

Title: Healthy Aging Across the Lifespan through Physical Activity: Translating Laboratory Research to the Community

Participating disciplines:

1. The Laboratory of Systems Physiology (LSP)
2. Biodynamics Research Laboratory (BRL)
3. Health Risk Assessment Program (HRAP)
4. School of Data Science (SDS)

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Target category: Future Opportunity and Investment

Keywords:

1. Aging
2. Physical activity
3. Joint Injury
4. Chronic Disease
5. Underserved Populations

Executive Summary

Research expertise in the Department of Kinesiology represents an area of future opportunity and investment to examine the influence of factors that lead to physical inactivity. Throughout the life of an individual one experiences emotional stressors, injuries, poor health choices, and environmental exposures that negatively impact health. Increasing physical activity can attenuate the negative health effects of these experiences and exposures, and improve quality of life. In the U.S., 75% of adults and 80% of high school students do not meet physical activity recommendations. Globally, physical inactivity is the 4th leading risk factor for mortality. Physical inactivity leads to the development of obesity, cardiopulmonary disease, metabolic disease, certain cancers, and impairs the healthy aging process. Physical inactivity is also a risk factor for and consequence of musculoskeletal disorders. The multitude of consequences of physical inactivity place a tremendous burden on the individual and healthcare system.

Our work with Mecklenburg Community Centers found that older adults with lower socioeconomic status are more likely to be physically inactive, resulting in the development of risk factors for cardiovascular disease, compared to those who engage in habitual exercise. Based on observations of physical inactivity in college-aged research participants and community-dwelling adults, we have investigated animal models of injury and learned how the limited physical activity that ensues negatively impacts cardiovascular and metabolic health in the animal. Animal models have also demonstrated how physical activity can mitigate the aforementioned negative health impacts in these animals after injury. Additionally, our human subjects research has resulted in alleviating physical impairments that persist after injury or chronic disease risk factors in order to allow people to maintain or resume physical activity.

The combined research agenda of our laboratories is to optimize health across the lifespan by deriving research questions from our community engagement to: 1) Develop a more comprehensive understanding of the pathological implications of physical inactivity throughout the lifespan, and 2) Implement physical activity programs in the community that lead to healthy aging. To accomplish this agenda, the Biodynamics Research Laboratory (BRL), Health Risk Assessment Program (HRAP), Laboratory of Systems Physiology (LSP), and School of Data Science (SDS) will participate in this project.

Our collaborative efforts will study epidemiological outcomes (SDS) and community health issues (HRAP) in our laboratories to investigate the pathological implications of physical inactivity. The evidence generated in our laboratories (BRL and LSP) will be applied back in the community (HRAP). Afterward, our HRAP group will assess the impact of the intervention with the at-risk populations. This process allows for field-testing of our laboratory-based findings, refinement of processes, and ultimately the development of evidence-driven interventions to achieve meaningful change in physical activity and health in the greater Charlotte community.

This proposal is a unique opportunity for all of our separate entities (basic research/ community/clinical groups) to work on a cohesive research agenda. By organizing around this research project, our unified team is excited to move the research goals of the University forward as we strive to improve health and physical activity throughout the lifespan.

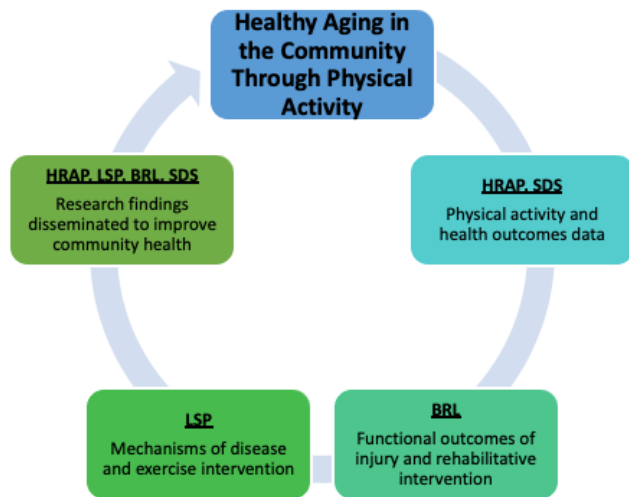


Figure 1. Collaborative Working Model

Evidence of Strength and Excellence

The foundation of our successful collaborative environment is the translation of laboratory research into meaningful outcomes at the community level. The diversity of our research infrastructure uniquely positions us to promote societal and lifestyle changes through physical activity to improve health. Our model of community-to-laboratory-to-community (Figure 1) is the underlying strength of our collaborative efforts. This large-scale collaboration will encompass a feedback loop approach. Through its numerous community health events and partnerships with Mecklenburg County Community

Centers, the HRAP gathers valuable data that informs the LSP and BRL on the relationship between health and physical activity across the greater Charlotte region. Additionally, the SDS contributes epidemiological findings to provide initial guidance for the BRL and LSP investigations. The interaction between physical activity and health will shape the theoretical basis driving the formation of our research questions on the mechanisms for adverse physiological health outcomes related to physical inactivity. The LSP and BRL will explore these mechanisms and develop community-based physical activity interventions. Thus far, our summative efforts have led to numerous scientific breakthroughs and community outreach partnerships to promote healthy aging, including:

- Identified cellular mechanisms regulating adult skeletal muscle health and glucose metabolism.
- Determine the effects of obesity and or injury on skeletal muscle integrity.
- Established and translated animal injury and rehabilitation models to clinical practice.
- Identified timepoints across lifespan for effective heart alterations with daily activity.
- Establish effective and low barrier exercise interventions to manage blood pressure.
- Contextualized the physical, psychosocial and financial consequences, as well as the associated co-morbidities of musculoskeletal injuries, across the lifespan.
- Developed innovative and accessible rehabilitation paradigms to combat stagnant treatment for threats to physical activity such as joint injuries, hypertension, and pulmonary disease.
- Developed mechanisms to prospectively and remotely track health outcomes from community partnerships.

The diverse, but complementary disciplines within our group, although not fully realized, have fostered productive collaborations that are now primed to increase in scale and focus on translational approaches to address questions regarding the physiological and community barriers

to physical activity. We will be designing community physical activity interventions that are based on our developing understanding of physical activity and physiological health. Our group is well positioned to improve the health of people in local communities and therefore increase the prominence of UNC Charlotte in community health initiatives.

The researchers directly involved with this project have extensive experience with collaborations within and between our laboratory groups, as noted in our curriculum vitae. Additionally, over the past few years we have experienced successful collaborations with the University of North Carolina at Chapel Hill, Duke University, University of Kentucky, University of Toledo, Georgia State University, Appalachian State University, North Carolina State University, Purdue University, The Sanger Heart and Vascular Institute, Slippery Rock University, KU Leuven in Belgium, Greenwich University in the UK, and University of New England in Australia. These relationships suggest the impact of our research along with our strong capacity to successfully work as a research team.

Collectively, our collaborative team has secured funding totaling over \$3,000,000 and published over 150 peer-reviewed manuscripts in the past five years. These publications are in high impact journals including: *Medicine and Science and Sports Exercise* (IF = 4.478; ranks 6 out of 83 in Sports Sciences), *Journal of Athletic Training* (IF = 2.253; ranks 30 out of 83 in Sports Science), and *AGE* (IF = 4.648; ranks 8 out of 53 in Geriatrics and Gerontology), *International Journal of Biological Sciences* (IF = 4.858; rank 207 out of 1257 in Biochemistry, Genetics and Molecular Biology), and *Biology* (IF = 3.79; ranks 19 out of 93 in Biology). Our multifaceted approach, robust scientific framework, and established relationships with numerous community health centers creates a wide spectrum of research projects and funding opportunities specific to healthy aging through physical activity. Moreover, as part of the Urban Research University, our team is ideally positioned to reach traditionally underserved populations through a variety of media platforms. Our collaborative work has resulted in media coverage by *The New York Times*, *Men's Health*, *Doctor Radio*, *Livestrong.org*, *EurekaAlert*, *Decan Chronicle*, *Medical Xpress*, *Everyday Health*, and *Medical Life Sciences News*.

Student Education and Research Training

Between the BRL and the LSP we have trained 14 doctoral students and 19 Masters students. We have 100% job (faculty positions) or postdoctoral placements of our PhD graduates. While the Department of Kinesiology does not have a PhD program it does participate in the interdisciplinary PhD programs in Biology and Health Services Research. It is important to note that a large percentage of our PhD students came to UNCC to work with their selected mentor in Kinesiology, despite not having a PhD program specific to their field of study in the Department of Kinesiology. Additionally, faculty regularly work with doctoral students from other programs at UNC Charlotte. Even without a departmental PhD program research faculty feel strongly about developing students as researchers and have included 16 undergraduate honors students, and worked to develop the Department's honor program to recruit students.

Alignment with Regional and National Priorities

With the U.S. annual population growth at its lowest since 1900, the growth of the 55 years and older population (27%) was 20 times greater than those under 55 (1.3%) over the past 10 years (US Census Bureau, 2020). Also, the average annual medical cost for an individual 65 years or older was approximately \$14,000, with an individual's annual cost doubling from age 70 to 90 years (Nat. Bur. Econ. Res., Working Paper 21270, 2015.). Thus, any efforts to improve one's health as they age would reduce the federal and personal financial burden, and improve one's quality of life. Knowing North Carolina ranks 9th in total population as well as residents over 65, there is a significant need to improve healthy aging in our community, state and region.

Federally, the concern over recent years regarding the need for addressing the impact of physical inactivity with the ageing population has grown. In an effort to address this issue, the National Institute on Aging (NIH) has published its strategic directions for research for the 2020-2025. Of the nine goals listed, the collaborative research conducted by our faculty has the ability to directly address 8 of the 9 goals. This alignment with their goals ensures we have avenues to seek extramural funding and support. In addition to the NIA, our core objectives directly align with regional and national funding opportunities focused on enhancing our understanding of the biology of aging and therapeutic interventions to promote healthy aging. A few examples of current priorities with federal funding our research group is in position to apply and be competitive with: NIH priority on chronic disease and aging: [High-Priority Research Topics](#), National Institutes of Aging Priorities: [R21 Grants | NIA](#), and [Translational Aging Research](#), American Federation of Aging Research ([AFAR](#)), Department of Defense ([DOD](#)).

Regionally, the priority for funding support for this area of investigation can be provided through North Carolina Biotech. NC Biotech ([Funding](#)) offers regional funding programs that help propel university researchers and set them up for larger scale funding opportunities. The Innovation Impact Grant supports purchase of core facility research equipment and the NCBiotech's Flash Grant Program supports seed money to support innovative research ideas.

The health-related impacts of physical inactivity is of primary concern with the governing body for exercise and physiological health, the American College of Sports Medicine. ACSM recently published the latest overview of the physical activity literature suggesting the serious impact of physical inactivity on various health-related outcomes and chronic diseases (Med. Sci. Sports Exerc. 51(6): 1227-1241, 2019) and calling for more action with this health concern.

The University of North Carolina at Charlotte is an Urban Research University that holds the Carnegie Community Engagement Classification. Additionally, the mission statement of the University speaks directly to impacting the health of the greater Charlotte area. Our program would tie scientific advancements from the LSP and BRL directly to the existing community health work performed yearly by HRAP. In this regard, we will directly enhance the health of the greater Charlotte area through scientific advancement. Additionally, all labs affiliated with this program routinely involve students, and thus the program will also enhance the community engagement of UNC Charlotte students, another component of the University mission.

Supporting Documents

Faculty	Contribution
Michael Turner, Associate Professor, Department of Kinesiology, Lead PI on this application	Member of the LSP . Expertise in physiological aging, cardiovascular system and physical activity. Identifying structural and functional alterations with the heart due to aging and exercise. Identification of genomic factors participating in behavior- and age-related alterations with the heart. Experience leading (R15) and Co-PI (RO1) of federally funded grants in aging and physical activity.
Susan Arthur, Associate Professor, Department of Kinesiology	Co-Director of the LSP . Expertise in using exercise to determine the cellular mechanisms regulating skeletal muscle integrity and injured, aged, obese and disease models. Identifying modes of exercise and nutrition interventions to enhance muscle health in injured, aged, obese and diseased skeletal muscle.
David Bellar, Professor and Chair Department of Kinesiology	Participant in HRAP and LSP . Expertise in community based research programs for diabetes and obesity prevention as well as for Cancer survivorship. Will contribute to the project by assisting with the translation of the laboratory findings into the community programming.
Luke Donovan, Assistant Professor, Department of Kinesiology	Member of BRL . Expertise in evaluating and rehabilitating sensorimotor and gait impairments in patients with joint injury. Additional experience includes quantifying the physical, psychosocial, and financial burden of joint injury.
Reuben Howden, Professor, Department of Kinesiology	Member of LSP . Expertise in cardiovascular health with an emphasis on hypertension. Has experience in both laboratory and community-based handgrip exercise training interventions to prevent and treat hypertension in healthy, aged and diseases populations.
Joseph Marino, Associate Professor Department of Kinesiology	Co-Director of the LSP . Expertise in tissue culture, rodent and human models to determine the effects of obesity and Type 2 Diabetes on skeletal muscle health, and feasible therapeutic and pharmacological interventions.

<p>Trudy Moore-Harrison, Clinical Assistant Professor, Department of Kinesiology</p>	<p>Director of HRAP. Expertise in community-based and evidence-based physical activity programs and gerontology. Additional experience in assessing cardio-respiratory fitness and examining ambulatory activity in different populations.</p>
<p>Rajib Paul, Associate Professor of Biostatistics, Department of Public Health Sciences</p>	<p>Member of SDS. Expertise in Bayesian Methods, Biostatistics, Infectious Diseases, Maternal and Child Health, Social Epidemiology, and Spatial and Spatio-temporal Statistics.</p>
<p>Brian Ring, Clinical Assistant Professor, Department of Kinesiology</p>	<p>Participant with HRAP. Expertise in clinical critical care, treatment of chronic cardiopulmonary disease, physiology, and community health engagement. Experience in clinical technology development, animal modeling of aerosol disease transmission, and pulmonary function testing.</p>
<p>Abbey Thomas, Assistant Professor, Department of Kinesiology</p>	<p>Member of the BRL. Expertise in neural, muscular, and biomechanical consequences of joint injury in humans. Experience using large data sets to understand effects of injury on physical activity across the lifespan.</p>
<p>Tricia Turner, Associate Professor, Department of Kinesiology</p>	<p>Member of the BRL. Expertise in both animal and human models of joint injury and the impact injury has on physical activity levels across the lifespan.</p>