Fiscal Year:	FY 2020	**Task Last Updated:**	FY 12/26/2019
PI Name:	Bouxsein, Mary Ph.D.		
Project Title:	Dose-Response Study of Musculoskeletal Outcomes Following Centrifugation in Adult Mice on ISS		
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) **Bone Fracture**:Risk of Bone Fracture due to Spaceflight-induced Changes to Bone (2) **Muscle**:Risk of Impaired Performance Due to Reduced Muscle Size, Strength and Endurance (3) **Osteo**:Risk Of Early Onset Osteoporosis Due To Spaceflight		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	02215-5400	**Congressional District:**	7
Comments:			
Project Type:	FLIGHT,GROUND	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	02/14/2019	**End Date:**	12/15/2020
No. of Post Docs:	1	**No. of PhD Degrees:**	
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
Contact Monitor:	Norsk, Peter	**Contact Phone:**	
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Flight Program:	ISS		
Flight Assignment:	NOTE: End date changed to 12/15/2020 per NSSC information (Ed., 7/24/20)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Farber, Charles Ph.D. (University of Virginia, Charlottesville) Ferguson, Virginia Ph.D. (University of Colorado, Boulder) Rutkove, Seward M.D. (Beth Israel Deaconess Medical Center, Inc.) Willey, Jeffrey Ph.D. (Wake Forest University)		
Grant/Contract No.:	80NSSC19K0534		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Mechanical loading is required for maintenance of the musculoskeletal system. Thus, exposure to spaceflight or reduced mechanical loading on Earth induces marked bone loss, muscle atrophy, and degradation of soft-tissue structures in both the knee (e.g., cartilage, menisci, and ligaments) and hip (e.g., cartilage) joints. This is a major concern for astronauts during and after long-duration spaceflight, as they may be at increased risk for reduced performance, bone fractures, and both early-onset osteoporosis and arthritis. Artificial gravity, via centripetal acceleration, is a possible approach to mitigate these deleterious changes. Yet, the ability of partial gravity induced by centripetal acceleration to inhibit adverse musculoskeletal changes in spaceflight remains unknown. Given the constraints of studying centrifugation as a countermeasure on Earth, spaceflight-based studies are needed. We propose to determine the effects of varying partial gravity levels on bone, muscle, and soft tissues of the hip and knee joints in adult mice flown aboard the International Space Station (ISS) in the Japan Aerospace Exploration Agency (JAXA) Mouse Habitat Unit. We will examine bone structure post-flight using high-resolution microcomputed tomography (microCT); bone cellularity using quantitative histomorphometry; bone function via biomechanical testing and nano-indentation; and bone composition via Raman spectroscopy and quantitative backscattered electron imaging. We will examine neuromuscular function via pre- and post-flight Rotorod testing, gait analysis, and grip strength measurements. Post-flight muscle analyses will include histology and electrical impedance myography. Post-flight analyses of joint soft-tissues will include structural measurements of cartilage, menisci, and ligaments using both contrast-enhanced high-resolution microCT and histology; molecular composition of cartilage and menisci using proteomics and Raman spectroscopy; and biomechanical properties of cartilage using nano-indentation. Cellular and molecular responses for bone, muscle, and joint soft tissues will also be evaluated via whole transcriptome analyses (e.g., RNASeq). Results from these integrated, comprehensive analyses will provide information regarding whether partial gravity, either induced by centripetal acceleration or via Moon or Mars environments, will protect from musculoskeletal deterioration during spaceflight, or whether additional countermeasures will be necessary.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	A better understanding of the effects of different levels of mechanical loading via centrifugation on the musculoskeletal system may inform interventions and rehabilitation protocols for individuals exposed to chronic immobilization or unloading.
Task Progress:	We have generated a combined study protocol with 3 principal investigators, and have also considered how to make the study protocol work with the objectives and requirements of our Japan Aerospace Exploration Agency (JAXA) colleagues.
Bibliography Type:	Description: (Last Updated: 02/21/2024)