Fiscal Year:	FY 2016	**Task Last Updated:**	FY 04/24/2018
PI Name:	Smith, Scott M Ph.D.		
Project Title:	Dietary Intake Can Predict and Protect Against Changes in Bone Metabolism During Space Flight and Recovery (Pro-K)		
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) **Food and Nutrition**:Risk of Performance Decrement and Crew Illness Due to Inadequate Food and Nutrition (2) **Nutrition**:Risk of Inadequate Nutrition (3) **Renal Stone**:Risk of Renal Stone Formation		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	NASA CENTER	**Phone:**	281-483-7204
Organization Name:	NASA Johnson Space Center		
PI Address 1:	Biomedical Research and Environmental Sciences Division/SK3		
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PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
Start Date:	07/01/2008	**End Date:**	08/31/2016
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:	Villarreal, Jennifer	**Contact Phone:**	281-483-7306
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Flight Program:	Shuttle/ISS		
Flight Assignment:	ISS ; STS-133 NOTE: End date changed to 8/31/2016 per PI (Ed., 4/7/15) NOTE: End date is 8/31/2015 per PI and T. Goodwin/JSC (Ed., 6/22/2011) NOTE: period of performance changed back to 7/1/2008-6/30/2011 per JSC info (4/2009) NOTE: period of performance changed to 8/1/2008-9/30/2011 per B. Corbin/JSC (3/2009)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Shackelford, Linda M.D. (NASA Johnson Space Center) Zwart, Sara Ph.D. (Universities Space Research Association/NASA JSC) Heer, Martina Ph.D. (University of Bonn)		
Grant/Contract No.:	Internal Project		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Bone loss is not only well documented among astronauts during space flight, but it is a condition that also affects millions of men and women on Earth each year. Many countermeasures have been proposed, and evaluated to several degrees of completion. To date, those showing potential have focused on either exercise or pharmacological interventions, but none have specifically investigated dietary intake alone as a factor to predict or minimize bone loss during space flight. We propose to document how the ratio of acid to base precursors in the diet is related to directional changes in markers of bone resorption and formation during flight and recovery from flight. There is a high likelihood for success in predicting the extent of bone loss from dietary intake patterns among astronauts during space flight given that this concept is strongly anchored in previous ground-based data from our laboratory and others. The notion of manipulating diet to minimize bone loss could also have significant social and economic impacts for NASA and for the general public -- especially given the increasing trends for diets that are high in animal protein and low in fruits and vegetables. The proposed experiments will evaluate a dietary countermeasure for bone loss that has no associated risks for side effects, no requirement for payload mass, and no additional crew time necessary during flight.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This protocol will provide valuable data that will contribute to understanding and counteracting the bone loss of weightlessness -- and more importantly will provide a dietary countermeasure to mitigate space flight-induced bone loss that does not have any associated risks for side effects, requires no payload mass, and will not require any additional crew time. In addition, the knowledge gained will have a significant impact on the general public, who has become accustomed to high-protein diets.
Task Progress:	The study is complete. Seventeen astronauts completed the inflight and postflight protocols. Samples were returned from ISS (International Space Station) on Shuttle flights in 2011 on STS-133, 134, and 135, and on SpaceX missions 1-5. Data have been presented at the Human Research Program Investigator Workshop in 2012, 2015, and 2018, and at the Experimental Biology meeting in April 2012 and March 2015. The data have been published in the American Journal of Clinical Nutrition. Advanced publication expected soon (proofs were returned in March 2018).
Bibliography Type:	Description: (Last Updated: 05/24/2023)
Abstracts for Journals and Proceedings	Zwart SR, Rice BL, Dlouhy H, Shackelford LC, Heer M, Koslovsky M, Smith SM. "Dietary acid load and bone turnover during long-duration spaceflight and bed rest." 2018 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 22-25, 2018. 2018 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 22-25, 2018. , Jan-2018
Articles in Peer-reviewed Journals	Zwart SR, Rice BL, Dlouhy H, Shackelford LC, Heer M, Koslovsky M, Smith SM. "Dietary acid load and bone turnover during long-duration spaceflight and bed rest." Am J Clin Nutr. 2018 May 1;107(5):834-44. https://doi.org/10.1093/ajcn/nqy029 ; PubMed PMID: 29722847 , May-2018
Articles in Peer-reviewed Journals	Smith SM, Heer M, Shackelford LC, Sibonga JD, Spatz J, Pietrzyk RA, Hudson EK, Zwart SR. "Bone metabolism and renal stone risk during International Space Station missions." Bone. 2015 Dec;81:712-20. Epub 2015 Oct 8. https://doi.org/10.1016/j.bone.2015.10.002 ; PubMed PMID: 26456109 , Dec-2015
NASA Technical Documents	Smith SM, Zwart SR, Douglas GL, Heer M. "Human adaptation to spaceflight: The role of food and nutrition. Second edition." Houston, TX: NASA Lyndon B. Johnson Space Center, 2021. 255 p. NP-2021-03-003-JSC. https://www.nasa.gov/sites/default/files/atoms/files/human_adaptation_2021_final.pdf , Apr-2021