2ND BIOMECHANICS IN SPORT AND AGEING SYMPOSIUM

ARTIFICIAL INTELLIGENCE

BUDAPEST, 15-16 OCTOBER 2024

PROGRAM and ABSTRACTS

HUNGARIAN UNIVERSITY OF SPORTS SCIENCE
BUDAPEST

SCIENTIFIC PROGRAM

15 October (Athens lecture hall, Level -1, K1 building)

09.00–15.00	Registration: main entrance reception, K1 Building
10.00–12.00	Social program options:
	A. Campus tour. Meet at registration area.
	B. Exercise at the Dr. Koltai Jenő Sports Centre, the state-of-the-art venue for university education and a practice site for the 2023 World Athletics Championship. Meet at entrance of Sports Center at Csörsz utca.
	C. Castle walking tour. Meet at registration area.
12.00–13.30	Lunch (on your own)
	Student award candidates mount their poster in the Aula for attendees and members of the jury to view during the Symposium
14.00–14.15	Opening — prof. dr Tamás Sterbenz, rector, symposium patron

THE BASICS

Chair: Alan Godfrey, Tibor Hortobágyi | Discussion leader: Melissa Boswell

14.15–15.00	Lead keynote: The world of AI in health care: Past, present, and the future — **Peter van Ooijen**, Machine Learning Lab Coordinator, Data Science Center in Health, University Medical Center Groningen, The Netherlands
15.00–15.15	Questions
15.15–16.00	Opening keynote 1: AI in the biomechanics of sport science: An overview — **Neil Cronin**, Neuromuscular Research Centre, Faculty of Sport and Health Sciences, University of Jyvaskyla, Finland
16.00–16.15	Questions
16.15–17.00	Opening keynote 2: AI in the biomechanics of aging research: An overview — **Claudine Lamoth**, Department of Human Movement Sciences, University Medical Center Groningen, The Netherlands

17.00–17.15 Questions

17.15–17:30 Set 1 of students deliver their 3-minute-long poster, pitches followed by 2 minutes of questions

17.15 Chimerem Amiaka: Redefining slip outcome classifications based on automated pattern recognition using machine learning

17.20 Gergő Bolla: Comparison of the diagnostic accuracy of resting-state fMRI driven machine learning algorithms in the detection of mild cognitive impairment

17.25 Yucheng Wang: Kinematic analysis of tennis serving techniques in athletes using different stances

17.30 Taysir Laajili: Self-esteem, wellbeing and health status of female athletes in the context of sport performance

17.30–19.30 Free program or guided city tour. Meet at registration area.

19.30 Dinner (on your own)

19.30 Speakers' dinner (C201 Rome seminar room). Sponsor: Human Movement Consulting Ltd.

16 October, Athens lecture hall, Level -1, K1 Building

08.00–15.00 Registration: main entrance reception, K1 Building

BODY STRUCTURE AND EXERCISE PRESCRIPTION

Chair: Zsuzsanna Kneffel | Discussion leader: Claudine Lamoth

09.00–09.20 Machine learning on prediction of relative physical activity intensity using medical radar sensor and 3D accelerometer — **Attila Biró**, Department of Physiotherapy, University of Malaga, Spain

09.20–9.40 Implementation and evaluation of machine/deep learning algorithms for physical activity recognition in older adults — **Luis Francisco Sigcha**, Data-Driven Computer Engineering Group, Department of Electronic and Computer Engineering, Health Research Institute, University of Limerick, Ireland

09.40–10.00 Assessment of exercise capacity in patients with pulmonary hypertension with actigraphy: on a journey of development of a novel endpoint — **Dzmitry Kaliukhovich**, Data Science and Digital Health, Johnson & Johnson Innovative Medicine, Beerse, Belgium

10.00–10.20 AI-aided muscle-tendon analysis in sports biomechanics research — **Neil Cronin**, Neuromuscular Research Centre, Faculty of Sport and Health Sciences, University of Jyvaskyla, Finland

10.20–10.40 Questions

10.40–11.00 Refreshment break outside Athens lecture hall. Set 2 of students deliver 3-minute-long poster pitches followed by 2 minutes of questions.

10.40 Eszter Pocsai: Neuromuscular and morphological characteristics of previously injured and non-injured biceps femoris in competitive athletes

10.45 Linjie Zhang: Effect of forefoot transverse arch stiffness on foot biomechanical response-based on finite element method

10.50 Zsófia Bokor-Tóth: Static and dynamic postural stability in individuals with mid-portion Achilles tendinopathy

10.55 Zanni Zhang: Effects of ankle dorsiflexion restriction on the lower limb biomechanics during long jump take-off

MOTOR-COGNITIVE FUNCTION AND AI IN AGING

Chair: János Négyesi, András Hegyi | Discussion leader: Peter M. A. van Ooijen

11.00–11.20 Brain connectome age as an intelligent tool for understanding risk factors in healthy aging — **Jesus Cortes**, Computational Neuroimaging Group, Biocruces-Bizkaia Health

11.20–11.40 Comparison of the diagnostic accuracy of resting-state fMRI driven machine learning algorithms in the detection of mild cognitive impairment — **Gergő Bolla**, Neurocognitive Research Center, National Institute of Mental Health, Neurology and Neurosurgery, Budapest, Hungary

11.40–12.00 Differentiation of patients with mild cognitive impairment and healthy controls based on computer assisted hand movement analysis — **András Attila Horváth**, Neurocognitive Research Center, National Institute of Mental Health, Neurology and Neurosurgery, Budapest, Hungary

12.00–12.30 Questions

12.30–14.00 Lunch provided for all registrants in the Aula

INJURY AND DISEASE

Chair: András Attila Horváth, Ádám Lelbach | Discussion leader: Neil Cronin

14.00–14.20 AI-aided automated recognition of asymmetric and fatigued gait — **Gusztáv Fekete**, Savaria Institute of Technology, Eötvös Loránd University, Szombathely, Hungary

14.20–14.40 What AI can (not) tell us about ACL re-injury — **Chris Richter**, Data and Technologies, Bavarian Digital Agency

14.40–15.00 AI-aided characterization of knee function — **Melissa Boswell**, Department of Bioengineering, Stanford University, Stanford, CA, USA

15.00–15.30 Questions

15.30–16.00 Refreshment break outside Athens lecture hall. Set 3 of students deliver 3-minute-long poster pitches followed by 2 minutes of questions.

15.30 Murilo Henrique Faria: Acute effect of intermittent hypoxia on the gait of people with parkinson's disease: preliminary results

15.35 Leila Bogdán: Comparsion of standard and standard plus neuromuscular eectrostimulation (NMES)-aided cross-education for ACL reconstruction rehabilitation: A proposal

15.40 Jingyi Ye: Effect of knee joint position on soleus muscle function during isokinetic plantarflexion

15.45 Beáta Csizmadia: The effects of resistance training on muscle-tendon function, elastic energy storage and walking economy in older adults - A proposal

15.50 Mehmet Akman: Relationship between achilles tendon stiffness and cost of walking in healthy middle-aged and older adults - A proposal

15.55 Mohamed Emam: Effects of eccentric overload resistance training on muscle quality, balance and cost of walking in older individuals - A proposal

PERFORMANCE ASSESSMENT AND PREDICTION WORKSHOP

Chairs and discussion facilitators: Annamária Péter, Leonidas, Petridis, Chris Richter, Jesus Cortes

16.00–16.45	Sensor-based activity recognition in health and disease — **Alan Godfrey, Connor Wall**, Department of Computer and Information Sciences, Northumbria University, Newcastle upon Tyne, UK
16.45	Social program options: A. Campus tour. Meet at registration area. B. Exercise at the Dr. Koltai Jenő Sports Centre, the state-of-the-art venue for university education and a practice site for the 2023 World Athletics Championship. Meet at entrance of Sports Center at Csörsz utca. C. Castle walking tour. Meet at registration area.
19.00	Consilior Kft. sponsor presentation
19.30	Closing dinner for all attendees and speakers together. (Dr. Koltai Jenő Sports Centre). Sponsor: Consilior Kft.

ABSTRACTS

INVITED SPEAKERS

MACHINE LEARNING ON PREDICTION OF RELATIVE PHYSICAL ACTIVITY INTENSITY USING MEDICAL RADAR SENSOR AND 3D ACCELEROMETER

Attila Biró
Department of Physiotherapy, University of Malaga, Spain
abiro@uma.es

In high-performance sports, monitoring physical activity using non-invasive athlete monitoring and controlling fatigue is crucial for injury prevention and optimizing performance. Due to the risk of injuries, using accelerometer-based smart trackers, activity measurement bracelets, and smartwatches to record health parameters during performance sports activities is prohibited.

This study investigates the use of machine learning (ML) models to predict the intensity of physical activities based on data from medical radar sensors combined with 3D accelerometers or IMUs. The novelty of this research lies in integrating a 24 GHz Doppler radar sensor, which measures heart rate (HR) and respiration without contact, with tri-axial (3D) acceleration data to estimate key performance metrics from the velocity of the activities.

The study utilized datasets from professional athletes and publicly available sources, incorporating various ML models for data analysis. Leave-one-out (LOO) cross-validation (CV), as well as out-of-sample testing (OST) methods, have been used to evaluate the level of accuracy in activity intensity prediction. The energy expenditure prediction with three-axial accelerometer sensors by using linear regression provided 97-99% accuracy on selected sports (cycling, running, and soccer). The ML-based RPE results using medical radar sensors on a time-series heart rate (HR) dataset varied between 90% and 96% accuracy. The ML models classify the rating of the perceived exertion and the metabolic equivalent of tasks performed consistently. The combination of radar and accelerometer data demonstrated significant potential for non-invasive monitoring of athletes, allowing for real-time adjustment of training loads to reduce injury risk.

These findings offer a promising approach to integrating ML and non-invasive sensor technology in sports to enhance both safety and performance.

Acknowledgments: This research was supported by the Biomedical Research Institute of Malaga (IBIMA) and the Faculty of Health Science, Queensland University Technology, Brisbane. The authors would also like to acknowledge the contribution of Toyo University during the research phase, which provided valuable resources for data analysis and student-athlete support.

COMPARISON OF THE DIAGNOSTIC ACCURACY OF RESTING-STATE FMRI DRIVEN MACHINE LEARNING ALGORITHMS IN THE DETECTION OF MILD COGNITIVE IMPAIRMENT

Gergo Bolla
Neurocognitive Research Center, National Institute of Mental Health, Neurology and Neurosurgery, Budapest, Hungary
gergobolla99@gmail.com

Mild cognitive impairment (MCI) is a potential therapeutic window in the prevention of dementia; however, automated detection of early cognitive deterioration is an unresolved issue.

The aim of our study was to compare various classification approaches to differentiate MCI patients from healthy controls, based on rs-fMRI data, using machine learning (ML) algorithms.

Own dataset (from two centers) and ADNI database were used during the analysis. Three fMRI parameters were applied in five feature selection algorithms: local correlation, intrinsic connectivity, and fractional amplitude of low frequency fluctuations. Support vector machine (SVM) and random forest (RF) methods were applied for classification.

We achieved a relatively wide range of 78-87% accuracy for the various feature selection methods with SVM combining the three rs-fMRI parameters. In the ADNI datasets case we can also see even 90% accuracy scores. RF provided a more harmonized result among the feature selection algorithms in both datasets with 80-84% accuracy for our local and 74-82% for the ADNI database. Despite some lower performance metrics of some algorithms, most of the results were positive and could be seen in two unrelated datasets which increase the validity of our methods.

Our results highlight the potential of ML-based fMRI applications for automated diagnostic techniques to recognize MCI patients.

ADVANCEMENTS IN AI FOR BIOMECHANICAL ASSESSMENT OF PHYSICAL FUNCTION

Melissa Boswell, PhD
Joe Gibbs Human Performance Institute, Huntersville, North Carolina, United States
mboswell@jghpi.com

Recent advancements in AI, coupled with the proliferation of wearable sensors and smartphones, offer promising avenues to overcome the economic and time constraints associated with traditional laboratory-based motion capture systems. These technologies enable us to monitor biomechanics in natural settings, providing a more holistic understanding of how individuals move and function.

This talk explores AI For physical function assessment, focusing on osteoarthritis and extending to sports and performance. Leveraging AI, we aim to revolutionize how we assess physical function, showcasing markerless pose estimation and deep learning models as cost-effective alternatives to traditional motion capture. AI models can also predict physical function outcomes from biomechanical data at scale, enhancing clinical motion analysis and rehabilitation. Additionally, smartphone-based tools enable self-assessment at home, bridging clinical assessments and real-world movement patterns. For example, a study will be presented which used a web-based tool to analyze sit-to-stand kinematics from at-home smartphone videos, associating maximum trunk angle with osteoarthritis status. This tool was later used in a digital clinical trial for knee osteoarthritis, offering a novel functional outcome measure with longitudinal assessment.

Towards the conclusion of the presentation, we will touch upon the exciting potential of AI in establishing environmentally valid biomechanics facilities, allowing for the collection of precise movement data during uninhibited sport-specific movement. This concept aligns with the broader goal of revolutionizing the quantification of human movement through innovative data acquisition systems and cutting-edge AI methodologies.

Overall, these tools can democratize access to and improve the validity of biomechanical assessments, enabling large-scale studies and decentralized clinical trials. This talk aims to showcase how AI can transform physical function assessment in both sports and ageing populations, paving the way for more personalized and effective interventions to improve quality of life and performance.

APPLICATIONS OF AI IN BIOMECHANICS AND SPORTS SCIENCE

Neil Cronin
University of Jyväskylä, Finland
neil.j.cronin@jyu.fi

Biomechanics research has traditionally been done in very controlled conditions, typically in an indoor laboratory, partly because of equipment restrictions.

With the recent proliferation of technologies such as mobile phones, low-cost cameras and wearable devices, coupled with artificial intelligence algorithms, it is now possible to quantify aspects of human movement outside of a lab. This can often be done at relatively low cost, and sometimes in real-time.

At the Symposium I will give two talks. In the first, I will introduce some of the recent applications of AI specifically in the sport and health domains, highlighting their potential, as well as some of the challenges associated with their use in the real world. In my second talk, I will focus specifically on AI-driven approaches to medical image analysis, with examples from several imaging modalities. In both talks, I will also address possible future directions in this exciting and dynamic field.

SENSOR-BASED ACTIVITY RECOGNITION IN HEALTH AND DISEASE

Alan Godfrey
Northumbria University, Newcastle upon Tyne, UK
alan.godfrey@northumbria.ac.uk

Sensor-based human activity recognition (HAR) is emerging as a powerful tool in healthcare. By leveraging data from wearable sensors like accelerometers and gyroscopes, HAR systems can monitor and analyse human movement patterns.

The ability to continuously track daily activities holds immense promise for preventative healthcare. HAR can be used to assess physical fitness levels, monitor adherence to exercise programs, and even detect early signs of decline in physical function.

This information can be crucial for promoting healthy lifestyles and preventing chronic diseases. Furthermore, HAR shows great potential in disease management. By analysing activity patterns, healthcare professionals can gain insights into disease progression, treatment effectiveness, and potential risks for complications. For instance, HAR can be used to monitor gait abnormalities in Parkinson's disease or track tremors in patients with essential tremor. This talk and demonstration will showcase the latest in HAR by exploring contemporary approaches such as the latest AI approaches.

AI-AIDED AUTOMATED RECOGNITION OF ASYMMETRIC AND FATIGUED GAIT

Dr Gusztáv Fekete
Department of Material Science and Technology, AUDI Hungária Faculty of Vehicle Engineering, Széchenyi István University
fekete.gusztav@sze.hu

Human gait cycle is influenced by numerous variables, including neurological, orthopaedic and pathological conditions. Due to these reasons gait analysis has a wide range of applications, e.g. diagnosis of neurological disorders, the study of disease progression, postural or the evaluation and improvement of athletic performance. Finding the best subset of gait features among biomechanical variables is considered very important due to its ability to identify relevant sports and clinical gait pattern differences to be explored under specific study conditions. This presentation proposes a new method of metaheuristic optimization-based selection of optimal gait features, considering such elements as fatigue or symmetric and asymmetric gait in order to filter those parameters, which are in essential use for gait pattern recognition.

Acknowledgements: This work was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (BO/00047/21/6) and the Department of Material Science and Technology, AUDI Faculty of Vehicle Engineering, Széchenyi István University.

DIFFERENTIATION OF PATIENTS WITH MILD COGNITIVE IMPAIRMENT AND HEALTHY CONTROLS BASED ON COMPUTER ASSISTED HAND MOVEMENT ANALYSIS

Andras Attila Horvath
Neurocognitive Research Center, National Institute of Mental Health, Neurology and Neurosurgery, Budapest, Hungary
andras.horvath.semmelweis@gmail.com

Aims: Current early stage diagnostic methods for cognitive decline are not suitable for regular wide scale screening. The Nyírő Gyula National Institute of Psychiatry and Addictology has partnered with Cursor Insight Ltd. (CI), a deep tech company specialized in movement analysis solutions in order to develop an easy to use screening system based on fine motor movement analysis to make early recognition of cognitive decline accessible to the wider population.

Methods: Digital solution - Dynamic movement components are assessed for predictive power regarding different variants and stages of cognitive decline by implementing the digitized versions of the following tests on a tablet + digital pen setup: handwritten signature; writing down heard numbers; Trail Making Test (A); Benson Figure Copy; Archimedes spiral. Subject groups - 50 clinically tracked patients at various stages of cognitive decline and 50 age matched controls. Expressive features are extracted from fine motor movement dynamics based on anonymized clinical track records.

Results: Results from a pilot study showed that dynamic features of fine motor movements can be used for proper early screening. The current work brought significant improvements to the pilot setup both in terms of usability and data quality and was utilized to discover new predictive fine motor dynamics features for cognitive decline.

Conclusions: In a collaboration between clinical and industrial partners, an easy to use screening system is proposed based on movement analysis that holds the promise of making early recognition of cognitive decline possible and accessible to the wider population.

ASSESSMENT OF EXERCISE CAPACITY IN PATIENTS WITH PULMONARY HYPERTENSION WITH ACTIGRAPHY: ON A JOURNEY OF DEVELOPMENT OF A NOVEL ENDPOINT

Dzmitry Kaliukhovich
Data Science and Digital Health, Johnson & Johnson Innovative Medicine, Morrisville, North Carolina, United States
dkaliukh@its.jnj.com

Pulmonary arterial hypertension (PAH) is a debilitating disease of pulmonary vasculature, characterized by progressive increases in pulmonary artery pressure and vascular resistance. A decrease in physical activity, together with dyspnea, is a leading symptom of PAH that reduces patients' quality of life. Although the 6-minute walk test is commonly used to measure exercise capacity in PAH, it does not fully reflect a patient's overall daily life physical activity (DLPA), providing only its snapshot within a controlled clinical setting. We evaluated whether actigraphy can facilitate continuous monitoring of exercise capacity in PAH.

TRACE was a randomized, placebo-controlled, double-blind, phase 4 study enrolling patients with PAH in World Health Organization functional class II/III, receiving stable endothelin receptor antagonist with/without phosphodiesterase type-5 inhibitor background therapy. The study evaluated the effect of selexipag on DLPA of patients witth PAH (registration no. NCT03078907 at https://clinicaltrials.gov/). Adult patients (N=108) were continously monitored with a wrist-worn accelerometer throughout the study. Distributions of step rate, distance and duration of patient's walking bouts were estimated at baseline, weeks 16 and 24 using 2-week periods of actigraphy data. Each of the three distributions constructed per patient was characterized by 21 metrics (mean, standard deviation, 19 percentiles [5th-95th, an increment of 5%]). The relationships between these metrics and the 6-minute walk distance (6MWD), Borg dyspnea index, and the PAH Symptoms and Impact questionnaire (PAH-SYMPACT) Physical Impact domain score were assessed at the three timepoints. Additionally, we evaluated test-retest reliability, and known-group and discriminant validity of each metric.

All metrics of step rate and bout distance were significantly correlated with 6MWD (positive correlations, p-values<0.005) and the PAH-SYMPACT Physical Impact domain score (negative correlations, p-values<0.05) at all timepoints. Negative correlations were also observed with the Borg dyspnea index and the actigraphy-derived metrics, with the majority reaching significance. Strong test-retest reliability was demonstrated (intra-class correlation coefficients ≥ 0.70). The metrics differentiated well between patients with varying disease severity levels.

In conclusion, actigraphy-derived metrics of patient's walking bouts correlate significantly with 6MWD, Borg dyspnea index and physical impacts of PAH, suggesting the utility of actigraphy in facilitating continuous monitoring of exercise capacity in adult patients with PAH.

AI IN THE BIOMECHANICS OF AGING – GAIT ANALYSIS

Prof. dr Claudine JC Lamoth
University of Groningen, University Medical Center Groningen, department of Human Movement Sciences, The Netherlands
c.j.c.lamoth@umcg.nl

Recent advancements in sensor technology have enabled the collection of comprehensive datasets from both clinical and real-world environments. This presentation will provide an overview of how AI methods (machine learning and deep learning approaches) can be integrated with wearable technology to study human gait patterns, particularly in aging. Motion capture sensors generate signals that can be transformed into variables representing the spatiotemporal, dynamic, kinematic, and kinetic aspects of gait.

These variables can detect changes in gait performance and adaptability associated with aging and various clinical conditions. However, the analysis often results in numerous variables, which provide a detailed description of gait but are often interrelated and vary in relevance across different populations. The high dimensionality and complexity of this data present a significant challenge in identifying the most meaningful features for accurate gait classification and phenotyping.

Machine learning techniques facilitate the identification of informative features and their interactions, enabling precise classification of individuals based on factors such as age, medication use, pathological conditions, cognitive decline, and fall risk.

This presentation will also delve into deep learning methods, such as Convolutional Neural Networks (CNNs) and Explainable AI (XAI). These approaches are particularly effective for analyzing time-series data from gait studies. Unlike machine learning methods that rely on hand-crafted features, CNNs process raw signals to automatically extract relevant features.

When combined with XAI, these models can offer valuable insights into the biomechanics of walking. The talk will emphasize how continuous monitoring of gait in both laboratory and real-life environments, enhanced by machine learning and deep learning approaches, provides important insights into various aspects of gait performance.

Examples from recent studies will be presented, and the opportunities and limitations of machine learning and deep learning in this field will be discussed.

Acknowledgment: dr. Xiao-ping Zheng, Department of Sports Science and Physical Education Faculty of Education, The Chinese University of Hong Kong

THE WORLD OF AI IN HEALTHCARE: PAST, PRESENT, AND FUTURE

Peter van Ooijen
Dept of Radiotherapy and Data Science Center in Health, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands
p.m.a.van.ooijen@umcg.nl

Artificial Intelligence (AI) has revolutionized the healthcare industry, transforming patient care and research paradigms. This keynote lecture provides an overview of the evolution of AI in healthcare, its current applications, and future prospects.

In the past, healthcare was heavily reliant on manual processes and intuition-based decision-making. The advent of AI brought about a paradigm shift, enabling data-driven decisions and automating routine tasks. Machine learning algorithms were developed to predict disease outcomes, while natural language processing facilitated the analysis of unstructured medical data.

Presently, AI's role in healthcare has expanded to include predictive analytics, precision medicine, and personalized patient care. Deep learning algorithms are being used for medical imaging interpretation, genomics, and drug discovery. AI-powered telemedicine and wearable technology have enhanced patient monitoring, while AI chatbots have improved patient engagement and adherence to treatment.

Looking ahead, the future of AI in healthcare promises even greater advancements. With the rise of new technology such as quantum computing and federated learning, we anticipate more sophisticated AI models capable of handling complex medical data while respecting privacy constraints. AI is expected to play a pivotal role in managing global health crises by predicting outbreaks and optimizing resource allocation.

However, the journey towards this future is not without challenges. Ethical considerations, data privacy, and the need for explainable AI models are pressing issues that need to be addressed. Moreover, the integration of AI into healthcare systems requires a multidisciplinary approach, involving clinicians, data scientists, ethicists, and policymakers.

In conclusion, AI has significantly shaped the healthcare landscape and will continue to do so. By overcoming current challenges and capitalizing on future opportunities, we can harness the full potential of AI to revolutionize healthcare delivery and research.

This keynote lecture aims to inspire and guide researchers and practitioners on this exciting journey of AI in healthcare.

UTILIZING AI IN BIOMECHANICS: WHAT AI CAN (NOT) TELL US ABOUT ACL RE-INJURY

Dr Chris Richter
byte Bavarian Digital Agency, München, Germany
chris@richtics.com

Artificial Intelligence (AI) is transforming numerous disciplines, including biomechanics. This presentation by Dr. Chris Richter will elucidate the multifaceted role of AI in the context of Anterior Cruciate Ligament (ACL) re-injury, addressing both its potential and limitations. The session will start with a foundational overview of AI, elucidating its core principles and relevance to biomechanics. This will be followed by a 'blue sky thinking' exercise, exploring potential future advancements AI might bring to the field.

While AI offers significant promise, it is not a universal solution. The talk will examine critical limitations of AI in biomechanics, underscoring the indispensable role of human expertise and the necessity of complementary technologies. Dr. Richter will explore how AI can enhance the efficiency of data capture and processing, facilitate the extraction of meaningful insights from complex datasets, and aid in the interpretation of these insights in unprecedented ways.

A key component of the talk will focus on strategies for practitioners to maximize AI's effectiveness, promoting a synergistic integration of AI technologies and human intelligence. Dr. Richter will also assess scenarios where AI may fall short, highlighting the intrinsic challenges and limitations.

The presentation will conclude with a forward-looking perspective, providing a view of the future of AI in biomechanics and ACL re-injury prediction.

IMPLEMENTATION AND EVALUATION OF MACHINE AND DEEP LEARNING ALGORITHMS FOR PHYSICAL ACTIVITY RECOGNITION IN OLDER ADULTS

Luis Francisco Sigcha
Data-Driven Computer Engineering Group (D2iCE), Department of Electronic and Computer Engineering, Physical Education and Sports Science (PESS), and Health Research Institute (HRI), University of Limerick, Ireland
luis.sigcha@ul.ie

Introduction: The accurate recognition of physical activity (PA) in older adults is crucial for understanding their lifestyle patterns and their impact on health outcomes. Wearable sensors and machine learning (ML) offer a promising avenue for enhancing the precision of PA. However, the heterogeneity of data and movement patterns across different ages can pose a challenge in developing general-use algorithms.

Objective: This study evaluates the generalization capability of ML algorithms in classifying six different types of PAs using a single sensor positioned on the thigh. This study uses an age-stratified data splitting approach to assess the performance of activity detection algorithms in an older participant cohort.

Methods: A data cohort of 151 participants (age: 18 to 71) from the larger data base of the WEALTH project (Wearable Sensor Assessment of Physical and Eating Behaviours) was selected. Participants engaged in a series of guided activities for 75 minutes, including sitting, standing, walking, jogging, sports activities, and cycling when wearing ActivPal sensors. Raw tri-axial accelerometer data were pre-processed to feed a random forest (RF) and convolutional neural network (CNN). Finally, classification models were trained only using data from young subjects (train-young, n=73, age: 18 to 50) and evaluated in two different cohorts namely, test-young (n=32, age: 18 to 50) and test-old (n=24, age: 60 to 71).

Results: The results indicate accurate overall classification rates (accuracy up to 85% for the CNN) in classifying the proposed PAs. However, a clear impairment was identified in the detection of specific activities such as walking and jogging in the older cohort. To improve these results, data augmentation techniques (e.g., time warp and magnitude warp and SMOTE) were used, boosting the accuracy of jogging classification by up to 5% without needing to increase the number of participants.

Conclusion: This study underscores the potential of ML techniques and data augmentation techniques to support the development of robust algorithms to classify PA in older adults. While the models achieved high overall accuracy, challenges were identified in the development general-use algorithms. The improvement of these algorithms can pave the way for improved monitoring and understanding of PA patterns in older adults.

Acknowledgements: The author acknowledges to: (1) WEALTH Project, funded by the Joint Programming Initiative a Healthy Diet for a Healthy Life (JPI HDHL) under STAMIFY (Standardised measurement, monitoring and/or biomarkers to study food intake, physical activity and health). Grant Agreement No 727565. The (2) Department of Physical Education and Sports Science (PESS). The (3) Health Research Institute (HRI). And the (4) Data-Driven Computer Engineering (D2iCE) Group at University of Limerick.

STUDENT PRESENTATIONS

RELATIONSHIP BETWEEN ACHILLES TENDON STIFFNESS AND COST OF WALKING IN HEALTHY MIDDLE-AGED AND OLDER ADULTS - A PROPOSAL

Mehmet Akman
Hungarian University of Sports Science, Department of Kinesiology, Budapest, Hungary
akmanmeh@hotmail.com

Introduction: Normal aging affects muscle-tendon functions. A hallmark of human tendon aging is the decrease in Achilles tendon stiffness. Reduced tendon stiffness is presumed to interfere with force transmission to the skeletal system. If so, the cost of walking, which is extensively documented to be ~20% higher in older vs. younger individuals, could be related to impaired by Achilles tendon function. The purpose of this study is to determine the relationship between Achilles tendon properties and cost of walking in healthy middle aged- and older aduts.

Method: Participants will be healthy individuals aged 40-75. Achilles tendon stiffness will be examined at rest and during low level muscle contractions on a dynamometer while seated. Ultrasound imaging will be performed to visualize the Achilles tendon and quantify tendon stiffness. Walking economy will be evaluated while walking on a treadmill at -20%,

-10%, 0%, +10%, and 20% relative to preferred walking speed (i.e., 0%). Cost of walking will be expressed as ml/kg/m oxygen. Additionally, force production capabilities of the calf muscle complex will be characterized by measuring maximal voluntary contraction of the plantar flexor muscles.

Findings: We expect to find an age-related decline in cost of walking and a decrease in Achilles tendon stiffness. Most importantly, we expect an association between cost of walking and tendon properties. We predict that plantarflexor force production is covariate in the cost of walking - tendon property relationship.

Discussion, Conclusions: These data have important implications for exercise prescription in aging, targeting cost of walking, tendon and musle properties.

REDEFINING SLIP OUTCOME CLASSIFICATIONS BASED ON AUTOMATED PATTERN RECOGNITION USING MACHINE LEARNING

Chimerem O. Amiaka
Department of Kinesiology, Brock University, St. Catharines, ON, Canada
ca15hi@brocku.ca

Background: Previous studies investigating slip recovery mechanisms have used different methods to classify slip outcomes. While visual observation is considered the subjective standard for classifying slip outcomes, researchers have also incorporated heel slip distance (HSD) or peak heel slip velocity (pHSV) thresholds as more objective indicators. Since these thresholds have not yet been validated, this study applied automated decision-tree machine learning model to objectively establish thresholds for slip movement outcome classification.

Methods: Fifty participants walked over low and high friction surfaces (n=516 total trials). Trials were initially classified as a no-slip (NS), slip-recovery (SR) or slip-fall (SF) outcome based on visual observation. Data from these trials were then analyzed by training and cross-validating a decision-tree model using HSD and pHSV as predictors, and visual observation as response labels. Sensitivity metrics were calculated to assess the decision-tree model's performance on slip classification. Results were compared to previously suggested thresholds, where NS, SR and SF outcomes have been described by a HSD of less than 1 cm, between 1-10 cm or greater than 10 cm, respectively (Cham & Redfern, 2001). Others have considered a pHSV less than or greater than 50 cm/s to be thresholds for a NS/SR or a SF outcome, respectively (Strandberg & Lanshammar, 1981).

Results: When HSD and pHSV were considered, our decision-tree model indicated that a NS, a SR and a SF outcome was differentiated by a HSD less than 1.4 cm, between 1.4-9.2 cm, and greater than 9.2 cm, respectively. In contrast, a pHSV less than 24.5 cm/s resulted in a NS while values above 24.5 cm/s classified as a SR. Our model classified 10 more positive NS cases, the same amount of SF cases, and one more positive SR outcome than previous HSD thresholds. When our model was compared to previous pHSV thresholds, our model performed better for identifying SRs (52 more) but worse for identifying NS (49 less).

Conclusions: The results indicate that the decision-tree model is better at differentiating between slip outcomes than previously suggested thresholds. Incorporating additional variables might further improve the ability of the decision-tree model to classify slip outcomes more accurately.

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COMPARSION OF STANDARD AND STANDARD PLUS NEUROMUSCULAR EECTROSTIMULATION (NMES)-AIDED CROSS-EDUCATION FOR ACL RECONSTRUCTION REHABILITATION: A PROPOSAL

Leila Bogdán
University of Pécs, Faculty of Sciences, Doctoral School of Biology and Sports Biology
leilavi98@gmail.com

Introduction: Anterior cruciate ligament (ACL) injuries, particularly in athletes, require effective rehabilitation strategies. Recent studies have examined the concept of cross-education. In this paradigm, training one limb increases muscle strength in the contralateral, non-trained limb. NMES added to unilateral training has emerged as an effective technique for improving muscle strength and knee function in patients following ACL reconstruction. Cuyul-Vásquez et al. (2022) demonstrated the effectiveness of cross-education in promoting recovery, while Minetto et al. (2018) and Minshull et al. (2021) highlighted NMES's role in promoting contralateral strength gains. This method is especially valuable for patients with limited use of their injured limb, accelerating recovery through stimulation of the uninjured side. An understanding of the biomechanics and recovery patterns (Gill et al., 2023) reinforces the importance of comprehensive rehabilitation, with NMES playing a significant role in optimizing patient outcomes during ACL rehabilitation, because an ACL injury causes sensory deprivation, i.e., mal-adaptive neuroplasticity.

Method: Participants will have an ACL rupture awaiting reconstruction surgery. Inclusion criteria are: athlete and non-athlete, reconstruction used autograft or allograft. Exlusion criteria is a re-injury. Test battery: Before surgery, and at 12 and 25 weeks post-surgery the following tests will assess clinical and neuromechanical functions. Clinical tests: star-excursion balance test (primary outcome), International Knee Documentation Committee (IKDC) subjective knee evaluation form and single leg hop test. Neuromechanical tests: maximal voluntary isometric contraction of musculus quadriceps femoris and single leg squat. Knee extension will be measured on dynamometer during maximal voluntary isometric contraction at 80°. Knee stability and proprioception will be evaulated with single leg squat performed on metronome reaching to 60° knee fexion using MyoMotion system. In the aim of test more knee functionality, single leg hop test will be performed. Video motion analysis will be used at star excution balance and single leg hop test. Measures of brain neuroplasticity: Structural and diffusion tension imaging outcomes will be assessed before surgery and after 8 weeks of complex rehabilitation programme.

Intervention: For 8 weeks, 3 sessions per week, for a total of 24 sessions, standard care will be delivered with and without NMES-aided cross-education. The rehabilitation program will start 2-3 weeks after surgery. Standard care will be supplemented NMES will comprise unilateral isometric and dynamic voluntary quadriceps contractions of the non-operated leg. Contraction intensity will be set at 65% of one repetition maximum. Participants will perform 3-4 sets of 12 repetitions. NMES will be superimposed on the contracting muscle (~10-40mA, T-ONE rehabilitation Electrostimulation device, I-TECH) using a bipolar stimulating electrode montage. The added cross-education training element will last up to ~10min per session in addition to standard care portion of rehabilitation.

Conclusions: We expect to preferential improvements in the primary and secondary outcomes following standard care supplemented with NMES-aided cross-education.

STATIC AND DYNAMIC POSTURAL STABILITY IN INDIVIDUALS WITH MID-PORTION ACHILLES TENDINOPATHY

Zsófia Bokor-Tóth
Department of Kinesiology, Hungarian University of Sports Science, Budapest, Hungary; National Institute for Sports Medicine, Budapest, Hungary
zsofia.bokor1989@gmail.com

Background: Achilles tendinopathy (AT) is one of the most common overuse sports injuries, particularly among runners. The impact of AT on plantar flexor function is well-documented. However, little is known about its effects on postural stability. This ongoing study aims to investigate differences in standing balance between individuals with AT and healthy controls.

Methods: The participants performed bilateral and unilateral standing tasks barefoot, with the aim to sway as little as possible. The tasks included static tests (with eyes open and eyes closed) and a dynamic test, where participants passed a 1 kg ball from hand to hand around their body. Each test lasted 30 s. Postural stability was assessed from center of pressure data recorded with separate force plates located under each foot. Electromyography activity was recorded using 32-channel high-density grids on the medial gastrocnemius and the soleus muscles. Muscle-tendon morphology, foot structure, level of kinesiophobia, and quality of life were further assessed. In this ongoing cross-sectional study, we aim to include 50 participants with mid-portion AT and an equal number of matched healthy controls. At this stage, unilateral stabilometric data from both the symptomatic (or more symptomatic) and asymptomatic (or less symptomatic) legs of eight participants have been analysed. Mean and SD are presented here.

Preliminary results: The path of the center of pressure was longer for AT participants on their symptomatic side during the unilateral static eyes-open test (1302±416 mm on the symptomatic side vs. 1226±566 mm on the asymptomatic side) similarly to the dynamic test (2369±606 mm on the symptomatic side vs. 2263±687 mm on the asymptomatic side). Meanwhile, greater body sway was observed on the asymptomatic side during the eyes-closed test (2518±633 mm on the symptomatic side vs. 2575±813 mm on the asymptomatic side).

Conclusion: Further analyses will be performed on the centre of pressure data, and the neural interplay between muscles will be examined by analysing the electromyography signals.

COMPARISON OF THE DIAGNOSTIC ACCURACY OF RESTING-STATE FMRI DRIVEN MACHINE LEARNING ALGORITHMS IN THE DETECTION OF MILD COGNITIVE IMPAIRMENT

Gergo Bolla
Neurocognitive Research Center, National Institute of Mental Health, Neurology and Neurosurgery, Budapest, Hungary
gergobolla99@gmail.com

Mild cognitive impairment (MCI) is a potential therapeutic window in the prevention of dementia; however, automated detection of early cognitive deterioration is an unresolved issue. The aim of our study was to compare various classification approaches to differentiate MCI patients from healthy controls, based on rs-fMRI data, using machine learning (ML) algorithms. Own dataset (from two centers) and ADNI database were used during the analysis. Three fMRI parameters were applied in five feature selection algorithms: local correlation, intrinsic connectivity, and fractional amplitude of low frequency fluctuations. Support vector machine (SVM) and random forest (RF) methods were applied for classification. We achieved a relatively wide range of 78-87% accuracy for the various feature selection methods with SVM combining the three rs-fMRI parameters. In the ADNI datasets case we can also see even 90% accuracy scores. RF provided a more harmonized result among the feature selection algorithms in both datasets with 80-84% accuracy for our local and 74-82% for the ADNI database. Despite some lower performance metrics of some algorithms, most of the results were positive and could be seen in two unrelated datasets which increase the validity of our methods. Our results highlight the potential of ML-based fMRI applications for automated diagnostic techniques to recognize MCI patients.

THE EFFECTS OF RESISTANCE TRAINING ON MUSCLE-TENDON FUNCTION, ELASTIC ENERGY STORAGE AND WALKING ECONOMY IN OLDER ADULTS - A PROPOSAL

Beáta Csizmadia
Hungarian University of Sports Science, Department of Kinesiology, Budapest, Hungary
csbea134@gmail.com

Background: Even during healthy aging, neuromuscular and motor abilities decline. These changes include a reduction in muscle volume and maximal voluntary muscle strength, leading to sarcopenia. Tendon properties also change, including a decrease in stiffness, which can negatively impact the ability to store and utilize elastic energy during movement. These changes

may affect walking economy, as older adults consume about 20% more metabolic energy during walking compared to younger individuals. Previous research has not pinpointed the exact cause of this discrepancy. Resistance training with eccentric overload could be a promising solution, as it is particularly effective at improving muscle-tendon function. However, no studies to date have investigated the effects of resistance training, especially with eccentric overload on walking economy in older adults.

Objectives: The aim of this study is to determine the effects of eccentric and concentric resistance training on muscle-tendon function, elastic energy storage and walking economy in healthy older adults.

Methods: Participants will be randomized into three groups: concentric overload, eccentric overload, and active control. Training sessions will be conducted three times per week for three months. Muscle strength, tendon properties, elastic energy storage and the metabolic cost of walking will be measured before and after the intervention. The primary statistical analysis will assess the interaction between the three groups and time.

Expected Result: Based on the literature, we hypothesize that eccentric overload resistance training will have more favorable effects on muscle-tendon properties compared to concentric overload and control training, and that these changes will be associated to improvements in walking economy.

Conclusion: The results of this study can be used to optimize resistance training protocols and enhance walking function in older adults.

Keywords: aging, resistance training, eccentric overload, muscle-tendon function, elastic energy storage, metabolic cost, sarcopenia, neuromuscular function, walking economy

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EFFECTS OF ECCENTRIC OVERLOAD RESISTANCE TRAINING ON MUSCLE QUALITY, BALANCE AND COST OF WALKING IN OLDER INDIVIDUALS - A PROPOSAL

Mohamed Emam
Semmelweis University, Budapest, Hungary
drmohamedelshenawy17@gmail.com

Introduction: Normal aging leads to declines in neuromuscular and mobility functions, including a ~60% decline in maximal voluntary force by age 70, accompanied by a ~25% reduction in muscle volume and quality (sarcopenia). Aging also affects tendon properties, contributing to functional capacity reductions in walking speed and balance.

Aims: Our study aims to determine the impact of eccentrically-biased resistance training on muscle-tendon function and associated changes in walking economy.

Methods - Participants: Approximately 60 individuals aged 60 and over will participate in a three-year study, randomized into two groups: Group 1: (Concentric contraction) 5 sets of 12 repetitions; Group 2: (Eccentric contraction) 5 sets of 10 repetitions, a 40% overload. Exercises include bilateral seated leg press, knee extension, and ankle press under metronome control.

Measurements: We plan to measure before and after training: maximal voluntary force, mechanical efficiency, muscle thickness, fascicle length, pennation angle, whole leg muscle content, physiological Cross-Sectional Area (PCSA), muscular adipose tissue (MAT), metabolic cost of walking, single leg calf-raise test, functional mobility tests and balance.

Results: We anticipate that eccentric overload resistance training will positively impact muscle quality properties, potentially reducing the cost of walking. This expectation is based on existing evidence suggesting that resistance training, particularly eccentrically-biased training, improves muscle strength, mechanical efficiency, and composition. Enhancing these muscle quality factors can lead to more effective force production and better energy economy during walking. Additionally, improvements in muscle architecture, such as increased muscle thickness and optimal pennation angles, may contribute to more efficient muscle contraction, ultimately reducing the metabolic cost of walking.

Discussion & conclusion: The findings of this study hold significant implications for exercise prescription in aging, particularly in reducing age-related declines in neuromuscular and mobility functions. Eccentric overload resistance training emerges as a potential intervention to enhance muscle quality, thereby positively impacting walking economy. The potential association between improved measures of muscle strength, mechanical efficiency, and muscle composition with enhanced walking economy provides novel approaches for prescribing exercise in aging populations. This intervention could improve functional mobility and quality of life by addressing declines in muscle quality that contribute to reduced physical performance.

ACUTE EFFECT OF INTERMITTENT HYPOXIA ON THE GAIT OF PEOPLE WITH PARKINSON'S DISEASE: PRELIMINARY RESULTS

Murilo Henrique Faria
São Paulo State University (UNESP), School of Sciences, Department of Physical Education, Human Movement Ressearch Laboratory (MOVI-LAB), Bauru, SP, Brazil
murilo.faria@unesp.br

Background: Parkinson's disease (PD) causes changes in gait biomechanics, such as slower and shorter steps and longer step duration, which increases the risk of falling. Although dopaminergic medication is the gold standard for treating PD, additional strategies to improve walking are often necessary. Recently, intermittent normobaric hypoxia (IH) has been proposed as a supplementary treatment for people with PD. However, the rationale for using IH is primarily based on pre-clinical studies (i.e., animal models), which limits its direct application in practical settings. Moreover, while limited evidence exists for the use of IH in people with PD, most studies have focused on non-motor symptoms, leaving the effects of IH on motor function unknown. In this context, the reduced oxygen availability associated with IH could impair motor control during gait, which should be carefully considered before its introduction into clinical practice.

Methods: The study involved 10 people with PD (71±5.92 years; 69.6±13.1 kg; 38-19 UPDRS; 3-2 H&Y). The hypoxia protocol consisted of 6 minutes at 10% O2, alternating with 5 minutes at 21% O2, totaling 24 minutes of IH and 15 minutes of normoxia. Gait data were acquired before and immediately after IH while the participants were under medication. Each participant completed four 2-minute trials (two before - maximum and self-selected speed - and two after IH). Data collection was carried out using 10 cameras of the Vicon Motion System. Step length, speed, width, duration, and the percentage of time spent in the swing and double support phases during gait were calculated. A paired sample t-test was conducted separately for each gait condition (maximum and self-selected speed).

Results: No statistically significant difference was found between before and after IH ($p > 0.05$). Conclusions: Acute IH did not affect gait parameters in individuals with PD. Additionally, no worsening of gait parameters was observed, suggesting that IH could be combined with other gait rehabilitation strategies. However, please consider that the findings should be interpreted with caution as they are based on a small sample size, and the hypoxia dosage was acute, which may not be enough to cause changes in gait parameters.

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SELF-ESTEEM, WELLBEING AND HEALTH STATUS OF FEMALE ATHLETES IN THE CONTEXT OF SPORT PERFORMANCE

Taysir Laajili
School of Doctoral Studies, Hungarian University of Sport Sciences, Budapest, Hungary
laajilitaysir@gmail.com

Background: Competing at a high level is challenging for athletes, both mentally and physically. Intense sport engagement is not always beneficial for health. This study investigates and compares self-esteem, wellbeing, and health status among athletes at different levels. Additionally, it examines whether the type of sport (individual versus team) affects the self-esteem and wellbeing.

Methods: A quantitative, observational survey was conducted, involving 296 female participants aged 18-35 years, divided into three groups based on their sport performance: high-performance athletes (41%), recreational athletes (27%), and individuals with no or lower levels of physical activity (32%). The Rosenberg Self-Esteem Scale, WHO-5 Well-Being Index, and the EuroQol Visual Analogue Scale were used to measure self-esteem, wellbeing, and health status, respectively.

Results: High-performance athletes exhibited significantly higher self-esteem, wellbeing, and health status compared to individuals with no or lower levels of physical activity. Recreational athletes showed better wellbeing than individuals with no or lower levels of physical activity and had no significant differences from high-performance athletes in any parameter. Results were not affected by whether the sport was individual or team-based.

Conclusions: These findings highlight that regular sport participation, whether at a recreational or high-performance level, provides substantial mental and physical health benefits, while individuals with no or lower levels of physical activity experience significantly lower levels of self-esteem, subjective wellbeing and health. The findings of this study suggest that regular sport activity, regardless of competitive level, provides substantial benefits, underscoring the importance of maintaining a physically active lifestyle.

Keywords: female athletes, health, individual sport, self-esteem, team sport, wellbeing

NEUROMUSCULAR AND MORPHOLOGICAL CHARACTERISTICS OF PREVIOUSLY INJURED AND NON-INJURED BICEPS FEMORIS IN COMPETITIVE ATHLETES

Eszter Pocsai
Department of Kinesiology, Hungarian University of Sports Science, Budapest, Hungary
pocsai.eszter@tf.hu

Strain injuries are frequently observed in the biceps femoris long head (BFlh), particularly in athletic activities that necessitate repeated sprinting. Despite extensive research into the mechanical aspects of these injuries, the incidence of such injuries continues to rise. The precise neuromuscular aspects of hamstring injuries remain unclear, particularly at the level of motor units.

The objective of this doctoral research is to investigate the motor unit activity and morphology of the BFlh in recently injured track and field athletes in comparison to healthy, non-injured athletes during submaximal contractions on a dynamometer (Study I). Subsequently, the impact of an eccentric fatigue protocol will be evaluated (Study II). The purpose of this poster presentation is to introduce the audience to the protocol of the two studies.

The findings of this study will elucidate whether there is a correlation between the neuromuscular or morphological characteristics of the biceps femoris muscle and a history of hamstring injuries. Furthermore, they will serve as a foundation for subsequent longitudinal follow-up studies and interventions. This novel approach may facilitate a deeper comprehension of the underlying mechanisms of injury, serve as a screening tool, and ultimately contribute to a reduction in injury rates.

KINEMATIC ANALYSIS OF TENNIS SERVING TECHNIQUES IN ATHLETES USING DIFFERENT STANCES

Yucheng Wang
School of Physical Education, Ningbo University, Ningbo 315211, China
wangyucheng010917@163.com

Background: The serve is one of the fundamental techniques in tennis, with two primary stances: the foot-up (FU) serve and the foot-back (FB) serve. This study aims to compare the technical differences between these two stances, investigating their distinct characteristics and patterns to assist athletes in improving their serve quality.

Methods: This study analyzed 12 tennis players (6 using the FU stance and 6 using the FB stance) using 3D video analysis and mathematical statistics to compare the kinematic data of the two serving techniques.

Results - Ball Toss and Racquet Lifting Phase: The ball toss height in the FU serve was significantly greater than in the FB serve ($p < 0.001$). Additionally, the average knee joint cushioning time for both the left and right knees was longer for FU servers than for FB servers ($p < 0.001$). / Backswing Phase: At the lowest point of the racquet head, the shoulder joint angle of FU servers was significantly greater than that of FB servers ($p < 0.05$), while the elbow joint angle was significantly smaller ($p < 0.05$). At the end of the backswing, the racquet head height for both FU and FB servers was significantly lower than their center of gravity height ($p < 0.05$). / Swing and Ball Impact Phase: The knee joint angles in the FU stance were significantly greater than in the FB stance ($p < 0.001$), while the hip joint angles were significantly smaller ($p < 0.001$).

Conclusions: Players who use the FU stance can achieve a higher contact point, resulting in a higher success rate of getting the ball over the net. This stance also allows for greater lower body extension, a larger vertical force component, and a more effective whipping action of the upper body. Conversely, athletes using the FB stance exhibit a smoother lateral force curve, with smaller displacements of the body's center of gravity in all directions, leading to better balance. Therefore, it is recommended that players strategically utilize both serving stances during matches to optimize their scoring efficiency.

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EFFECT OF KNEE JOINT POSITION ON SOLEUS MUSCLE FUNCTION DURING ISOKINETIC PLANTARFLEXION

Jingyi Ye
Department of Kinesiology, Hungarian University of Sports Sciences, Alkotás utca 44-48. Budapest, Hungary
yejingyi1999@gmail.com

Background: Contribution to ankle moment is influenced by the knee joint position because the gastrocnemii muscles span the knee joint as well.

Objective: However limited information is available on the effect of knee joint position on soleus activation under dynamic plantarflexion, hence the aim of this study was to investigate if soleus have a compensatory strategy during knee flexed plantarflexion in order to reduce the magnitude of the decrement in ankle moment.

Methods: Isokinetic dynamometry with EMG and ultrasound measurements was used to investigated muscle tendon interaction of medial gastrocnemius and soleus during knee flexed and extended plantarflexions using various angular velocities. 17 healthy males were participated in this study.

Results: Flexed knee plantarflexions resulted in lower peak ankle moments at all ankle angular velocities by 18% (p=0.1062) at 30°·s-1, 44% (p<0.001) at 60°·s-1 and by 18%, (p=0.0001) at 120°·s-1. SOL showed significantly higher EMG activity during knee flexed plantarflexion at 30°·s-1 (p=0.0094) and 60°·s-1 (p=0.0142). The magnitude of mean shortening of MG and SOL did not show significant difference between knee flexed and knee extended plantarflexion.

Conclusions: Our research provides an indirect evidence of soleus muscle compensatory strategy during knee flexed plantarflexion at low angular velocity contractions.

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EFFECT OF FOREFOOT TRANSVERSE ARCH STIFFNESS ON FOOT BIOMECHANICAL RESPONSE--BASED ON FINITE ELEMENT METHOD

Linjie Zhang
Department of Radiology, Ningbo No. 2 Hospital, Ningbo, China
gabriel.zlj97@gmail.com

Background: The plantar vault, comprising the transverse and longitudinal arches of the human foot, is essential for impact absorption, elastic energy storage, and propulsion. Recent research underscores the importance of the transverse arch, contributing over 40% to midfoot stiffness. This study aimed to quantify biomechanical responses in the ankle-foot complex by varying the stiffness of the deep metatarsal transverse ligament (DTML).

Methods: Using CT image reconstruction, we constructed a complex three-dimensional finite element model of the foot and ankle joint complex, accounting for geometric complexity and nonlinear characteristics. The focus of our study was to evaluate the effect of different forefoot transverse arch stiffness, that is, different Young's modulus values of DTML (from 135 MPa to 405 MPa), on different biomechanical aspects of the foot and ankle complex. Notably, we analyzed their effects on plantar pressure distribution, metatarsal stress patterns, navicular subsidence, and plantar fascial strain.

Results: Increasing the stiffness of the DTML has significant effects on foot biomechanics. Specifically, higher DTML stiffness leads to elevate von Mises stress in the 1st, 2nd, and 3rd metatarsals, while concurrently reducing plantar pressure by 14.2% when the Young's modulus is doubled. This stiffening also impedes navicular bone subsidence and foot lengthening. Notably, a 100% increase in the Young's modulus of DTML results in a 54.1% decrease in scaphoid subsidence and a 2.5% decrease in foot lengthening, which collectively contribute to a 33.1% enhancement in foot longitudinal stiffness. Additionally, doubling the Young's modulus of DTML can reduce the strain stretch of the plantar fascia by 38.5%.

Conclusion: Preserving DTML integrity sustains the transverse arch, enhancing foot longitudinal stiffness and elastic responsiveness. These findings have implications for treating arch dysfunction and provide insights for shoe developers seeking to enhance propulsion.

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EFFECTS OF ANKLE DORSIFLEXION RESTRICTION ON THE LOWER LIMB BIOMECHANICS DURING LONG JUMP TAKE-OFF

Zanni Zhang
Faculty of Sport Science, Ningbo University, Ningbo 315211, China
zhangzanni@gmail.com

Background and Objective: Long jump is an athletic event that requires speed, power, force application, and balance, with each phase (approach, take-off, flight, and landing) being crucial to performance. The take-off board is an excellent auxiliary tool for take-off training; however, previous research has neglected the limiting effect of the take-off board on ankle dorsiflexion range of motion. Therefore, it is imperative to explore the biomechanical changes in the lower extremities during long jump under varying degrees of ankle dorsiflexion.

Methods: A total of 30 subjects were enrolled in this study. Data were collected using dominant leg jumps in the absence of ankle dorsiflexion (NW, no wedge plate) and 10° (10W, 10°wedge plate) and 20° (20W, 20°wedge plate) restrictions. Following this a musculoskeletal model was developed to simulate and calculate biomechanical data. Finally, One-dimensional parametric statistical mapping (SPMI1D) was utilized to evaluate between-group variation in outcome variables using a one-way repeated measures analysis of variance (ANOVA).

Results: As the ankle restriction angle increased, vertical velocity gain increased significantly with higher ankle restriction angles: NW (3.34 ± 0.21m/s), 10W (3.65 ± 0.14 m/s), 20W (3.77 ± 0.12 m/s) ($p < 0.001$). However, horizontal velocity loss was only significantly higher at 20W ($p = 0.002$). The highest peak extension angle, angular velocity, and power were observed at 10W for the knee and hip joints ($p < 0.05$). Joint forces at the ankle, knee, and hip were significantly affected by the different pedal angles, with increased forces observed in various joint actions ($p < 0.001$).

Conclusions: Athletes with ankle dorsiflexion limited to about 10° have an increase in vertical velocity with minimal loss of horizontal velocity, which has the potential to result in a faster jump and improved long jump performance, and the co-activation of the muscles around the knee increases, which may be due to the body's compensatory response to compensate for the limited ankle dorsiflexion, thus enhancing knee stability. Therefore, it is recommended that athletes try to adopt an ankle dorsiflexion limit of about 10° in long jump training to improve their long jump performance and minimize the risk of injury.

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HUNGARIAN UNIVERSITY
OF SPORTS SCIENCE
BUDAPEST

Hungarian University of Sports Science
Department of Kinesiology
1123 Alkotás utca 42-48, Budapest, Hungary
tf.hu/bsa | info.biomechanics@tf.hu