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| **Fiscal Year:** | FY 2015 | **Task Last Updated:** | FY 03/31/2015 |
| **PI Name:** | Smith, Scott M Ph.D. | | |
| **Project Title:** | Nutritional Status Assessment: SMO 016 | | |
| **Division Name:** | Human Research | | |
| **Program/Discipline:** | HUMAN RESEARCH | | |
| **Program/Discipline--Element/Subdiscipline:** | HUMAN RESEARCH--Biomedical countermeasures | | |
| **Joint Agency Name:** | | **TechPort:** | No |
| **Human Research Program Elements:** | (1) **HHC**:Human Health Countermeasures | | |
| **Human Research Program Risks:** | (1) **Immune**:Risk of Adverse Health Event Due to Altered Immune Response (IRP Rev F)<br>(2) **Nutrition**:Risk of Inadequate Nutrition<br>(3) **Osteo**:Risk Of Early Onset Osteoporosis Due To Spaceflight (No longer used, July 2020) | | |
| **Space Biology Element:** | None | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | None | | |
| **PI Email:** | scott.m.smith@nasa.gov | **Fax:** | FY 281-483-2888 |
| **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 | | |
| **PI Address 2:** | 2101 NASA Pkwy | | |
| **PI Web Page:** | | | |
| **City:** | Houston | **State:** | TX |
| **Zip Code:** | 77058-3607 | **Congressional District:** | 36 |
| **Comments:** | | | |
| **Project Type:** | FLIGHT | **Solicitation / Funding Source:** | Directed Research |
| **Start Date:** | 10/01/2005 | **End Date:** | 11/30/2014 |
| **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:** | Shuttle/ISS | | |
| **Flight Assignment:** | ISS<br>NOTE: End date is 11/30/2014; misunderstanding re previous note of 9/30/20 end date (Ed., 3/31/15)<br>NOTE: End date is 9/30/2020 per L. Smith/HRP/JSC (Ed., 6/10/14)<br>NOTE: End date is 5/30/2014 per HRP Master Task List dtd 7/12/2011 (Ed., 8/9/2011) | | |
| **Key Personnel Changes/Previous PI:** | | | |
| **COI Name (Institution):** | Zwart, Sara ( USRA )<br>Heer, Martina ( University of Bonn )<br>Coburn, Stephen ( Indiana University, Purdue University Fort Wayne ) | | |
| **Grant/Contract No.:** | Directed Research | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

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| **Task Description:** | SMO 016. These studies are designed to provide information about the changes in nutritional status and calcium and bone metabolism during and after space flight. It is well known that the status of some vitamins (i.e., folate, vitamin K, vitamin D) is decreased after long-duration space flight. Never before have we been able to investigate most of these changes during flight. In-flight data will assist in the interpretation of post-flight data, and it will help to assess countermeasure efficiency during flight. The investigators will measure blood levels of vitamins, minerals, oxidative damage markers, markers of iron and calcium metabolism, bone- and calcium-regulating hormones, markers of cardiovascular risk (associated with nutritional status), stress hormones, and urinary markers of bone turnover. These will provide a complete profile of nutritional status and bone and calcium metabolism, and will be important for understanding the effects of the countermeasures under consideration as well as the mechanisms of alterations that occur during space flight. Data will be collected before, during, and after flight. The main potential benefit of this research is obtaining more information about the bone loss and changes in nutritional status that occur during space flight, and knowledge of how effective bone-loss countermeasures are for extended duration space flight. The information gained here will also be important for developing new treatments for metabolic disorders in the general population.<br>See also http://www.nasa.gov/ |
| **Rationale for HRP Directed Research:** | |
| **Research Impact/Earth Benefits:** | Nutritional status is clearly altered after long-duration space flight. As indicated above, several nutrients demonstrate decreased status (despite adequate intake in some cases) after long-duration space flight. It is imperative that we determine the mechanism and kinetics of these changes if we are going to send crew members on exploration-class missions. The inclusion of in-flight blood/urine collections and expansion to include more parameters to better monitor nutritional status is required to better understand the role of nutrition in bone health, changes in body composition, oxidative damage, and defining nutritional requirements. Maintaining and monitoring nutritional status are important for ensuring crew health during space flight, and will be critical as we begin to embark on the longer duration exploration missions in the future. Understanding the interrelationship between nutritional status and other physiological systems inflight may also help to better understand human health for those on Earth. Several findings have arisen from this study, and resulted in publications. These contribute to the understanding of the role of nutrition in health and disease in all populations, including and well beyond astronauts. |
| **Task Progress:** | SUPPLEMENTAL REPORTING FOR FINAL REPORT (March 2015)<br>This study is complete. The findings from the Nutrition SMO have shed light on a number of metabolic issues that are important for human long-duration space flight. Given the comprehensive nature of the Nutritional Status Assessment protocol, there are likely many lessons to be learned, beyond those already identified. These data will be a valuable resource for years to come.<br><br>Sample collection protocols were well executed, and samples were returned on Space Shuttle and SpaceX flights. 32 subjects completed the protocol. Individual data briefings have been provided to all available crewmembers. Findings have been briefed to the Human Health and Performance Directorate, the Human Research Program (HRP) and its Human Health Countermeasures Element, and the International Space Station Medical Project. Data have been published in peer-reviewed journals, presented at the HRP Investigators' Workshop, and have been presented at national and international scientific meetings. A recent update to the nutrition evidence report, published in book form, includes large amounts of Nutrition SMO data (Smith SM, Zwart SR, Heer M. Human Adaptation to Spaceflight: The Role of Nutrition (NP-2014-10-018-JSC). Houston, TX: National Aeronautics and Space Administration Lyndon B. Johnson Space Center; 201) (available through open access at http://www.nasa.gov/ ; http://go.nasa.gov/ ). Data have been shared with other investigators, per data sharing agreements and documentation, and the database transferred to the Life Sciences Data Archive.<br><br>ANNUAL REPORT FROM JULY 2014<br><br>As of July 2014, 32 subjects have completed the protocol, and all samples have been returned to Earth from ISS. Some analyses are pending, and should be completed in the coming months. Individual data briefings have been provided to most crewmembers. Preliminary findings have been briefed to the Space Life Sciences Directorate, the Human Research Program (HRP) and its Human Health Countermeasures Element, and the International Space Station Medical Project, and have been presented at the HRP Investigators' Workshop. Preliminary data have also been published in peer-reviewed journals, and presented at national and international scientific meetings, and transferred to the Life Sciences Data Archive. |
| **Bibliography Type:** | Description: (Last Updated: 03/19/2022) |
| **Articles in Peer-reviewed Journals** | Smith SM, Zwart SR, Heer M, Hudson EK, Shackelford L, Morgan JL. "Men and women in space: bone loss and kidney stone risk after long-duration space flight." J Bone Miner Res. 2014 Jul;29(7):1639-45. http://dx.doi.org/ ; PubMed PMID: 24470067 , Jul-2014 |
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| **Articles in Peer-reviewed Journals** | Zwart SR, Launius R, Coen GK, Charles JB, Smith SM. "Body mass changes during long-duration spaceflight." Aviat Space Environ Med. 2014 Sep;85:897-904. http://dx.doi.org/ ; PMID: 25197887 , Sep-2014 |
| **Articles in Peer-reviewed Journals** | Smith SM, Abrams SA, Davis-Street JE, Heer M, O'Brien KO, Wastney ME, Zwart SR. "50 years of human space travel: implications for bone and calcium research." Annu Rev Nutr. 2014 Jul 17;34:377-400. http://dx.doi.org/ ; PubMed PMID: 24995691 , Jul-2014 |

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| **Articles in Peer-reviewed Journals** | Smith SM, Zwart SR. "Magnesium and space flight." Nutrients. 2015 Dec 8;7(12):10209-22. http://dx.doi.org/ ; PubMed PMID: 26670248; PubMed Central PMCID: PMC4690080 , Dec-2015 |
| **Articles in Peer-reviewed Journals** | Smith SM, Castaneda-Sceppa C, O'Brien KO, Abrams SA, Gillman P, Brooks NE, Cloutier GJ, Heer M, Zwart SR, Wastney ME. "Calcium kinetics during bed rest with artificial gravity and exercise countermeasures." Osteoporos Int. 2014 Sep;25(9):2237-44. Epub 2014 May 27. http://dx.doi.org/ ; PubMed PMID: 24861908; PubMed Central PMCID: PMC4521405 , Sep-2014 |
| **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:// ; PubMed PMID: 26456109 , Dec-2015 |
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| **Articles in Peer-reviewed Journals** | Frings-Meuthen P, Luchitskaya E, Jordan J, Tank J, Lichtinghagen R, Smith SM, Heer M. "Natriuretic peptide resetting in astronauts." Circulation. 2020 May 12;141(19):1593-5. https:// ; PMID: 32392103 , May-2020 |
| **Books/Book Chapters** | Heer M, Titze J, Smith SM, Baecker N. "Nutrition, physiology and metabolism in spaceflight and analog studies." Cham, Switzerland: Springer, 2015. 69 p. http://dx.doi.org/ , Jul-2015 |
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| **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:// , Apr-2021 |