Fiscal Year:	FY 2022	**Task Last Updated:**	FY 11/29/2021
PI Name:	Bailey, Susan M. Ph.D.		
Project Title:	Telomeres and the One Year Mission Project		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SR**:Space Radiation		
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:	susan.bailey@colostate.edu	**Fax:**	FY 970-491-7742
PI Organization Type:	UNIVERSITY	**Phone:**	970-491-2944
Organization Name:	Colorado State University		
PI Address 1:	Environmental and Radiological Health Sciences		
PI Address 2:	1618 Campus Delivery		
PI Web Page:			
City:	Fort Collins	**State:**	CO
Zip Code:	80523-1618	**Congressional District:**	2
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	01/31/2019	**End Date:**	01/30/2026
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:	1	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NASA JSC
Contact Monitor:	Elgart, Robin	**Contact Phone:**	281-244-0596 (o)/832-221-4576 (m)
Contact Email:	shona.elgart@nasa.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Jeevarajan, Antony Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	80NSSC19K0434		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The ultimate goal of the studies proposed here is to establish temporal profiles of human telomere length dynamics and DNA damage responses of importance for maintenance of human health and performance during long-duration deep space missions. We hypothesize that telomere length dynamics (changes over time) represent a particularly relevant and informative biomarker of health for the astronauts, as it reflects the combined experiences and exposures encountered during spaceflight. That is, an astronaut's individual genetic susceptibilities, unique lifestyle stresses encountered (e.g., nutritional, psychological, physical), and particular environmental exposures (e.g., altered atmospheres, microgravity, space radiations) are all integrated and captured as changes in telomere length. Thus, the rate at which telomeres shorten provides a general measure of health that can be linked to aging, as well as to risk of developing age-related pathologies, ranging from reduced immune function and dementia, to cardiovascular disease and cancer. Importantly, functional telomeres are also essential for maintaining genomic integrity and stability, as they protect chromosomal termini from inappropriate degradation, and prevent these natural DNA ends from being recognized as broken DNA and triggering inappropriate DNA damage responses (DDRs). To identify trends in adaptations to human health and performance during long-duration low-Earth orbit, we propose telomere length and DDR/cytogenetic measures pioneered and validated in the NASA Twins Study/first One Year Mission, across the Integrated One-Year Mission Project onboard the International Space Station and the concurrent ground analog (prolonged isolation) component.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Identifying interactive effects of genetic and nongenetic telomere length determinants and DDRs will improve understanding of aging and aging trajectories (disease risk), as well as guide future studies and development of potential strategies for improving health-span, not only in astronauts on long-duration missions, but for those on Earth, too.
Task Progress:	To date, and taken together, our results suggest that chronic low-dose, low-dose rate exposure to the space radiation environment contributes to the changes in telomere length dynamics and DDRs observed. Chronic oxidative stress correlated with telomere length dynamics and damaged telomeres, and heterogeneous telomere lengths, were consistent with transient activation of ALT (telomerase independent telomere length maintenance mechanism). Cytogenetic analyses revealed direct evidence of IR (irradiation)-induced DNA damage (chromosome abnormalities) during spaceflight (inversions, satellite associations), some of which persisted after spaceflight (inversions). Reduced white blood cell counts correlated with radiation dose, reflective of lymphocyte radiosensitivity (cell killing), and suggestive of redistribution of leukocyte subsets as previously reported. Thus, changing cell population dynamics in response to chronic space radiation exposure may be at least partially responsible for our observations. Telomeres 2 will further explore and validate these foundational results, as well as provide critical mechanistic insight necessary for better understanding potential adverse health and/or aging impacts of long-duration spaceflight.
Bibliography Type:	Description: (Last Updated: 04/25/2024)
Articles in Peer-reviewed Journals	Cornforth MN, Bedford JS, Bailey SM. "Destabilizing effects of ionizing radiation on chromosomes: Sizing up the damage." Cytogenet Genome Res. 2021 Sep;161(6-7):328-51. Review. https://doi.org/10.1159/000516523 ; PMID: 34488218 , Sep-2021
Articles in Peer-reviewed Journals	Grigorev K, Foox J, Bezdan D, Butler D, Luxton JJ, Reed J, McKenna MJ, Taylor L, George KA, Meydan C, Bailey SM, Mason CE. "Haplotype diversity and sequence heterogeneity of human telomeres." Genome Res. 2021 Jul;31(7):1269-79. https://doi.org/10.1101/gr.274639.120 ; PMID: 34162698; PMCID: PMC8256856 . , Jul-2021
Articles in Peer-reviewed Journals	Luxton JJ, Bailey SM. "Twins, telomeres, and aging-in space!" Plast Reconstr Surg. 2021 Jan 1;147(1S-2S):7S-14S. https://doi.org/10.1097/PRS.0000000000007616 ; PMID: 33347069 , Jan-2021
Articles in Peer-reviewed Journals	Cunningham K, Hinton TG, Luxton JJ, Bordman A, Okuda K, Taylor LE, Hayes J, Gerke HC, Chinn SM, Anderson D, Laudenslager ML, Takase T, Nemoto Y, Ishiniwa H, Beasley JC, Bailey SM. "Evaluation of DNA damage and stress in wildlife chronically exposed to low-dose, low-dose rate radiation from the Fukushima Dai-ichi Nuclear Power Plant accident." Environ Int. 2021 Oct;155:106675. Epub 2021 Jun 10. https://doi.org/10.1016/j.envint.2021.106675 ; PMID: 34120002 , Oct-2021
Articles in Peer-reviewed Journals	Nelson CB, Alturki TM, Luxton JJ, Taylor LE, Maranon DG, Muraki K, Murnane JP, Bailey SM. "Telomeric double strand breaks in G1 human cells facilitate formation of 5' C-rich overhangs and recruitment of TERRA." Front Genet. 2021 Mar 25;12:644803. https://doi.org/10.3389/fgene.2021.644803 ; PMID: 33841503; PMCID: PMC8027502 , Mar-2021