

<b>Fiscal Year:</b>	FY 2009	<b>Task Last Updated:</b>	FY 02/18/2010
<b>PI Name:</b>	De Witt, John Ph.D.		
<b>Project Title:</b>	Biomechanical Analysis of Treadmill Locomotion on the International Space Station		
<b>Division Name:</b>	Human Research		
<b>Program/Discipline:</b>	HUMAN RESEARCH		
<b>Program/Discipline--Element/Subdiscipline:</b>	HUMAN RESEARCH--Biomedical countermeasures		
<b>Joint Agency Name:</b>	<b>TechPort:</b>	No	
<b>Human Research Program Elements:</b>	(1) <b>HHC:</b> Human Health Countermeasures		
<b>Human Research Program Risks:</b>	(1) <b>Muscle:</b> Risk of Impaired Performance Due to Reduced Muscle Size, Strength and Endurance		
<b>Space Biology Element:</b>	None		
<b>Space Biology Cross-Element Discipline:</b>	None		
<b>Space Biology Special Category:</b>	None		
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<b>Zip Code:</b>	77058	<b>Congressional District:</b>	22
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<b>Project Type:</b>	FLIGHT	<b>Solicitation / Funding Source:</b>	Directed Research
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<b>No. of PhD Candidates:</b>	<b>No. of Master' Degrees:</b>		
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<b>No. of Bachelor's Candidates:</b>	<b>Monitoring Center:</b> NASA JSC		
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<b>Flight Program:</b>	ISS		
<b>Flight Assignment:</b>	ISS		
<b>Key Personnel Changes/Previous PI:</b>			
<b>COI Name (Institution):</b>	Ploutz-Snyder, Lori ( USRA/NASA Johnson Space Center ) Scott-Pandorf, Melissa ( Wyle/NASA Johnson Space Center ) English, Kirk ( NASA Johnson Space Center ) Everett, Meghan ( University of Houston ) Guilliams, Mark ( Wyle/NASA Johnson Space Center ) Newby, Nate ( Wyle/NASA Johnson Space Center )		
<b>Grant/Contract No.:</b>	Directed Research		
<b>Performance Goal No.:</b>			
<b>Performance Goal Text:</b>			

	<p>There are many factors that may contribute to the deconditioning that occurs during long-term microgravity exposure. Countermeasures hardware limitations, suboptimal exercise programming, and alterations in gait biomechanics may all contribute to physiological losses. During the NASA International Space Station Exercise Prescription Workshop in October 2008, internal and external experts identified a need to better quantify specific physiological responses to exercise in microgravity. Knowledge of resistance exercise biomechanics while on ISS will provide insight as to why bone, muscle and cardiovascular health are lost during long duration spaceflight.</p> <p>The ARED was installed on the ISS in early 2009 with the intent of increasing the resistance exercise capabilities during in-flight exercise. The device is capable of providing up to 600 lbs of resistance, incorporates a vacuum cylinder and flywheel resistance system to provide constant and inertial resistance, and allows for the performance of many typical exercises, including the deadlift and parallel squat. Resistance exercise has been performed by astronauts during spaceflight to protect against health losses that occur during microgravity exposure. Despite exercise performance, crewmembers regularly return from missions with bone, muscle, and cardiovascular losses. The proposed iRATs exercise prescription has been developed with the intent of optimizing exercise effectiveness by increasing intensity and volume.</p> <p>Resistance exercises that load the axial skeleton, such as the parallel squat and deadlift, have been proposed to be critical components of a program designed to maximize the stimuli for bone remodeling. However, there is little evidence regarding the efficacy of specific exercises at providing the joint loads necessary for maintenance of bone. For example, within NASA there is disagreement whether squats performed with heavy loads using a decreased range of motion are superior to the same exercise performed with lighter loads over an increased range of motion. In addition, exercise biomechanics can be altered by modifying variables such as stance width, grip width, range of motion, cadence, and joint orientation. An optimal exercise form may exist that maximizes joint forces, which in turn allows for the specific targeting of the most vulnerable bone sites.</p> <p>Computer simulation performed in concert with measured data can be used to approximate the loads experienced throughout the musculoskeletal system. The LifeMod System (LifeModeler, Inc., San Clemente, CA) is a dynamics-based software platform that computes the muscle and bone forces that occur during a specific motion. The modeling system can determine the forces that cause a motion (inverse dynamic analysis), and predict motion given a set of muscle forces (forward dynamic analysis). Inverse and forward dynamic simulations are beneficial for analyzing specific movement patterns and for predicting how changes in motion can affect exercise kinetics and related physiological benefits.</p> <p>A comprehensive understanding of the kinematics and kinetics of resistance exercise performance in microgravity is necessary to optimize exercise prescriptions by including the exercise variations that have the greatest potential health benefits. However, to date, there have been no biomechanical investigations of resistance exercise performance on the ISS or of ARED exercise in microgravity. Collecting biomechanical data during actual exercise sessions on the ISS is expensive and complex, but is required for program optimization. We are proposing a systematic evaluation that increases the probability of success while minimizing impacts on crew time. Our intent is to be the first group to perform biomechanical exercise analysis during long-term ISS missions. Our goal is to provide timely, relevant, and necessary feedback that can be used to increase the health benefits of the in-flight exercise program.</p>
<b>Rationale for HRP Directed Research:</b>	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.
<b>Research Impact/Earth Benefits:</b>	
<b>Task Progress:</b>	<p>New project for FY2009.</p> <p>[Ed. note: project added to Task Book in February 2010 when information received from JSC]</p>
<b>Bibliography Type:</b>	Description: (Last Updated: 02/11/2021)