Fiscal Year:	FY 2021	**Task Last Updated:**	FY 05/20/2021
PI Name:	Lee, Stuart M.C. Ph.D.		
Project Title:	Determining the Dose Response Profile of the Headward Fluid Shift during Varying Gravity Levels		
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:	(1) **Cardiovascular**:Risk of Cardiovascular Adaptations Contributing to Adverse Mission Performance and Health Outcomes		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77058-2749	**Congressional District:**	36
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
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No. of Post Docs:		**No. of PhD Degrees:**	
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No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
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Flight Assignment:			
Key Personnel Changes/Previous PI:			
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Grant/Contract No.:	Directed Research		
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Task Description:	Long-duration stays in weightlessness have resulted in changes in the function and structure of the eye in some astronauts which has been described as Spaceflight-Associated Neuro-ocular Syndrome (SANS). The leading hypothesis is that ocular changes associated with SANS result from chronic exposure to the weightlessness-induced headward fluid shift. The resulting venous congestion in the upper body may impair cerebrospinal and lymphatic fluid drainage from the skull and contribute to some of the changes in the eye. Further, venous stasis may develop in some astronauts, increasing the risk of a venous thrombus. Countermeasures that reverse the headward fluid shift during spaceflight such as centrifugation or lower body negative pressure have been proposed as means to relieve venous congestion associated with weightlessness and thus may mitigate the risk of SANS, venous thrombosis, and other spaceflight-induced cardiovascular adaptations. However, the amount of fluid shift reversal required to prevent SANS, venous thrombosis, and cardiovascular adaptations is unresolved. Parabolic flight provides a unique opportunity to evaluate the acute changes in the headward fluid shift within the venous compartment induced by varying levels of gravity during partial gravity and weightlessness. The primary task objectives are to determine whether exposures to partial gravity levels (G-levels) similar to extraterrestrial levels (Moon and Mars) will provide protection against the headward fluids shifts that may be associated with the development of SANS, venous thromboembolism (VTE), and cardiovascular deconditioning. With the results from this partial gravity parabolic campaign, we will provide additional data that will contribute to comprehensive models of the relationship between G-levels and internal jugular vein (IJV) dimensions, pressure, and flow. Furthermore, investigating IJV hemodynamics bilaterally and studying the IJV in these subjects during parabolas producing weightlessness will better inform NASA regarding the risk of SANS and venous thrombosis and aid in the development of appropriate countermeasures. Specific Aims 1. Determine the relationship between G-level and upper body venous hemodynamic parameters associated with a headward fluid shift, including IJV pressure, flow pattern, and cross-sectional area. 2. Determine if the relationship between G-level and upper body venous hemodynamic parameters is different between the left and right sides of the body. 3. Determine whether the supine posture in normal gravity produces similar internal jugular vein hemodynamics as occurs in acute weightlessness.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research. This work was recommended by the Human Health Countermeasures (HHC) element to be performed as a directed study (a) to fulfill the partial gravity flight campaign human data collection objectives outlined in the previously-selected NASA Research Announcement (NRA; NNJ15ZSA001N-AG); (b) to provide the necessary data to accelerate HHC Spaceflight Associated Neuro-ocular Syndrome (SANS) risk reduction; and (c) to provide the necessary headward fluid shift data to help inform requirements for future lunar (Artemis Program) and Mars exploration. This proposed task will allow Human Research Program (HRP) to take advantage of a planned European Space Agency (ESA)-sponsored partial gravity parabolic flight opportunity in Spring or Summer of 2022. Furthermore, utilizing the same study design and outcome measures as the first campaign will ensure data consistency, enable us to leverage previously-developed human research documentation, hardware, and engineering analyses required by the parabolic flight provider (cost efficiency). When our first study was selected as part of a NASA Research Announcement (NRA) (NNJ15ZSA001N-AG), the power analysis indicated that data should be collected from 15 subjects. However, the ESA parabolic flight plan limited data collection to 9 subjects. Due to technical constraints and reduced operator support in the first campaign, internal jugular vein (IJV) area was obtained in only 8 of 9 subjects and IJV pressure only in 3 subjects at the lower G-levels. Thus, collecting data from 9 additional subjects as outlined here will allow us to fully explore the threshold G-level required to prevent venous congestion (IJV area and pressure) and altered flow patterns. In addition, this will allow us to assess the effects of right vs. left IJV anatomy on IJV dimension, pressure, and flow to varying G-levels, which has not been previously explored and may be key in assessing SANS and thrombosis risks. Finally, the previous partial gravity parabolic flight campaign did not include parabolas producing weightlessness, and thus the previous dose-response curves describing the relationship between G-level and IJV area required the assumption that IJV dimensions in the supine posture was a suitable analog. With the addition of weightlessness parabolas in a new campaign, this approach will be validated. Data from this project also will complement the weightless parabolic flight study recently funded for our laboratory (Characterization of Jugular Venous Blood Flow during Acute Fluid Shifts, Principal Investigator: Karina Marshall-Goebel, Ph.D., 80JSC019N0001-OMNIBUS - HERO Appendix B: NASA Human Research Program Omnibus Opportunity).
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2021.
Bibliography Type:	Description: (Last Updated: 02/22/2024)