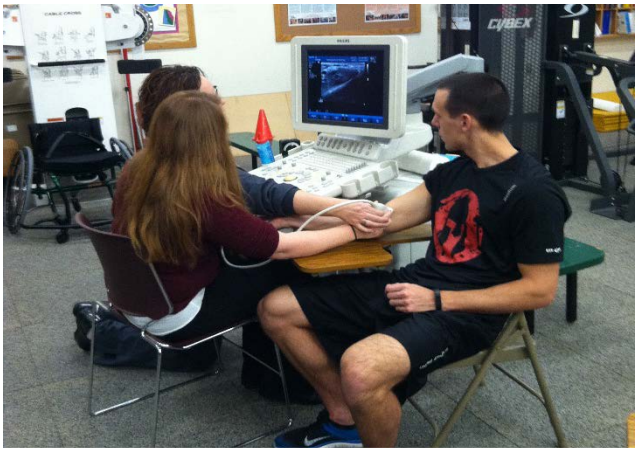
Kyle. J. Hackney, PhD, CSCS

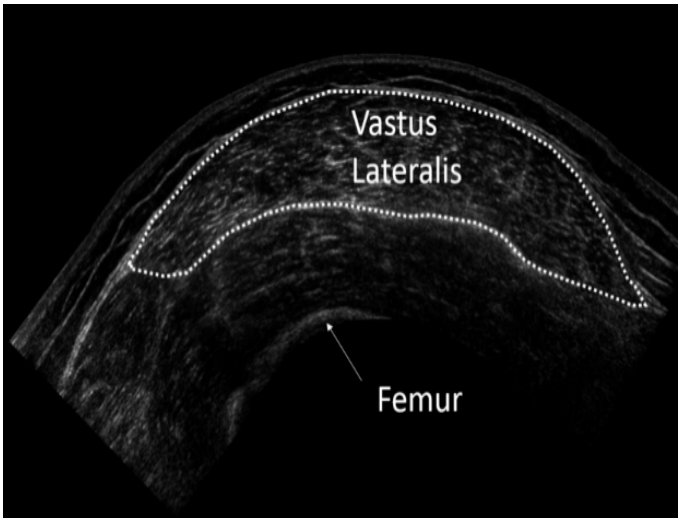
The overarching aims of the Muscle, Metabolism, and Ergogenics Laboratory are to: 1) understand how exercise, nutrition, and environmental stimuli interact to produce phenotype changes (examples- skeletal hypertrophy, strength gain, fatigue resistance); and 2) implement these regimens across a variety populations (recreational exercisers, elite athletes, aging adults, individuals with disabilities, or other specialized populations) that may benefit. Within this scope three research areas are highlighted: 1) Human Performance and Ergogenic Aids; 2) Countermeasures to Inactivity or Musculoskeletal Disuse; 3) Neuromuscular Health in Aging.

Research Area: 1) Human Performance and Ergogenic Aids.

The fundamental question being asked in this research area is *"can athletic or occupational performance be optimized through exercise training and nutrition?* Exercise training is highly variable and specific to the sport or occupational tasks required; therefore; in this research area we strive to make meaningful contributions to a science that is rapidly evolving and adapting. Many outcome variables in this research area are considered classic (example- VO_2 max, lactate threshold, one repetition max, vertical jump, agility timing); while others are highly innovative (example- blood flow and muscle cross-sectional area assessment via ultrasound). Nutritional modulation can occur in a variety of ways and may include: 1) alterations in total energy intake, macronutrient percentages, and the amount of water consumed; 2) moderate increases in specific foods or dietary supplements (examples vitamins, carbohydrate, caffeine, and phosphocreatine); or 3) complex changes in dietary habits (removal casein, gluten, or dairy).



Example-Brachial artery blood flow assessment in collaboration with dietary supplement and exercise intake.



Example of Panoramic Ultrasound for muscle cross-sectional area

Research Area: 2) Countermeasures to Strength Loss During Inactivity/Disuse or Injury.

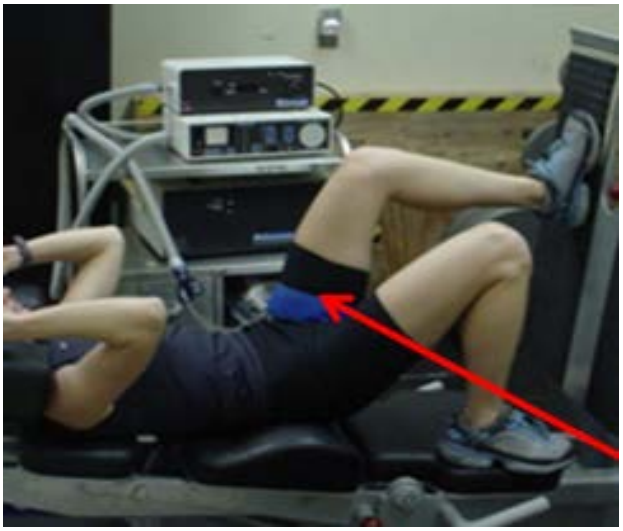
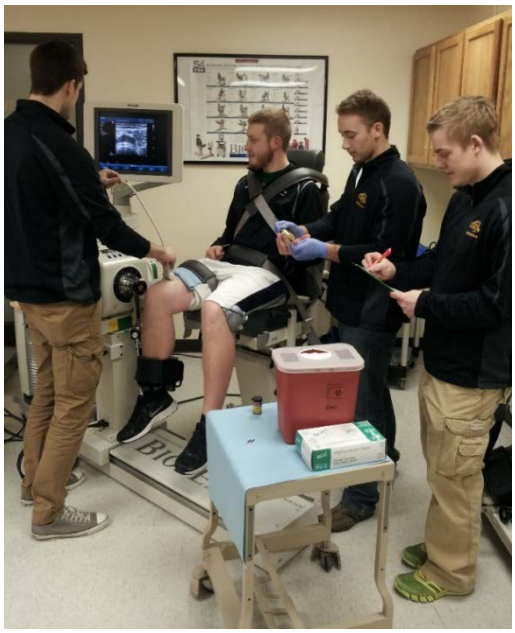


Figure 3- Example of compression exercise via inflation cuff (blue)

Example-Weighted Suit Model approach to Astronaut Related Task Simulations. Weighted Suit simulates 105 lbs mass on earth of NDX-2 Planetary Space Suit developed at UND.

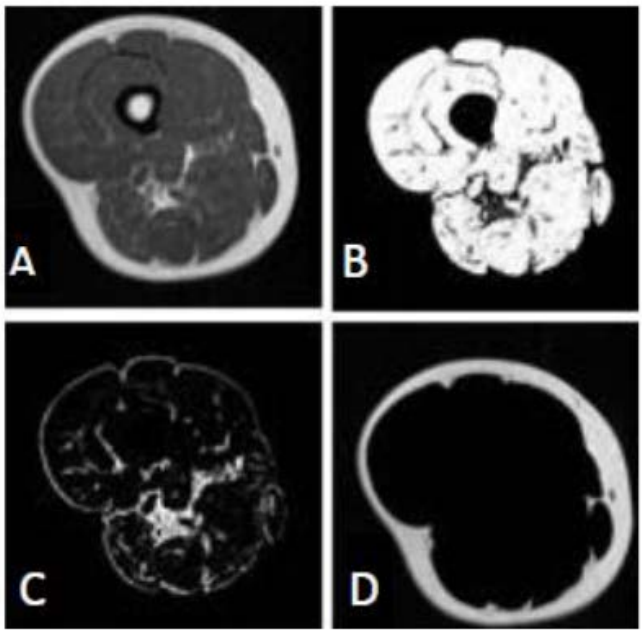
The fundamental question being asked in this research area is *"can exercise prescription, nutritional intake, or a combination of exercise and nutrition overcome the negative effects of inactivity/disuse or enhance recovery from injury?"* Changes in muscle morphology, metabolism, and function are a well-known consequences of inactivity or disuse. This may occur from: 1) an accumulation of small events such as sitting 8 hours each day; 5 days per week at a sedentary job, 2) extended immobilization following injury, surgery, or hospitalization; or 3) a very complex endeavor such as prolonged exposure to microgravity via spaceflight. In this focus, we strive to explore these adaptations using multiple analogs (examples- unilateral limb suspension, boot walking, etc).Our goal is to explore novel interventions such as leucine, L-argine, and/or creatine supplementation, compression exercise, or combination of both nutritional supplementation and exercise to combat the negative consequences of deconditioning from inactivity/disuse or injury. Further, we within this area we seek to answer the question, "*What is the acceptable level of fitness loss for an astronaut during long duration spaceflight*?" Muscle mass, strength, and endurance losses are an unwelcomed reality once gravitational loading is removed. Our initial research in this area has a used a weighted suit model in attempt to understand fitness and performance thresholds that could help NASA define fitness for duty requirements.



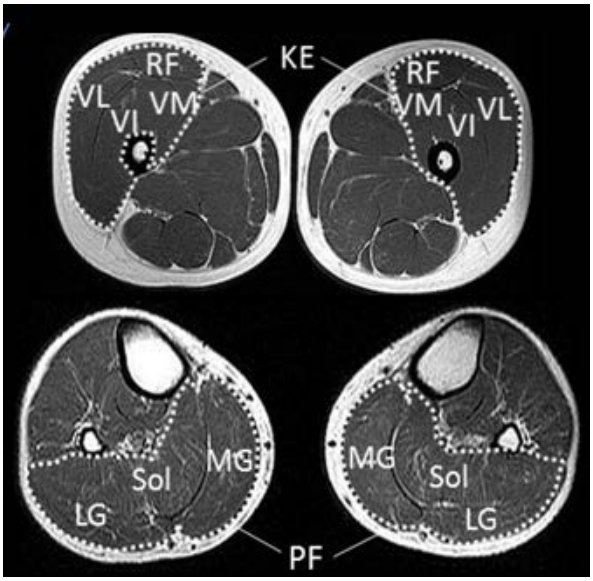
Undergraduate exercise science students explore the metabolic and perceptual responses to compression resistance exercise

Research Area 3) Neuromuscular Health in Aging.

In the United States individuals over the age of 65 years is the fast growing segment of the population. In North Dakota the population is expected to increase by 50% by 2025 (from 98,595 to 148,060). Unfortunately, the fifth decade of life is associated with an age related reduction in muscle mass (sacropenia) and strength (dynapenia). The fundamental question being asked in this research area is *"What exercise and nutrition interventions may be the most effective in prolonging the negative effects of sarcopenia, dynapenia, and the loss of functional independence as we age?* In this area, advances from research area 1 and 2 are applied to the middle-aged and aging populations. We seek to 1) observe changes in muscle morphology using gold-standard analysis techniques such magnetic resonance imaging (MRI) and dual energy x-ray absorptiometry (DEXA); 2) explore strength/endurance and steadiness using Biodex; 3) examine neural drive using the interpolated twitch technique; and 4) evaluate real world changes in task performance and function (example- ability to complete activities of daily living).



Example of : A) MRI scan of upper leg with segmentation for: B) muscle volume, C) intermuscular adipose tissue, D) subcutaneous adipose tissue



Example MRI scan of upper (KE= knee extensors) and lower (PF=plantar flexors) limbs.

Current and Past Projects

Primary Student Advisor:

Doctoral Students-

Kara Stone, MS, HNES- PhD dissertation: TBD

Chris Kotarsky, MS- HNES- PhD dissertation TBD.

Nate Dicks, MS- HNES- PhD dissertation TBD

Logan Pitts, HNES, PhD dissertation TBD

Masters Students-

Sean Mahoney- HNES, MS thesis- topic blood flow restricted aerobic exercise for astronauts.

Shane Mccullough- HNES, MS thesis- TBD

Previous students-

Dan Streeter, BS- Dept. HNES MS thesis- L-arginine, resistance exercise, and flow mediated dilation (graduated 05/2017).

Whitney Larsen, BS- Dept. HNES MS thesis- Strength and rate of force development for load carriage (graduated 05/2017).

Chris Kotarsky, MS- HNES-MS thesis- Body weight training and muscle quality (graduated 05/2016).