Fiscal Year:	FY 2011	**Task Last Updated:**	FY 06/02/2011
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		
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Zip Code:	55905	**Congressional District:**	1
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
Start Date:	08/01/2008	**End Date:**	07/31/2013
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:	Baumann, David	**Contact Phone:**	
Contact Email:	david.k.baumann@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 7/31/2013 per NSSC information (Ed., 7/16/2012) 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:	Dr. Sundeep Khosla was removed from the study in the fall of 2010.		
COI Name (Institution):	Sibonga, Jean (NASA-Johnson Space Center)		
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 U.S. 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 U.S. crewmembers following long-duration space flight.
Task Progress:	Overview of Year 3 As investigators external to NASA, we have encountered several different data access issues which have posed a challenge to progress on work over the years. We continue to work with our collaborators at NASA to identify ways to overcome these challenges in order to make progress on analyses. During this third year of funding, NASA-JSC colleagues have completed assembly of the bone density datasets for U.S. crewmembers who have consented to the study. At NASA-JSC, comprehensive risk factors known to be related to bone health are being assembled and work is ongoing. At Mayo, data analyses for Aim 1 have progressed on bone density changes in both short and long-duration crewmembers. Fracture prediction models have been developed using the Mayo cohort. Data cleaning and exploratory work for Aim 2 is ongoing based on risk factor data available, but some data is still being assembled. 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 now been achieved in all 36 U.S. crewmembers (28 men, 8 women) who have flown on at least one long-duration space mission on Mir or ISS and had a postflight bone density measured as of December 2010 (100% participation rate). We have also obtained informed consent on U.S. crewmembers (26 women and 158 men) who have flown on a short-duration mission and had at least one bone density measurement available as of December 2010 (85% participation rate). We created age- and gender-expected prediction models for bone mineral density (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 U.S. crewmembers. We have applied the created prediction models to the NASA cohort of long-duration U.S. crewmembers. Based on our prediction models, following 6-18 months after returning from a long-duration flight, BMD at most sites was still lower than predicted in men. However, in women BMD at all sites was not significantly different than what would be predicted. In additional analyses in men extending follow-up to 3 years after return from a long-duration flight, BMD at most sites was now closer to predicted except for the hip where it was still significantly lower than predicted. Preliminary results have been presented within this past year at national meetings of the American Society of Bone and Mineral Research, American College of Rheumatology, and the International Academy of Astronautics. In analyses involving U.S. crew who have only served on short-duration missions in space, we found that men who had longer cumulative days in space had lower bone density at the spine but not other sites. In women, we found no significant association between BMD, at any site, and duration of space exposure. These initial results therefore suggest that there may not be any long-term negative effects of short duration spaceflight on bone density in women or, at most sites, in men. Our preliminary findings were presented at the annual meeting of the Aerospace Medical Association. 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, bone turnover markers, and surrogates of exercise status in-flight, such as changes in strength measures, and lean muscle mass. Data assembly and cleaning is ongoing. Exploratory descriptive analyses are being conducted on data available.
Bibliography Type:	Description: (Last Updated: 07/01/2019)

Abstracts for Journals and Proceedings	Amin S, Achenbach SJ, Atkinson EJ, Melton LJ, Khosla S, Sibonga J. "Bone Density Following Long-Duration Spaceflight and Recovery." Presented at the 2010 American Society of Bone and Mineral Research Annual Meeting; Toronto, Ontario, Canada, October 15-19,2010. J Bone Miner Res 2010 Sep;25(Suppl 1):SA0319. Available at: http://www.asbmr.org/Meetings/AnnualMeeting/AbstractDetail.aspx?aid=d5b1d514-89d3-44a4-add2-44aadefbfd3a ; accessed 6/02/2011. , Sep-2010
Abstracts for Journals and Proceedings	Amin S, Achenbach SJ, Atkinson EJ, Melton LJ, Khosla S, Sibonga J. "Bone Density Following Long-Duration Spaceflight and Recovery." Presented at the 74th Annual Scientific Meeting of the American College of Rheumatology, Atlanta, Georgia, November 6-11, 2010. Arthritis & Rheumatism 2010 Oct;62(10 Suppl):S398 (abstract #959). http://www.rheumatology.org/education/annual/FinalAbstract2010.pdf , Oct-2010
Abstracts for Journals and Proceedings	Amin S, Achenbach SJ, Atkinson EJ, Sibonga JD. "Bone Density Following Three Years of Recovery from Long-Duration Space Flight." Presented at the 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. 18th IAA Humans in Space Symposium, Houston, TX, April 11-15, 2011. , Apr-2011
Abstracts for Journals and Proceedings	Amin S, Achenbach SJ, Atkinson EJ, Khosla S, Sibonga JD. "Does Short-Duration Space Flight Have a Negative Effect on Bone Density?" Presented at the 82nd Annual Scientific Meeting of the Aerospace Medical Association, Anchorage, Alaska, May 8-12, 2011. Aviation, Space, and Environmental Medicine. 2011 Mar;82(3):266 (abstract #189). , Mar-2011
Significant Media Coverage	Amin S, Achenbach SJ, Atkinson EJ, Melton LJ, Khosla S, Sibonga J. "Press release on abstract, 'Bone Density Following Long-Duration Spaceflight and Recovery,' presented at the 74th Annual Scientific Meeting of the American College of Rheumatology." Press release, 74th Annual Scientific Meeting of the American College of Rheumatology, November 2011., Nov-2011