

Fiscal Year:	FY 2020	Task Last Updated:	FY 09/29/2020
PI Name:	Lee, Stuart M.C. Ph.D.		
Project Title:	Defining the Relation Between Biomarkers of Oxidative and Inflammatory Stress and Atherosclerosis Risk in Astronauts During and After Long-Duration Spaceflight		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
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:	FLIGHT	Solicitation / Funding Source:	2010 Crew Health NNJ10ZSA003N
Start Date:	03/01/2016	End Date:	05/10/2022
No. of Post Docs:	0	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:	0	Monitoring Center:	NASA JSC
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Flight Program:	ISS		
Flight Assignment:	ISS		
Key Personnel Changes/Previous PI:	August 2019 report: Steven Laurie, Ph.D. is CoInvestigator. January 2017: Remove Dr. Rob Ploutz-Snyder as CoInvestigator; Add: Dr. Alan Feiveson as Collaborator.		
COI Name (Institution):	Smith, Scott Ph.D. (NASA Johnson Space Center) Feiveson, Alan Ph.D. (NASA Johnson Space Center) Stenger, Michael (NASA Johnson Space Center) Laurie, Steven Ph.D. (KBR/NASA Johnson Space Center)		
Grant/Contract No.:	Internal Project		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	<p>NOTE: Continuation of "Defining the Relation Between Biomarkers of Oxidative and Inflammatory Stress and Atherosclerosis Risk in Astronauts During and After Long-Duration Spaceflight" ; previous Principal Investigator was Dr. Steven Platts, until March 2016.</p> <p>Atherosclerosis is the major contributor to cardiovascular disease-related morbidity and mortality. Research indicates that many of the risk factors commonly associated with atherosclerosis contribute to endothelial dysfunction, a process which presents early in life before angiographic evidence of disease and precedes the clinical manifestation of many cardiovascular disease-related disorders. In an effort to compensate for the initial risk factor-related disruptions to homeostasis, there is a compensatory upregulation of atheroprotective mechanisms. However, in the absence of appropriate risk factor management, these defense mechanisms may become overwhelmed and less able to reestablish normal function. Key systems that help maintain vascular homeostasis and are susceptible to differential deleterious alterations include those that help balance levels of oxidative and inflammatory stress. New evidence suggests that long-duration spaceflight may promote oxidative and inflammatory stress through mechanisms such as radiation exposure, diet, physical inactivity, and psychological stress. However, there are no data supporting a causal link between biomarkers of oxidative and inflammatory stress and indices of vascular endothelial dysfunction in spaceflight. As such, we proposed to examine the relation between biomarkers of oxidative and inflammatory stress and well-established measures of vascular endothelial dysfunction (flow mediated dilation (FMD)) and carotid intima-media thickness (cIMT) in astronauts before, during, and after long duration spaceflight.</p>
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	<p>It is well known that inflammation is a key contributor to the development of atherosclerosis. There is also emerging work showing the link with oxidative damage. This work may contribute to general clinical science by showing the interactions of multiple stressors in a unique environment (spaceflight).</p>
Task Progress:	<p>INTRODUCTION: Long-duration missions onboard the International Space Station (ISS) and exploration class missions to the Moon, Mars, or a nearby asteroid expose astronauts to increased risk of oxidative and inflammatory damage. Oxidative stress and inflammation may result from a variety of sources, including radiation, psychological stress, reduced physical activity, altered nutritional status, and exposure to oxygen-rich environments, such as during extravehicular activity (space walks). Increased oxidative damage and inflammation accelerate the development of atherosclerosis, and thus could be a long-term health concern for astronauts. The purpose of this investigation is to determine (1) if biomarkers of oxidative and inflammatory stress measured in blood and urine are elevated with spaceflight, (2) if indices of increased atherosclerosis risk are present before, during, and after long duration spaceflight, and (3) if biomarkers of oxidative and inflammatory stress are related to indices of atherosclerosis risk in International Space Station (ISS) astronauts. This was the first study to propose assessing immediate and long-term risk for atherosclerosis using biochemical, structural, and functional measures before, during, immediately after, and up to five years after spaceflight.</p> <p>METHODS: To meet the objectives of the study, 13 astronauts have been studied before, during, and up to 5 years after long duration missions aboard ISS. Levels of oxidative and inflammatory stress biomarkers, some of which we have previously shown to be elevated with spaceflight, were measured from blood and urine samples taken before, during, and after spaceflight. Arterial structure have been assessed before, during, and after spaceflight using measures of carotid artery wall thickness, while arterial function will be measured in the brachial artery before flight and after landing. Increased carotid artery wall thickness and decreased brachial artery function, measured using standard clinical ultrasound, are well-established indices of atherosclerosis risk.</p> <p>RESULTS: While biomarkers of oxidative stress and inflammation are elevated during spaceflight, arterial structure and function were not changed by spaceflight. Biomarkers of oxidative stress and inflammation increased during spaceflight but most returned to preflight levels within 1 week after landing. Common carotid artery intima-media thickness, stiffness, and distensibility were not different than preflight at any time. As a group, neither mean endothelium-dependent nor -independent vasodilation changed from pre- to postflight. It is unclear whether future exploration missions, with an extended duration in altered gravity fields and increased radiation exposure may be problematic.</p> <p>DISCUSSION: Here we report no significant change in common carotid and brachial arterial structure and function in 13 astronauts participating in long-duration spaceflights aboard the ISS. In general, biomarkers of inflammation and oxidative stress were elevated during the mission, but returned to preflight levels within a week of landing. Further, we examined the relation between the arterial adaptations to spaceflight in individual astronauts and some key biomarkers associated with cardiovascular disease risk and vascular remodeling. In this healthy population of middle-aged astronauts, we found only a weak association between changes in high sensitivity- CRP (Cardiac Rhythm Problems) and carotid artery changes within subjects. Spaceflight-induced changes in endothelium-independent vasodilation, in particular, were related to changes in some of the biomarkers of oxidative stress.</p>
Bibliography Type:	<p>Description: (Last Updated: 02/22/2024)</p>
Abstracts for Journals and Proceedings	<p>Lee SMC, Ribeiro LC, Martin DS, Smith SM, Zwart SR, Laurie SS, Macias BR, Stenger MB. "Defining the Relationship between Biomarkers of Oxidative and Inflammatory Stress and the Risk for Atherosclerosis in Astronauts during and after Long-Duration Spaceflight." 2020 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 27-30, 2020.</p> <p>Human Research Program Investigators' Workshop, Human Exploration Small Steps Lead to Giant Leaps: Translating Research into Space Exploration. 2020 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 27-30, 2020. , Jan-2020</p>
Articles in Peer-reviewed Journals	<p>Lee SMC, Ribeiro LC, Martin DS, Zwart SR, Feiveson AH, Laurie SS, Macias BR, Crucian BE, Krieger S, Weber D, Grune T, Platts SH, Smith SM, Stenger MB. "Arterial structure and function during and after long-duration spaceflight." J Appl Physiol (1985). 2020 Jul 1;129(1):108-23. https://doi.org/10.1152/jappphysiol.00550.2019 ; PMID: 32525433 , Jul-2020</p>