Fiscal Year:	FY 2010	**Task Last Updated:**	FY 06/03/2010
PI Name:	Amin, Shreyasee M.D.		
Project Title:	Epidemiologic Analyses of Risk Factors for Bone Loss and Recovery Related to Long Duration Space Flight		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
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) **Osteo**:Risk Of Early Onset Osteoporosis Due To Spaceflight		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	amin.shreyasee@mayo.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	507-284-4277
Organization Name:	Mayo Clinic College of Medicine		
PI Address 1:	200 First Street SW		
PI Address 2:			
PI Web Page:			
City:	Rochester	**State:**	MN
Zip Code:	55905	**Congressional District:**	1
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
Start Date:	08/01/2008	**End Date:**	07/31/2012
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
Contact Monitor:	Norsk, Peter	**Contact Phone:**	
Contact Email:	Peter.norsk@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 7/31/2012 per C. Guidry/JSC (2/7/2011) NOTE: Period of performance changed to 8/1/2008-7/31/2011 (from 5/20/08-5/19/11) per C. Guidry/JSC (3/2010)		
Key Personnel Changes/Previous PI:	None in past year.		
COI Name (Institution):	Khosla, Sundeep (Mayo Clinic) Sibonga, Jean (USRA)		
Grant/Contract No.:	NNX08AQ20G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Bone loss is estimated to occur at a rate of 1% per month in space (microgravity), particularly in weight-bearing bones in the legs and spine. This rate of loss is equivalent to what we might lose in a year with advancing age on Earth. It remains unknown what this loss signifies for future fracture risk in crewmembers. While unloading of the skeleton in the weightless environment of space is considered the key factor contributing to bone loss, there are likely other factors that also play a role. Current prevention strategies have not been effective at preventing this bone loss. Improved understanding on the risk for fracture following long-duration space flight, as well as the factors contributing to bone loss in microgravity, and its recovery, are needed in order to develop better prevention strategies for the benefit of crew health, both during and after long-duration space exploration, and mission success. The proposed research will take advantage of an established population-based cohort, which includes men and women of an age range similar to crewmembers in the US space program, who have had bone density measured over time. We will make comparisons between bone densities of crewmembers and the population-based data and use fracture prediction models derived from the cohort to make estimations on fracture risk among crewmembers. We will also explore the data already gathered to date during the US human space program in order to summarize the current state of evidence available on additional risk factors related to bone loss and recovery in microgravity. The ultimate goal of this research proposal is to provide evidence-based information which may assist in guiding the direction of further research required to better understand the risk of bone loss and fracture among crewmembers and the strategies that could be developed to prevent it from occurring.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This work will help establish the occupational risk of short and long-duration microgravity exposure on longterm bone health consequences among US crewmembers. It will also serve to provide a comprehensive summary of the current evidence available on risk factors related to bone loss and recovery among US crew members following long-duration space flight.
Task Progress:	I. SPECIFIC AIMS: AIM 1: To investigate the risk of microgravity exposure on long-term changes in bone health and fracture risk. AIM 2: To provide a summary of the current evidence available on potential risk factors for bone loss, recovery and fracture following long-duration space exploration. II. SUMMARY OF WORK RELATED TO AIMS: A. Overview of Year 2 During this second year of funding, NASA-JSC colleagues have been assembling the bone density datasets for all remaining US crewmembers and consenting the approximate 250 men and women in the US space program, who have had at least one bone density measured. At NASA-JSC, comprehensive risk factors known to be related to bone health are also being assembled and work is ongoing. At Mayo, data analyses for Aim 1 have been initiated with respect to the bone density data available on long-duration crewmembers. Fracture prediction models have also been developed using data on risk factors available in both US long-duration crewmembers and in the Mayo cohort. Initial data cleaning and exploratory work for Aim 2 has begun based on risk factor data available and shared to date, although complete datasets on risk factors (e.g., ,bone turnover markers, lean muscle mass, personal and family history of fractures, medication use, etc) are still being assembled. B. Progress Related to AIM 1: To investigate the risk of microgravity exposure on long-term changes in bone health and fracture risk. . Informed consent has been achieved in all 32 US crewmembers (26 men, 7 women; age range: 37-54 years) who have flown on at least one long-duration space mission (100% participation rate). To date, we have obtained informed consent on 123 (53%) of the 232 remaining US crewmembers (21/36 women and 102/196 men) who have had at least one bone density measurement available. The consenting process is ongoing. 3 have declined and 3 are lost to follow-up. Bone density datasets for all long-duration crewmembers have been assembled and cleaned. Bone density datasets for the remaining US crewmembers are still being assembled at NASA-JSC. We anticipate that NASA-JSC colleagues will have consenting status complete and bone density datasets assembled and ready to share with Mayo investigators, for those who have consented, by the end of the second year of funding. i) Creation of a bone mineral density (BMD) prediction model using the Mayo cohort: We have created age- and gender-expected prediction models for BMD derived from 348 men (age range at baseline: 22-90 years) and 351 women (range: 21-93 years) representing an age-stratified, random sample of the adult community population (Mayo Rochester Bone Health Study cohort) and who have had longitudinal BMD measurements at identical sites to the US crewmembers. We then applied the created prediction models to the NASA cohort of long-duration US crewmembers. Based on our models, the BMD at all sites immediately post-flight in US crewmembers were all significantly lower than would be expected. We did observe a unique finding of greater than expected loss of BMD in some upper arm sites which raises the possibility of other risk factors contributing to bone loss during space flight unrelated to mechanical unloading, but is being further explored. There were also observed differences between men and women which warrant further exploration, and that will be addressed in analyses related to Aim 2. Preliminary work also reveal that following 6-18 months post-flight, BMD at most sites in US long-duration crewmembers is becoming closer to the expected values. However, the hip BMD still is significantly lower than expected at 1 year post-flight. ii) Creation of a fracture prediction model using the Mayo cohort: Fracture prediction models were also created using the Mayo Rochester Bone Health Study cohort, separately for men and women who were at least age 35. Fracture predictions for 5 and 10 years following the BMD measurement were estimated for immediate pre-flight, immediate post-flight and ~1 year post-flight BMD. We are currently conducting

	further analyses towards improvement of these models before final interpretation. C. Progress Related to AIM 2: To provide a summary of the current evidence available on potential risk factors for bone loss, recovery and fracture following long-duration space exploration. Data assembly at NASA-JSC on risk factors known to be related to bone loss and fracture risk is ongoing. We will use these data to help better understand the variability in BMD loss and recovery, post-flight. Risk factor data include, but are not limited to, medication use, personal and family history of fractures, bone turnover markers, and surrogates of exercise status in-flight, such as changes in strength measures, VO2 max and lean muscle mass. Data assembly and cleaning is ongoing. Exploratory descriptive analyses are being conducted on data available. Observed differences between men and women in Aim 1 will also be explored further by examining the role of different risk factors on bone loss.
Bibliography Type:	Description: (Last Updated: 07/01/2019)
Articles in Peer-reviewed Journals	Amin S. "Mechanical factors and bone health: Effects of weightlessness and neurologic injury." Current Rheumatology Reports. 2010 Jun;12(3):170-6. Review. PMID: 20425519 , Jun-2010