Fiscal Year:	FY 2015	**Task Last Updated:**	FY 07/02/2019
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:**	11/30/2016
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:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: End date showing as 11/30/2016 per NSSC information (Ed., 5/3/17) NOTE: Extended to 7/31/2016 per NSSC information (Ed., 4/19/16) NOTE: Extended to 7/31/2015 per J. Sibonga/JSC and NSSC information (Ed., 7/16/14) NOTE: Risk/Gap changes per IRP Rev E (Ed., 3/14/14) NOTE: End date is 7/31/2014, per NSSC information (Ed., 8/9/13) 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 Ph.D. (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 U.S. 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 U.S. 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:	[Ed. note: compiled in July 2019 from PI report submitted to JSC Human Research Program in 2015 covering period through July 2015. Note also that some publications after July 2015 have been added to Bibliography section in case no further report received.] 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. Overview of Findings Related to AIM 2 (Ed. note 7/1/19: see FY2013 report for AIM 1 findings): 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-Johnson Space Center (JSC) on risk factors known to be related to bone loss and fracture risk was completed in early 2012. We have now performed analyses on these available data to help better understand the variability in hip bone mineral density (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 data cleaning were completed. We noted that there were limited data on risk factors available beyond the initial return post long-duration flights, so analyses are restricted to the immediate post-flight period. Following review of all the different measures available for analyses, we identified several different risk factors which may help identify those at greatest risk for bone loss during long-duration missions. These included pre-flight measures of elevated bone resorption, as well as surrogate markers of better muscle strength and greater aerobic capacity pre-flight. Our results suggest that individuals with high bone resorption markers preflight may benefit most from anti-resorptive therapy before a long-duration mission. Our findings also suggest that those who are the most physically fit preflight may have bones that have adapted to greater than average loading stimuli and therefore may be more susceptible to enhanced bone resorption once unloaded in microgravity, reinforcing the importance of maintaining adequate physical conditioning during long-duration spaceflight. Of note, our results are from data largely prior to US crewmembers having access to the advanced resistive exercise device (ARED), which may have helped overcome this important risk factor. Manuscripts are in preparation summarizing our findings for peer-reviewed publication. Abstracts relating to preliminary analyses from this work have been presented at the annual meetings of the American Society of Bone and Mineral Research, American College of Rheumatology, International Academy of Astronautics Humans in Space Symposium, Aerospace Medical Association.
Bibliography Type:	Description: (Last Updated: 07/01/2019)
Articles in Peer-reviewed Journals	Farr JN, Melton LJ 3rd, Achenbach SJ, Atkinson EJ, Khosla S, Amin S. "Fracture incidence and characteristics in young adults aged 18 to 49 years: A population-based study." J Bone Miner Res. 2017 Dec;32(12):2347-54. Epub 2017 Oct 3. https://doi.org/10.1002/jbmr.3228 ; PubMed PMID: 28972667; PubMed Central PMCID: PMC5732068 , Dec-2017
Articles in Peer-reviewed Journals	Michalski AS, Amin S, Cheung AM, Cody DD, Keyak JH, Lang TF, Nicolella DP, Orwoll ES, Boyd SK, Sibonga JD. "Hip load capacity cut-points for Astronaut Skeletal Health NASA Finite Element Strength Task Group Recommendations." NPJ Microgravity. 2019 Mar 14;5:6. eCollection 2019. https://doi.org/10.1038/s41526-019-0066-3 ; PubMed PMID: 30886891; PubMed Central PMCID: PMC6418107 , Mar-2019