Reasoning of dissertation topic and competency of potential supervisor for admission onto joint LSU and TU doctoral studies in 2021

Area of research (title and code)	**Natural science (N000)**
Field of research (title and code)	Biology (N010)
Topic of research	**Biomechanical properties of musculoskeletal tissues**
Institution	**Lithuanian Sports University**

Potential supervisor

Pedagogical and scientific degree	Name, surname	Academic position
PhD	Danguole Satkunskiene	Senior researcher

Short reasoning of proposed dissertation topic

Title

The morpho-mechanical profile of obese muscle and tendon and prevention models of non-functional adaptations

Short research description (including aims and objectives) (maximum 1500 characters).

The role of obesity on musculoskeletal remodelling and, in particular, on the morpho-mechanical profile of muscle and tendons represent a relatively new field of investigation. Considering the widespread obesity and the spectrum of problems arising from this disease, the study and characterisation of the different outcomes from it guarantees both a practical and research-oriented applicability. Thus, to build a descriptive model of musculoskeletal morpho-mechanical adaptations arising from obesity, populations exposed to different stimuli (regular exercise and nutrition diets) may discover new insights and support monitoring processes and decision making in the obesity treatment therapy procedures.
Thus, the primary aims of the current project will be to characterise the morpho-mechanical musculoskeletal profile of obese individuals in comparison with physically active and athletic populations, to build theoretical frameworks of remodelling processes linked to such changes and to build models of intervention to successfully monitor and prevent non-functional adaptations to the musculoskeletal system in obese individuals.
Objectives:

1. To determine the morpho-mechanical profile of muscle and tendon of obese non-active, obese physical active, healthy physically active and athletic populations in interaction with the muscle function.
2. To determine the effect of different diets of obese and healthy participants on muscle growth, function and mechanical properties (animal models).
3. To determine the effect of different loading stimuli on obese muscle-tendon function and mechanical properties.

Relevance of the problem, its novelty at national and international level (maximum 1500 characters).

Recent studies have shown that obesity impact the passive and active structure of muscles alter their contractile function, cause tendon and tissue extracellular matrix (ECM) pathology. These changes affect the biomechanical properties of musculoskeletal tissues, decline muscle functions, increase the risk of injury, reduce mobility, and promote obesity-associated health risks and disease (1-7).
Obesity affects tendon structure through impaired glucose tolerance, increases in advanced glycation end-products (AGEs), the release of inflammatory cytokines, increased collagen disorganisation and increased load on the tendon. In tendon tissue, AGEs build-up results in alterations in collagen structure and binding along with changes in the non-collagenous components of tendon tissue. Because obese tissue is considered chronically inflamed, obesity-associated ECM remodelling can also directly contribute to tissue mechanical properties and alter

tissues' proper development and homeostasis. Obese ECM has been shown to display increased profibrotic components, including collagen I and VI, fibronectin, and hyaluronic acid (6, 7). These changes could lead to stiffening of the muscle and tendon tissue (2, 3) or decreased stiffness, especially with ageing (4). The molecular changes affect muscle morpho-mechanical properties, contractile function and phenotype. In vivo, obesity can increase the absolute force and power produced; isolated muscle preparations show that obesity often leads to a decrease in force produced per muscle cross-sectional area and power produced per muscle mass (1). Because only fragmentary studies have been performed and their findings are controversial, the relationship between alterations in muscle and tendon biochemistry caused by obesity and biomechanical properties of these tissues is not entirely understood and required further investigations.

1. Tallis, J., James, R. S., & Seebacher, F. (2018). The effects of obesity on skeletal muscle contractile function. Journal of Experimental Biology, 221(13).
2. Taş, S., Yılmaz, S., Onur, M. R., Soylu, A. R., Altuntaş, O., & Korkusuz, F. (2017). Patellar tendon mechanical properties change with gender, body mass index and quadriceps femoris muscle strength. Acta orthopaedica et traumatologica turcica, 51(1), 54-59.
3. Docking, S. I., Hart, H. F., Rio, E., Hannington, M. C., Cook, J. L., & Culvenor, A. G. (2021). Age, Body Mass Index, and Physical Activity Partly Explain Variability in the Prevalence of Achilles Tendon Abnormalities: A Systematic Review and Meta-Analysis of Imaging Studies in Asymptomatic Individuals. Journal of Orthopaedic & Sports Physical Therapy, (0), 1-80.
4. Tomlinson, D. J., Erskine, R. M., Morse, C. I., Pappachan, J. M., Sanderson-Gillard, E., & Onambélé-Pearson, G. L. (2021). The combined effects of obesity and ageing on skeletal muscle function and tendon properties in vivo in men. Endocrine, 1-12.
5. Macchi, M., Spezia, M., Elli, S., Schiaffini, G., & Chisari, E. (2020). Obesity increases the risk of tendinopathy, tendon tear and rupture, and postoperative complications: a systematic review of clinical studies. *Clinical Orthopaedics and Related Research®*, *478*(8), 1839-1847.
6. Seo B.R. et al. Obesity-dependent changes in interstitial ECM mechanics promote breast tumorigenesis. Sci. Transl. Med. 2015; 7301ra130
7. Sun K. et al. Fibrosis and adipose tissue dysfunction. Cell Metab. 2013; 18: 470-477.
8. Provenzano P.P. et al. Contact guidance mediated three-dimensional cell migration is regulated by Rho/ROCK-dependent matrix reorganisation. Biophys. J. 2008; 95: 5374-5384.

Research methods and possibilities for conducting these studies (maximum 1500 characters).

- Musculoskeletal B-mode ultrasonography (muscle architecture, tendon dimensions, muscle, and tendon quality)
- Shear-wave elastography (muscle and tendon biomechanical properties)
- Surface electromyography (muscle activity)
- Dynamometry (muscle and tendon biomechanical properties testing procedures and performance assessment)
- Physical condition assessment tools
- Inflammatory cytokines evaluation (e.g., IL-6; IL-8)
- Animal models.

Please indicate the links between the proposed topic for the doctoral thesis and biomechanics / physical therapy / sports study programs.

The proposed topic for the doctoral thesis has direct link with study programs: master's SPORTS PHYSIOLOGY AND GENETICS module Mechanical properties of biological tissues; PhD BIOLOGY: PHYSIOLOGY module Advanced Exercise Physiology.
Is the proposed topic for the doctoral thesis related to currently funded research projects? Please indicate the links between the proposed topic for the doctoral thesis and funded research projects **No**
Is the proposed topic for the doctoral thesis related to joint research with a foreign institution? Please indicate the links between the proposed topic for the doctoral thesis and research with a foreign institution **No**

Currently I am supervisor of ___0___ doctoral students.

Supervisor  Danguolė Satkunskienė

(signature) (Name, surname)

Date: 03-05-2021