Fiscal Year:	FY 2023	**Task Last Updated:**	FY 04/14/2023
PI Name:	Adler, Robert M.D.		
Project Title:	Magnetic Resonance Imaging (MRI) to Assess Changes to Trabecular Microarchitecture of the Hip		
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		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	23249-0001	**Congressional District:**	4
Comments:	Contact Co-PI email for communications.		
Project Type:	GROUND	**Solicitation / Funding Source:**	2021 HERO NNJ21ZSA001N-FLAGSHIP, Appendix A: NASA Research and Technology Development to Support Crew Health and Performance in Space Exploration Missions
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Flight Program:			
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Task Description:	Background: Studies of bone loss in International Space Station (ISS) astronauts, using quantitative computed tomography (QCT) of the hip and spine and high-resolution-peripheral QCT (HRpQCT) of the lower leg, describe loss of trabecular bone mineral density (Trb vBMD) that is not detectable by the clinical test for osteoporosis (Op), i.e., dual-energy X-ray absorptiometry (DXA) areal bone mineral density (aBMD). Both QCT and HRpQCT revealed losses in Trb vBMD immediately following long duration (LD) spaceflight and continuing in some individuals even after recovery periods of a year or more. We reported rapid rates of spaceflight hip QCT Trb vBMD loss, relative to terrestrial aging rates. In a pilot study, hip QCT showed lack of recovery of hip Trb vBMD to baseline in 4 of 10 astronauts evaluated 2 years after return to Earth. Analyses of serum and urine collected during spaceflight showed significant in-flight elevation of bone resorption (BR) markers in the 4 astronauts who did not recover Trb vBMD vs. the 6 astronauts who did; a biomarker for bone formation (BF) remained unchanged until ~120 days into the flight. Biochemical assays consistently show BR exceeding BF during spaceflight, accounting for a rapid loss of Trb vBMD, which could also increase the risk for disrupted trabecular connectivity. While the efficacy of an oral bisphosphonate to mitigate spaceflight bone loss has been substantiated in an astronaut flight study, there is reduced willingness in some stakeholders to use a pharmaceutical countermeasure. Hence, there is a concern for the risk of irreversible losses in trabecular connectivity in the absence of an anti-resorptive countermeasure. Such trabecular disruptions are associated with skeletal fragility and fractures in other populations undergoing bone loss but have not been characterized in astronaut hips because of prohibitive radiation exposures needed for high-resolution imaging of deeply embedded bone. HRpQCT has low radiation and sufficient resolution to study microarchitecture, but only for peripheral sites such as the lower leg and wrist. Hence, it is critical to apply a technology with no ionizing radiation such as magnetic resonance imaging (MRI) to safely define the effect size of spaceflight on hip trabecular microarchitecture. Hypothesis: A 3-Tesla (3T) MRI scanning protocol can detect changes in hip trabecular microarchitecture, some of which could be irreversible, with prolonged skeletal unloading after spinal cord injury (SCI). Specific Aims: 1) Identify and consent individuals with SCI to assess the effects of prolonged unloading to the hip; 2) Apply a previously-validated 3T MRI protocol to characterize serial changes in hip trabecular microarchitecture of SCI subjects at 3-, 6-, 12-, and 24-mo following injury; and 3) Compare the ability of 3T MRI to discriminate loss of trabecular connectivity between subjects with SCI (Aim 1) and age- and sex-matched ambulatory controls. Methods: Use off-the-shelf equipment (coils) and an MRI method, previously used to study microarchitectural changes with steroid-induced bone loss, to evaluate individuals with SCI (from a pool of 800 veterans with SCI served by McGuire VA Medical Center) to verify the detection of disruptions to microarchitecture with skeletal unloading. Able-bodied military personnel will serve as controls to determine if the SCI disuse condition can be used as a ground-based analog of LD spaceflight to correlate spaceflight duration with changes in hip microarchitecture. Deliverables: A 3T MRI protocol to perform pre-and postflight measurements in astronauts. Significance: Characterization Gap: Changes to trabecular microarchitecture associated with rapid bone loss and with skeletal fragility and fractures will be described in LD astronauts. HRR Gaps: "Osteo 3: we need a validated clinically relevant method for assessing the effect of spaceflight on Op or fracture risk in LD astronauts" and "Osteo 6: How do skeletal changes due to spaceflight modify the terrestrial risk of osteoporotic fractures?"
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2023.
Bibliography Type:	Description: (Last Updated:)