203657; PubMed Central PMCID: PMC8962425 , Feb-2022