Physical Therapy Department Research
Annual Report for 2012
Prepared by:
Jack Dennerlein, Director of Research
31 March 2013

Mission
The Department of Physical Therapy’s research mission is to build the evidence for best practices to maintain and improve the health and wellbeing of the local, national, and global community members.

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Highlights from 2012
The Department of Physical Therapy had an excellent year with regard to research in 2012. The department grew significantly with new faculty and research facilities. Researchers were very productive publishing their work and submitting new grants applications to expand our current activities in upcoming years. Highlights from the 2012 calendar year include

- 45 peer reviewed journal publications
- Over 37 peer reviewed conference abstracts, papers, and presentations
- Over 400 citations of works by PT faculty with an average H-index of 7.2
- $5.7 million multi-year grants submitted to external agencies with PT faculty as PIs
- $686,695 of funded research activities in 2012
- Three new tenure-track faculty
- 2,600 square footage of new research and laboratory space
- 22 Undergraduate Research Awards
- Creation and naming of the Department's Director of Research, Jack Dennerlein
- Creation and hiring of the Department’s Grant’s Budget Manager, Krista Robinnetta

Description of research program
The mission of research within the Department of Physical Therapy is to build the evidence for best practices to maintain and improve the health and wellbeing of the local, national, and global community members. We meet this goal successfully through a range of research projects that examine, for example, PT education methods in the fields and practice, pain and injury mechanisms in the laboratory, treatment protocols, and population based epidemiology and intervention research.

At the heart of the research is the success of the department’s faculty and the resources. The department has ten tenure-track and fifteen clinical full time faculty devoted to the department’s research mission. The department has 4,900 square feet of research laboratories mostly located within Robinson Hall equipped with the state of the art research equipment. Equipment include systems to measure human motion, posture and force, neurophysiology, muscle and tissue physiology, and musculoskeletal structure and include intervention systems such as rehabilitation robots and office ergonomic furniture. Other capabilities include survey and population data base resources and software.

A strength of the research program is the department’s local and global research partners. Within Northeastern the Department has strong partners with the Health Sciences Department in Bouvé College of Health Science along with research partners in the College of Engineering, College of Science, the College of Arts, Media & Design, and the College of Social Sciences and Humanities. Within Boston the faculty collaborate with centers at neighboring institutions such as Harvard Medical School, Harvard School of Public Health, Dana Farber Cancer...
Institute, Tufts Medical Center, Boston University, Massachusetts General Hospital, Brigham and Women’s Hospital, and the Liberty Mutual Research Institute for Safety. In terms of national and global partners, the Department’s faculty have strong ties with the University of Massachusetts Amherst, New York University, SUNY Upstate Medical School, University of Washington, Vanderbilt, University of Southern Denmark, and VU University in Amsterdam.

**Growth with new faculty, new facilities and new administration!**

The department’s research expanded with three new faculty starting for the 2012-2013 academic year with Assistant Professor Sheng-Che Yen, PT, PhD, Assistant Professor Christopher Hasson, Ph.D. and Professor Jack Dennerlein, Ph.D. Dr. Yen joins us from Sensory Motor Performance Program at Rehabilitation Institute of Chicago. His primary research interest is in robotic rehabilitation, motor adaptation, and coordination. Dr. Hasson joins us from Department of Biology here at Northeastern. His research aims to understand how concurrent changes in the musculoskeletal and nervous systems contribute to decrements in movement control and performance. Dr. Dennerlein joins us from the Harvard School of Public Health. His research interest is in the prevention of work-related musculoskeletal disorders and injury through experimental and observational studies of the work environment.

Along with these new faculty come 2,600 square feet of new research facilities doubling the size of the department’s research space. The three new spaces will be equipped with the latest state of the art human kinesiology and rehabilitation systems.

With the expansion, the Department has added a new Director of Research and Grants Budget Manager. Dr Jack Dennerlein has 15 years of experience of leading federally funded research. As director of research, he will assist the department in identifying new opportunities for research and mentoring the development of junior faculty research programs. Ms Krista Robinnette joins the department from the University of Saint Louis. She will assist researchers within the department manage budgets related to awarded grants.

**New grants!**

Dr. Amee L. Seitz, PhD, PT, in collaboration with Professors Dagmar Sternad and Miriam Leeser from the College of Science and College of Engineering, recently received an Interdisciplinary Tier 1 Seed Grant to fund a project titled “Development of an Adaptive Clinician-Friendly Virtual Rehabilitation System for Post-Operative Shoulder Therapy”. The project aims to develop and evaluate a custom virtual rehabilitation system using low cost gaming technology, such as the Microsoft Kinect, for in-home use in patients undergoing rehabilitation following shoulder surgery. The grant will allow Dr. Seitz and her team the ability to
validate the system and test the feasibility for in-home use in a pilot study of post-operative shoulder patients. The system will provide clinicians the ability to remotely monitor a patient’s home program and progress. Ultimately the use of this system can decrease cost, reduce utilization, and increase the effectiveness of post-operative rehabilitation.

Dr. Dennerlein initiated his project entitled “Integrated approaches to health & safety in dynamic construction work environment”, which is funded through the Harvard School of Public Health (HSPH) Center for Work, Health and Wellbeing. The goals and aims of this study are to develop and test worksite-based, multi-component, and integrated musculoskeletal disorder prevention and health promotion intervention for workers in commercial construction. This four year project will implement programs on several work-sites in the metropolitan Boston area and will then follow workers for six months after the intervention to determine changes in their health and behaviors. The HSPH Center for Work, Health, and Wellbeing (http://centerforworkhealth.sph.harvard.edu/) is also supporting Dr. Dennerlein’s involvement in the development and testing of an integrated health intervention for patient care unit workers at two local hospitals in Boston. In addition, Dr Dennerlein worked with Dr. Dinesh John of the Department of Health Sciences in obtaining funding from the Center to pilot test the physiological effects of standing workstations on the health of sedentary and overweight office workers.

Undergraduate research:
The Department has been extremely active engaging undergraduate students in research ensuring that we integrate our research and education missions. In 2012, we had 22 Provost’s Undergraduate Research Awards. Here are some highlights from this year’s recipients:

Impact of Global Clinical Experiences on PT Professional Development (Lorna Hayward)
Kenny Venere and Andrea Pallais traveled with Dr. Lorna Hayward to Quito and Latacunga Ecuador to provide physical therapy services to a community partner (For His Children). To assess the impact of this 6 year initiative that has resulted in 80 NU DPT participating in this project, 6 interviews were conducted with community stakeholders. At the end of the Spring semester, an online survey will be sent to all 80 alumni to gather data on the impact of the Ecuador program on professional development and cultural competency.

Biomechanics of the injured Shoulder (Amee Seitz)
Caralyn Baxter worked with Dr. Amee L. Seitz in the Biomotion Research Laboratory examining modifiable mechanisms responsible for faulty biomechanics of the upper extremity associated with musculoskeletal injuries. Injuries such as rotator cuff tears or tendinopathy have a dramatic impact on a patient’s ability to fully participate in activities of daily living particularly in an aging...
population. Results of this project will lead to improvements in rehabilitation to restore health related quality of life and maximize functional independence.

**Development of Novel Devices for Neurorehabilitation** (Maureen Holden)

Ben Miller and John Corsino worked with Prof. Maureen Holden in the Neurorehabilitation Research Laboratory examining eight tasks that were designed to assess/train standing balance and pre-gait activities in patients with stroke using a newly developed rehabilitation system (NUVABAT – NU Virtual Ankle and Balance Trainer) with mechanical, virtual reality (VR) and robotic components. The purpose was to evaluate/tune parameters and difficulty levels for these tasks with healthy subjects (n=20) prior to testing patients with stroke. We found that performance and perceived difficulty scores differed significantly for easy vs hard levels of the tasks (as expected), but surprisingly, did not differ on these factors for older vs younger subjects. Most likely this occurred because we customized the task parameter settings to each subject’s initial performance abilities, a useful feature for training in patient populations. The work was presented at the National meeting of the American Physical Therapy Association, and is part of a Dr. Holden’s larger project to develop the NUVABAT device for use in clinical neurorehabilitation of patients with stroke.
# APPENDIX

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Description of Laboratories

Occupational Biomechanics and Ergonomics Laboratory (Jack Dennerlein)
001 Robinson Hall 1190 square feet
The Occupational Biomechanics and Ergonomics Laboratory research aims to prevent work-related musculoskeletal disorders by understanding injury mechanisms through laboratory and field studies that utilize biomechanics, neuromuscular, exposure-response, and intervention study designs and methods. Located on the ground floor of Robinson Hall, this space contains a state of the art office space for research staff and trainees and a human movement and biomechanics laboratory space, both approximately 600 square feet. The flexible design of biomechanics laboratory space allows for a range of experiments investigating thumb movements while using mobile computing technology to the ergonomics of dynamic office workstation designs. The laboratory contains equipment to measure human motion and posture, surface electromyography, and applied forces. Human motion equipment includes Northern Digital Optotrak system and Ascension Technology Mini-Bird systems. Electromyography equipment include a 12 channel Delsys and an 8 channel wireless Mega systems. Load cells to measure force include custom made force plates for computing to ATI 3-axis force-torque sensors.

Center for Cancer Survivorship Studies (Ann Marie Flores)
406 Robinson Hall 320 square feet
The mission of the center is to describe and evaluate issues of cancer survivorship that affect physical and functional well-being and quality of life after a cancer diagnosis with special emphasis on minorities, the poor and medically underserved. The center is also devoted to the development and testing of physical therapy and technological interventions to improve physical and functional well-being and quality of life after a cancer diagnosis. The center encourages collaborative research that includes the fields of physical therapy, biostatistics, public health, epidemiology, sociology, biomedical & biomechanical engineering, psychology, nursing, oncology (surgical, medical and radiation), pharmacy sciences, cancer, and cell biology.

Neuromotor Systems Laboratory (C.J. Hasson)
4th Floor Richards Hall 700 square feet
The goal of the Neuromotor Systems Laboratory is to understand how the nervous system learns, interacts with, and takes advantage of the properties of the musculoskeletal system and the external environment to achieve task goals. They are particularly interested in understanding how age-related changes in the neuromuscular system contribute to decrements in movement performance and stability. The laboratory’s larger room will contain an isolated experimental room and a separate office area for research staff and student activities. The experimental room will house an electromyography system (records muscle activity), a high-performance robotic arm, and high-performance computers for modeling, simulation, and data analysis. This equipment will be used to perform human motor control and learning experiments. A separate room will house Dr.
Hasson’s office and a small workshop that will be used to fabricate custom apparatuses and maintain experimental equipment. [http://www.northeastern.edu/neuromotorsystems/]

Neurocognitive Rehabilitation Research (Prudence Plummer-D'Amato)
Lab 404 Robinson Hall 750 square feet
The mission of the Neurocognitive Rehabilitation Research Lab is to conduct interdisciplinary research along two main themes: analysis of the interactions between cognition and motor functions; and the design, development and evaluation of rehabilitation strategies for people with deficits in cognitive function and/or motor control after neurological injury. A central focus of our research is the rehabilitation of walking in community-dwelling individuals with stroke. Dr. Plummer-D’Amato’s research is supported by the American Heart Association.

Teaching and Learning Innovation Program (Lorna Hayward)
Dr. Hayward’s research centers on the scholarship of teaching and learning as it relates to student learning, cultural competency, professional role formation and novice to expert transitions. Dr. Hayward designs and examines educational models that involve the use of technology, standardized patient interactions, and experiential education in physical therapist students. Dr. Hayward’s research is currently supported by the Kenneth B. Schwartz Center and the Wellesley Village Church.

Neurorehabilitation Laboratory (Maureen Holden)
402 Robinson Hall 500 Square Feet
The Neurorehabilitation Laboratory’s mission is to develop new and more effective methods to rehabilitate patients with motor control deficits. In particular, we are interested in patients who have suffered neurological impairments following stroke or traumatic brain injury. We are involved in the study of sensorimotor contributions to motor control and learning, and in the development and application of newer technologies to assist neurorehabilitation. Projects include the study of motor learning and generalization using virtual environments, studies of hand motor control through the use of an instrumented glove in patients with stroke and healthy subjects, development of two novel rehabilitation devices (Smart Glove and NU Virtual Ankle and Balance Trainer) in collaboration with Prof. Constantinos Mavroidis, NU Engineering, and studies of motor retraining for patients with stroke in a rehabilitation setting in Japan, with Prof. Toshiaki Tanaka, University of Tokyo.

Rehabilitation and Epidemiology Trainee Program (Maura D. Iversen)
The mission of the Rehabilitation and Clinical Epidemiology Trainee Program is to provide students with exposure to clinical translational research in the area of rehabilitation sciences. A central focus of our research is the design, evaluation and implementation of behavioral and rehabilitation interventions to improve health outcomes in persons with arthritis. Specific areas of expertise include studies of persons with rheumatoid arthritis, systemic lupus erythematosus, spinal stenosis and osteoporosis. Dr. Iversen’s work is / has been funded by the National
Institutes of Health, the Research & Education Foundation, Foundation for Physical Therapy, the Arthritis Foundation and Farnsworth Foundation.

**Biomotion Research Laboratory (Amee Seitz)**

404 Robinson 400 Square Feet

The mission of the Biomotion Research Laboratory is to investigate neuromuscular and biomechanical mechanisms, the efficacy of rehabilitation, and associated clinical outcomes of upper extremity musculoskeletal disorders related to aging and repetitive overuse during work or sport. The 400 sq. ft. dedicated research lab space, located within 404 Robinson Hall at Northeastern University, has state of the art equipment and dedicated space for motion analysis, ultrasound imaging, electromyography, patient examination, and computer workstations for processing and analysis. The lab pursues collaborative research in the fields of biomedical engineering, orthopedics, rehabilitation medicine, motor control and human movement science to optimize patient outcomes, participation, and health related quality of life.

**Neurophysiology Laboratory (Robert Sikes)**

Mugar Hall 300 Square Feet

The Neurophysiology Laboratory of the Department of Physical Therapy explores the role of limbic system brain structures in pain and stress. The lab conducts pre-clinical electrophysiological experiments using animal models of cutaneous and visceral pain. This facility is one of very few that records simultaneous neuron activity at multiple levels of the pain transmission network and is part of a multidiscipline collaboration with labs at Northeastern and Boston University Medical School which conduct the brain imaging and behavior testing of these animals. The lab is located in 319 Mugar Building which provides close proximity to the animal facilities and brain imaging center. With 300 sq-ft the lab has adequate space for neurophysiological recording in small animals, surgical procedures, histological processing, light microscopy and preliminary data analysis. The lab is equipped with state of art neurophysiological recording, stereotaxic micropositioning, stimulus control and physiological monitoring systems. For histology there is a Nikon Optiphot microscope and a microtome for tissue preparation. There are multiple computer systems including a server that provides access for remote data analysis. Additional equipment includes a fume-hood, flammable storage cabinet, refrigerator and drying oven.

**Laboratory for Locomotion Research (Sheng-Che Yan)**

4th Floor Richards Hall, 750 Square Feet

The goals of Laboratory for Locomotion Research are to: (a) understand how the central nervous system achieves sensorimotor control during gait; (b) develop and test gait rehabilitation programs for patients with sensorimotor control problems. The lab is located in the 4th floor of the university’s Richards Hall and has a total space of 600 ft2. A separate office (150 ft2) is adjacent to the lab that will be served as an examination room for healthy and patient subjects. The lab will be equipped with state of the art equipment and software for gait analysis.
Peer reviewed publications in 2012


Peer Reviewed Conference Abstracts, Presentations and Papers


17. **Iversen MD** Longitudinal Examination of the Impact of Disease Activity on Physical Activity Participation in Rheumatoid Arthritis. APTA Annual Conference and Exposition. Tampa, FL. June 8th, 2012.


34. Sternad D, Abe MO, and Hasson CJ (2012). Deterministic and stochastic error amplification and skilled performance. Society for Neuroscience 42nd Annual Meeting, New Orleans, LA, October 13-17 [Abstract No. 88.18].


Grants Submitted ($6.7 million)

2012 External Funding: Total $6,637,881 ($5,752,587 with faculty as PI or Co-PI)

<table>
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<th>Agency</th>
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<th>Direct Costs</th>
<th>Faculty</th>
<th>Status</th>
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<tbody>
<tr>
<td>National Institute for Occupational Safety and Health</td>
<td>Randomized Controlled Trial of Whole Body Vibration Intervention in Truck Driver</td>
<td>$1,396,817</td>
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<td>HSPH Center for Work, Health and Well being</td>
<td>‘Standing Up’ Against Sedentary Behavior: A Pilot Study in Office Workers</td>
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<td>HSPH Center for Work, Health and Well being</td>
<td>‘The Emerald Small Business Model Health and Wellness Program Pilot Aimed to disseminate integrated worker health programs among small/medium employer</td>
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<td>APTA Section on Women's Health</td>
<td>Moving On: A pilot test for acceptability and feasibility of an early physical therapy education intervention for breast cancer survivors</td>
<td>$5,000</td>
<td>Flores (PI)</td>
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<td>American Federation for Aging Research</td>
<td>Virtual Aging: An Original Approach to Understanding How Altered Muscle Dynamics Affects Movement Control in Older Adults</td>
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<td>National Science Foundation</td>
<td>Robotic Reinforcement: A New Approach for Robotic Gait Rehabilitation after Stroke</td>
<td>$1,070,362</td>
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<td>The Village Church Outreach grants program</td>
<td>Connection of People, Place and Profession</td>
<td>$2,530</td>
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<td>Patient Centered Outcomes Research Institute</td>
<td>Triggering Options for Urban Communities with Hypertension</td>
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<td>National Science Foundation</td>
<td>A Smart Patient –centered rehabilitation system to promote physical activity and enhance physical therapy for rheumatoid arthritis (RPLAY)</td>
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<td>National Institutes of Health (R21)</td>
<td>Real-world assessment of dual-task performance after stroke</td>
<td>$439,415</td>
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<td>American Physical Therapy Association Orthopaedic Section Foundation Grant</td>
<td>Effectiveness of a rehabilitation program emphasizing motor control for individuals with rotator cuff tendinopathy: a randomized clinical trial</td>
<td>$15,000</td>
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<td>National Science Foundation (PI Erdogmus)</td>
<td>Noninvasive Brain Controlled Hand Prosthetics – Optimal Shared Control through Modeling of Motor Learning</td>
<td>$888,660</td>
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<td>National Science Foundation (PI Mavroidis)</td>
<td>Virtual Reality Augmented Ankle and Balance Trainer</td>
<td>$381,915</td>
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<td>National Science Foundation (PI Mavroidis)</td>
<td>Ankle and Balance Robotic Trainer Augmented With Interactive Gaming</td>
<td>$241,644</td>
<td>Holden (Co-I)</td>
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<td>National Institute of Arthritis and Musculoskeletal and Skin Diseases (R21)</td>
<td>Study of Physical Activity Rewards after Knee Surgery</td>
<td>$150,000</td>
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<td>Pending</td>
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<td>Pediatric Orthopedic Society of North America</td>
<td>Development of a pediatric version of Marx Activity Scale</td>
<td>$9,000</td>
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<td>Canadian Institutes of Health Research Grant (PI- JS Roy)</td>
<td>Predicting the outcome of rehabilitation in individuals with rotator cuff tendinopathy</td>
<td>$102,735</td>
<td>Seitz (Co-I)</td>
<td>Not Funded</td>
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**Internal Funding: Total Submitted $154,413**
## Funded Grants ($685,695 in direct costs in 2012)

### 2012 External Funding: Total direct costs for 2012 $606,848
(Listing only grants amounts to Northeastern University)

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<tr>
<td>National Institute for Occupational Safety and Health</td>
<td>HSPH Center for Excellence to Promote a Healthier Workforce</td>
<td>$147,012</td>
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<td>National Institute for Occupational Safety and Health</td>
<td>Center for Construction Research and Training: Effectiveness of employee safety incentive programs in construction</td>
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<td>University of Washington &amp; State of Washington Safety Health Investment Projects</td>
<td>Randomized Controlled Trial of a Whole Body Vibration Intervention in Truck Drivers</td>
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<td>Dennerlein (PI)</td>
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<td>APTA Section on Women's Health</td>
<td>Moving On: A pilot test for acceptability and feasibility of an early physical therapy education intervention for breast cancer survivors</td>
<td>$5,000</td>
<td>Flores (PI)</td>
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<td>The Village Church Outreach grants program</td>
<td>Connection of People, Place and Profession</td>
<td>$2,530</td>
<td>Hayward (PI)</td>
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<td>Kenneth B. Schwartz Center Fund of Massachusetts General Hospital (MGH.)</td>
<td>Creating a Culturally Competent and Inter-professional Aware Health Care Environment within the Spaulding Rehabilitation Hospital.</td>
<td>$10,100</td>
<td>Hayward (PI)</td>
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<td>National Institutes of Health R21</td>
<td>Southern Community Cancer Survivorship Study.</td>
<td>$80,000</td>
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<td>National Institute of Arthritis and Musculoskeletal and Skin Diseases</td>
<td>Tai Chi and Knee Osteoarthritis</td>
<td>$60,000</td>
<td>Iversen (PI)</td>
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<td>American Heart Association: Scientist Development Grant</td>
<td>Training dual task walking after stroke: effects on attentional and locomotor control</td>
<td>$70,000</td>
<td>Plummer-D'Amato</td>
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<td>The Shapiro Family Foundation</td>
<td>Advancement of the MassMATCH Assistive Technology School Swap Program</td>
<td>$12,000</td>
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<td>National Institute of Arthritis and Musculoskeletal and Skin Diseases (R21)</td>
<td>Randomized Controlled Trial to Improve Adherence with Osteoporosis Care</td>
<td>$73,375</td>
<td>Iversen (Co-I)</td>
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**Internal Funding: Total ($78,847)**

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<tr>
<td>Northeastern University Tier 1 Grants</td>
<td>Boston Puerto Rican Cancer Survivorship Study</td>
<td>$50,000</td>
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<td>Northeastern University Provost CIETL Research Funds</td>
<td>Assessment within Physical Therapy, Innovative Educational Strategies</td>
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<td>Northeastern University Undergraduate Research</td>
<td>22 Different research projects involving undergraduates students involvement in research</td>
<td>$24,712</td>
<td>11 Faculty Members</td>
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