Fiscal Year:	FY 2023	**Task Last Updated:**	FY 02/16/2023
PI Name:	Levine, Benjamin D M.D.		
Project Title:	Coronary Anatomy and Physiology During 1 Year in Space		
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		
PI Email:	benjaminlevine@texashealth.org	**Fax:**	FY 214 345-4618
PI Organization Type:	UNIVERSITY	**Phone:**	214-345-4619
Organization Name:	The University of Texas Southwestern Medical Center at Dallas		
PI Address 1:	Institute for Exercise and Environmental Medicine (IEEM)		
PI Address 2:	7232 Greenville Ave, Suite 435		
PI Web Page:			
City:	Dallas	**State:**	TX
Zip Code:	75231-5129	**Congressional District:**	5
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	2019 HERO 80JSC018N0001-HHCHFBP: Human Health Countermeasures, Human Factors, Behavioral Performance. Appendix D
Start Date:	04/20/2020	**End Date:**	04/19/2034
No. of Post Docs:	2	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NASA JSC
Contact Monitor:	Brocato, Becky	**Contact Phone:**	
Contact Email:	becky.brocato@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date is now 4/19/2034 per HHC element and NSSC information (Ed., 6/21/21)		
Key Personnel Changes/Previous PI:	PI Benjamin D. Levine, MD ; CoI Michael W. Bungo, MD ; CoI Jonathan R. Lindner, MD [Note Linda Loerch is no longer CoI]		
COI Name (Institution):	Bungo, Michael M.D. (University of Texas Health Science Center at Houston) Lindner, Jonathan R. M.D. (Oregon Health & Science University)		
Grant/Contract No.:	80NSSC20K0987		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Since the majority of experienced astronauts are middle aged, they are at risk for developing serious cardiovascular events such as a myocardial infarction or sudden cardiac death, especially during high intensity exertion. Studies led to the current flight medicine practice of screening all astronaut candidates (and following all active crew members) with coronary artery calcium (CAC) scoring. However, atherosclerosis is a progressive process. The development of vascular calcification may be preceded by substantial non-calcified plaque, which may be most prone to rupture and cause an acute coronary syndrome. Radiation and inflammation may exacerbate this natural history. Coronary atherosclerosis impairs coronary endothelial function which can then both initiate and stimulate progression of atherosclerosis. Recent flight studies have suggested that non-coronary vascular beds may stiffen with reduced vascular reserve during 6-month International Space Station (ISS) missions, and ground-based studies have identified the surprising capacity for coronary atherosclerosis to evolve rapidly under extreme stress. In addition, the Principal Investigator (PI) team recently completed the Integrated CardioVascular (ICV) study that demonstrated: a) although cardiac arrhythmias did not increase in space in most astronauts, unexpectedly, left atrial (LA) size increased out of proportion to the changes in left ventricular (LV) size; and b) there was a subset of crew (1/13 or 8%) who had substantial increases in both ventricular and atrial arrhythmias. These data raise the specter of increased risk for atrial fibrillation (AF), the most common arrhythmia in the US which occurs a decade earlier in astronauts than in the general population. We speculate that the combination of spaceflight plus exercise countermeasures could magnify LA dilation and lead to AF during a 2-3 yr Mars mission. AF in astronauts is a particular concern with prolonged spaceflight because of limited access to care and the risk of impaired exercise performance, poorly controlled ventricular response, deterioration of ventricular function, and arterial emboli (including stroke).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Learning more about the natural progression of atherosclerosis in the spaceflight environment may have "spin-off" benefits for characterizing these processes in terrestrial populations. In addition, out exploratory aim in this project is to determine if a blood biomarker panel might be predictive of alterations in the atherosclerotic process. Should this prove useful, the direct benefit to clinical care on Earth would be significant.
Task Progress:	During this past year, the Coronary team has moved inexorably to implementation to flight with multiple informed consent briefings, and practice sessions (“dry and wet runs”) in the NASA Johnson Space Center (JSC) Cardiovascular Lab as well as at the imaging center at Baylor College of Medicine. We have performed baseline data collection on our first subject and consented 2 others. Key accomplishments include: 1). Regular meetings with Complement of Integrated Protocols for Human Exploration Research (CIPHER) team including Research Integration (ROI), JSC Cardiovascular Lab, and the Principal Investigator (PI) teams. 2). Completion of practice dry runs for all aspects of our experiments and demonstrated feasibility and technical readiness. 3). Completion of practice wet runs using volunteers from the JSC Human Subjects Database, demonstrating the team’s ability to accomplish the experiments with high data quality and adherence to timelines. 4). Completed baseline data collection on 1 subject with excellent data quality, and subject satisfaction. Although there were a few hiccups regarding the standardization of pregnancy testing in female subjects, this problem was resolved, and good practices are in place. 5). Refined video presentations for informed consent briefings and presented our part of the CIPHER experiments to multiple crews. Two additional crew members have consented, though one was ultimately withdrawn by NASA. 6). Maintained (Institutional Review Board) IRB approval for all experiments involving multiple modifications. This was a mammoth effort that was ultimately managed smoothly. 7). Posters presented at annual Human Research Program (HRP) meeting with active participation by the investigators.
Bibliography Type:	Description: (Last Updated: 05/20/2025)
Articles in Peer-reviewed Journals	Levine BD, Nicol ED, Davos CH. "Space: The final frontier?" 2022 Aug 5;29(10):1396-1398. https://doi.org/10.1093/eurjpc/zwac125 ; PubMed PMID: 35711101 , Aug-2022
Articles in Peer-reviewed Journals	Roldan P, Ravi S, Hodovan J, Belcik JT, Heitner SB, Masri A, Lindner JR. "Myocardial contrast echocardiography assessment of perfusion abnormalities in hypertrophic cardiomyopathy." Cardiovasc Ultrasound. 2022 Sep 19;20:23. https://doi.org/10.1186/s12947-022-00293-2 ; PubMed PMID: 36117179 PubMed PMID: PMC9484161 , Sep-2022