Fiscal Year:	FY 2009	**Task Last Updated:**	FY 04/09/2009
PI Name:	Clarke, Mark Ph.D.		
Project Title:	Monitoring of Bone Loss Biomarkers in Human Sweat: A Non-Invasive, Time Efficient Means of Monitoring Bone Resorption Markers under Micro and Partial Gravity Loading Conditions		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	Yes
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:	mclarke@mail.uh.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	713-743-9854
Organization Name:	University of Houston		
PI Address 1:	Health and Human Performance		
PI Address 2:	3855 Holman St, Garrison Rm 104		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77204	**Congressional District:**	18
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
Start Date:	05/20/2008	**End Date:**	05/19/2011
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Meck, J@n	**Contact Phone:**	281-244-5405
Contact Email:	janice.v.meck@nasa.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	O'Connor, Dan (University of Houston)		
Grant/Contract No.:	NNX08AQ37G		
Performance Goal No.:			
Performance Goal Text:			
	We propose to validate that the rate and extent of unloading-induced bone loss in humans can be assessed by monitoring the levels of two bone resorption markers in sweat, namely ionized calcium and collagen break-down products. Initial testing will be carried out in three populations (at rest and during activity) that have different constitutive levels of bone remodeling, namely young normal healthy individuals, air-force cadets undergoing regular heavy resistance training and healthy elderly individuals. All groups will include both male and female participants. Biomarker concentration will be determined in contemporaneous samples of sweat, blood and urine collected during both short (24 hr) and long-term studies (six months)to define the relationship between biomarkers levels in the respective biological samples. Bone mineral density (BMD) measures will be incorporated in the long-term studies to test the predictive value of sweat biomarkers with regard to overall bone remodeling. Future testing will utilize subjects undergoing bed-rest simulations of		

Task Description:	micro- or partial gravity loading conditions. Several different sweat collection techniques will be investigated to determine the most appropriate and efficient means of sample collection suitable for deployment during a space flight mission. These experiments will also include investigation of the most appropriate biomarker analysis techniques that allow for future deployment in micro- or partial gravity environments. This near-real-time monitoring approach may also provide the information required to justify modifying an ineffective bone loss countermeasure prescription during a mission. One of the approaches tested will be a novel, micro-fabricated fluid collection capillary array, known as the micro-fabricated sweat patch (MSP) device, specifically developed for use in microgravity. The MSP technology was initially developed because of its potential to become an autonomous, solid-state collection/analysis device worn on the skin of an astronaut requiring little or no crew interaction to perform its monitoring function.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Loss of bone mass, density and structural integrity is a significant health risk in a variety of populations such as the elderly, post-menopausal women, young female athletes and astronauts. Such changes in overall bone quality lead to a greater risk of bone fracture and potentially a reduced rate of bone healing after injury. The ability to monitor biomarkers of bone remodeling (e.g. ionized calcium, collagen cross links) using sweat as an analytical sample provides an attractive alternative to the more invasive and costly measures presently employed such as a bone density scans by DXA, 24 hour urine collection protocols or whole blood analyses. The development of a non-invasive, skin-mounted monitoring device which allows the quantitation of ionized calcium and/or collagen cross links in sweat will allow bone loss to be monitored in a wide variety of terrestrial populations that to date have not easily been monitored outside of a clinical setting. This particular project focuses on validating the concept that sweat analysis can be used as a non-invasive means of monitoring bone loss in crew members during periods of mechanical unloading under altered gravitational conditions. In addition, this project is also investigating the best technical approach to collecting a sweat sample which is specifically applicable to the space-flight environment while utilizing well-accepted, clinically validated analytical methods. Development of a technology capable of real-time monitoring of biomarkers of bone loss that satisfies the criteria required for use in the space-flight environment (i.e. non-invasive/non-intrusive, passive, small, light-weight, low power) has many direct applications in various populations here on Earth.
Task Progress:	During the first nine months of this project we have demonstrated definitively that human sweat contains significant amounts of both ionized calcium and total collagen cross-links that can be detected using standard analytical laboratory techniques. In addition, calcium levels in sweat samples approach that found in urine when sweat is produced under active sweating conditions. We have also discovered significant technical issues with the use of the commercial OsteoPatch/Pharmchek (OPD) technology for collecting sweat samples, namely that (1) the device contains significant amounts of endogenous calcium within the evaporative pad and (2) non-uniform extraction of both calcium and T-CCL occurs from the evaporative pad during “reconstitution” of sweat constitutents. Tasks 1-3 for Year One are essentially complete. Additional data will be gathered using our newest batch of microfabricated sweat patch (MSP) devices with regard to sweating rate to augment the data already gathered for Task 3. Task 4 (i.e. comparison of biomarker concentration in urine and sweat) is ongoing and will now focus on samples collected using the MSP technology due to the technical issues identified with the OPD technology and the unsuitability of the catch pocket device (CPD) technology for deployment in altered gravity conditions.
Bibliography Type:	Description: (Last Updated: 03/08/2018)