Fiscal Year:	FY 2011	**Task Last Updated:**	FY 05/04/2011
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
Start Date:	06/01/2008	**End Date:**	09/30/2012
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:	0	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2012, per NSBRI information (Ed., 1/17/2013)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Baldwin, Kenneth (University of California, Irvine) Caiozzo, Vincent (University of California, Irvine)		
Grant/Contract No.:	NCC 9-58-MA01601		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Extended space flight as well as existence on 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 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 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:	To date, this project has demonstrated that a very modest amount of time invested in exercise using the multi-mode exercise device (M-MED) can produce substantial increases in muscle function and cardiovascular fitness. In particular, the fact that M-MED based exercise induces performance gains at many movement speeds suggests that it may be superior to more traditional methods. In total, these findings show that this equipment and these protocols developed specifically for space flight related application may provide a basis for broader use in situations where space and time constraints may limit access to effective exercise.
Task Progress:	This study is designed to investigate the effectiveness of a new exercise device, multi-mode exercise device or M-MED, for use during long-duration spaceflights for the maintenance of cardiovascular and musculoskeletal fitness of astronauts. The M-MED is gravity independent and provides both the high force resistance and low force rowing type resistance. To date the results indicate that foot forces in resistance mode exercise on M-MED are similar to those seen using free weight exercises. Electromyography (EMG) studies demonstrate that similar activation levels are seem in key muscles during either M-MED based or free weight resistance exercise. EMG during rowing demonstrate that the thigh, leg and arm muscles are robustly activated. Endurance mode exercise was also found to stimulate recruitment of the muscles which support the spine. In a recently completed study, 32 subjects (16 male, 16 female) completed 5 weeks of combined resistance and endurance training using the M-MED. Muscle strength increased ~20% while aerobic fitness measured as maximal oxygen consumption (VO2max) increased ~8%. M-MED training increased time to hand grip fatigue by ~70% and leg extension fatigue by ~27%. Thigh muscle cross sectional area increased ~11% as a result of training. Additional deliverables include cross validation of VO2max testing results between the M-MED device and laboratory standard cycle ergometry based testing protocols. As requested by NASA, additional studies have demonstrated that M-MED based exercise can increase the size and strength of the calf and hamstrings muscle groups. These results demonstrate that the M-MED device can be used for both training and physical work capacity testing providing a platform for in-flight assessment. In summary, findings to date indicate that the gravity independent M-MED is a viable option for resistance- and endurance-mode exercise during flight and/or planetary exploration thereby addressing two critical risks: 1) cardiovascular deconditioning; 2) Decreased muscle strength, endurance and size (atrophy). Endurance mode exercise may have the added benefit of maintaining and, possibly, improving endurance of arm muscles of flight crews as well as aiding in the maintenance of lower back stability and loading during flight and planetary exploration.
Bibliography Type:	Description: (Last Updated: 06/04/2024)