Fiscal Year:	FY 2009	**Task Last Updated:**	FY 06/05/2009
PI Name:	Adams, Gregory R. Ph.D.		
Project Title:	Integrated Endurance and Resistance Exercise Countermeasures Using a Gravity Independent Training Device		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Musculoskeletal Alterations Team		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Aerobic**:Risk of Reduced Physical Performance Capabilities Due to Reduced Aerobic Capacity (2) **Muscle**:Risk of Impaired Performance Due to Reduced Muscle Size, Strength and Endurance		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Irvine	**State:**	CA
Zip Code:	92697-0001	**Congressional District:**	48
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2007 Crew Health NNJ07ZSA002N
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No. of Post Docs:	1	**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:	1	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Baldwin, Kenneth (University of California, Irvine) Caiozzo, Vincent (University of California, Irvine)		
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Performance Goal No.:			
Performance Goal Text:			

Extended space flight as well as existence on the Moon and Mars will require exercise equipment and training protocols designed to maintain physical fitness and general health. NASA has determined that current flight rated exercise hardware is not appropriate for use on the future Crew Exploration Vehicle (CEV) (JSC SAT Report 12/06). Studies will investigate protocols designed to maintain both cardiovascular and musculoskeletal fitness using a gravity independent multi-mode exercise device (M-MED), which has been identified by NASA as potential flight hardware. M-MED can provide either high resistance strength- or low resistance endurance-mode exercises. Phase I -ground based integrated strength & CV exercise training under normal weight bearing conditions. Phases 2&3 - application of this protocol with progressive levels of inactivity. Measurements - total body physical work capacity, muscular mass, strength and sustained muscle endurance (i.e., EVA related issues). CV-related exercise using M-MED "aerobic" mode configuration

Task Description:	designed to minimize the time spent in exercise using high power output, short duration interval training. On alternate days, the M-MED will be configured for strength training which has been shown to result in increased muscle strength and size. These studies will validate the efficacy of concurrent endurance and strength training as a high economy approach to flight crew physical fitness, using a scientifically proven exercise modality that has a high probability for use during prolonged spaceflight missions. This work directly addresses primary requirements in the NSBRI RFA: 1. "New, innovative exercise hardware for deployment on CEV, lunar and Martian surfaces that provide efficient means for maintenance of aerobic capacity, bone and muscle strength, and endurance with sufficient reserve for contingencies". 2. "New, innovative exercise protocols that minimize in-flight crew time necessary to maintain aerobic capacity and muscle strength and endurance, and facilitate reserve for contingencies on lunar and Martian missions".
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The cellular and molecular analyses conducted as part of these studies will provide important information about the mechanisms by which the body adapts to increased and decreased loading. In particular, the interplay between resistance mode and endurance mode exercise and how this effects cellular and molecular adaptation has not been extensively studied. As such these findings will be of benefit to clinicians and practitioners who deal with conditions involving muscle wasting and cardiovascular disease. The M-MED device itself represents a potentially useful modality for the maintenance of both cardiovascular and musculoskeletal health. This could be of benefit in circumstances when limitations in cost or space requirements preclude the availability of a wide spectrum of exercise equipment.
Task Progress:	The primary tasks for year one involved procurement, validation and instrumentation of the M-MED. The M-MED was delivered to UCI in September of 2008. Validation studies including comparisons with free weights (see below) commenced immediately and were conducted in parallel with engineering tasks. As presented at the recent NASA HRP workshop, preliminary studies using the M-MED device indicate that foot force measurements of resistance mode exercise are similar to those seen using free weight exercises. Similarly, electromyography (EMG) studies demonstrate that similar activation levels are seem in key agonist muscles during either M-MED based or free weight resistance exercise. These findings indicate that the gravity independent M-MED is a viable option for resistance mode exercise during flight and during planetary exploration. When configured for endurance mode rowing exercise, EMG measurements indicate that, in addition to the thigh and leg muscles, there is a robust activation of upper and forearm muscles. This suggests that M-MED endurance mode exercise may have the added benefit of maintaining and, possibly, improving strength and endurance of arm muscles of flight crews. Significantly, endurance mode exercise also stimulated robust recruitment of the muscles which support the spine. This finding suggests that M-MED based exercise may promote the maintenance of lower back stability and loading during flight and planetary exploration. Foot force measurements obtained during endurance mode rowing exercise demonstrated that forces equivalent to earth normal walking (e.g., 1G) were generated during this exercise. This result indicates that, in addition to the cardiovascular benefits of this exercise, time spent rowing will contribute to musculoskeletal loading as well. This suggests that M-MED endurance mode exercise should contribute significantly to crew health maintenance while maximizing the value of time spent on countermeasure exercise. In response to NASA JSC requests, the M-MED device has been instrumented to provide power output measurements during endurance mode exercise. This technological modification will facilitate the monitoring of crew exercise volume. The addition of this capability will also allow the M-MED device to be used for in-flight and planetary quantitative exercise capacity testing of crew members.
Bibliography Type:	Description: (Last Updated: 06/04/2024)