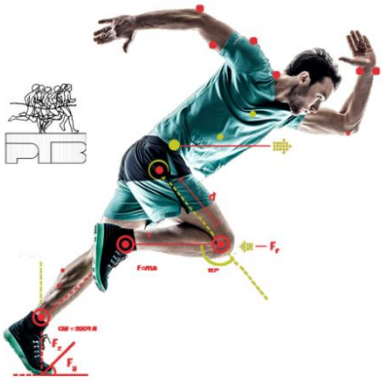
www.wcongress.pl/union

BIOMECHANICS2025
INTERNATIONAL CONFERENCE
OF THE POLISH SOCIETY OF BIOMECHANICS

6th World
Scientific Congress
Quality of Life
in Interdisciplinary Approach



22-24.10.2025 Kochcice
POLAND

Book of Abstracts

Sponsors

COMEF
AVE D3 B3D
Spectro-Lab Laboratoria Przyszłości
ANYBODY TECHNOLOGY
DANTEC DYNAMICS

Partners

JAN EVANGELISTA PURKYNĚ UNIVERSITY IN ÚSTÍ NAD LABEM
Faculty of Education
CZĘSTOCHOWSKA AKADEMIA TAEKWON-DO
PHYSICAL ACTIVITY REVIEW

Book of Abstracts

These are the original abstracts submitted to Biomechanics2025 and 6th World Scientific Congress Quality of Life in Interdisciplinary Approach,
Kochcice, Poland, October 22-24, 2025

REVIEWED BY:

Prof. dr hab. Jacek Wąsik - Jan Długosz University in Częstochowa, Częstochowa, Poland
Prof. dr hab. Michalina Błażkiewicz-Janeczko – The Józef Piłsudski University of Physical Education in Warsaw, Warsaw, Poland

Published by PPHU Projack, Czestochowa, Poland

Dear Colleagues and Friends,

We are delighted to welcome you to Kochcice, near Częstochowa, for the **Biomechanics 2025 and 6th World Scientific Congress "Quality of Life in an Interdisciplinary Approach"**, taking place in Poland from October 22 – 24, 2025.

This year's Congress demonstrates that, despite global challenges, we have successfully brought together a diverse and multidisciplinary community of researchers and practitioners. For the very first time, two major scientific events have been combined: the International Biomechanics Conference — founded in 1987 under the auspices of the Polish Society of Biomechanics — and the World Scientific Congress *"Quality of Life in an Interdisciplinary Approach"*. This historic integration marks a significant milestone in advancing both fields.

We are honored to host participants from **12 countries** — the United Kingdom, Germany, the Czech Republic, Slovakia, Ukraine, Uzbekistan, Spain, Algeria, Turkey, Hungary, Italy and Poland — representing **43 research institutions**.

This Congress provides a unique platform for interdisciplinary dialogue, knowledge exchange, and collaboration. As organizers, we hope it will inspire meaningful discussions and foster lasting research partnerships.

We wish you every success in your presentations and an enriching experience throughout the Congress.

With warm regards,

Organizing and Scientific Committee

Prof. Dr hab. Jacek Wąsik

Prof. Dr hab. Michalina Błażkiewicz-Janeczko

Dr hab. Sławomir Winiarski, prof. AWF

SPONSORS:

comef.com.pl

COMEF is a dynamic company operating since 1993 in the field of research, technological and medical instrumentation. As a trusted representative of renowned global manufacturers, COMEF delivers cutting-edge solutions, leading technologies, and comprehensive technical support. The company offers a wide range of applications - including chemical and thermal analysis, imaging, electrochemistry, thin-film deposition, and lab infrastructure - and provides full installation, service, calibration, and training.

spectro-lab.pl

Spectro-Lab is a private, Polish company established in 1981. The company is one of the biggest sales and service supplier of laboratory equipment – analytical and testing for quality control and R&D laboratories in Poland. Our team is more than 50 sales and service specialists. Since 2012 main office is located in Łomianki near Warsaw, second office is in Tychy (Silesia). We are an exclusive representative of: Dantec Dynamics (Optical measurement systems), MTS Systems (Tensile machines, Fatigue test systems), Weiss/Voetschtechnik Technik (Testing chambers), IMV Corporation (Electrodynamic Vibration Test Systems), Thermo Fisher Scientific (Analytical equipment), Q-LAB Corporation (Weathering testers), Buehler Ltd. (Metallographic Sample Preparation), etc.

b3d.com.pl

B3D is a Polish technology company specializing in additive manufacturing (3D printing) and reverse engineering, offering 3d printing machines and comprehensive services from 3D scanning and modeling to production. Beyond conventional 3D solutions, B3D is the developer of the AVE3D scanner and ONE SHOT technology - the world's first dynamic 4D scanning system capable of capturing real-time movement and geometry. This breakthrough solution enables motion-based 3D data acquisition (so-called "4D scanning") and is currently being implemented in medical, dental, and industrial applications. AVE3D with ONE SHOT provides real-time 3D reconstruction at 60 FPS, revolutionizing diagnostics, rehabilitation, digital smile design, and robotic process control. Serving sectors such as industry, medicine, logistics, and automotive, B3D combines technological innovation with precision, an individual customer approach, and competitive pricing - positioning itself as a key innovator in Europe's 3D and 4D technology landscape.

anybodytech.com

AnyBody Technology is a pioneer and leading provider of mechanical modeling of the living body, in particular musculoskeletal modeling. The all-dominating area of application is of course the human body, but our technology applies to analysis of any creature. Our base technology is the AnyBody Modeling System – the simulation engine – and the AnyBody Managed Model Repositories for instance containing the world's most comprehensive human full-body musculoskeletal model.

PARTNERS:

Organizer:

Institute of Physical Culture Sciences, Jan Długosz University in Częstochowa, Częstochowa, Poland

International Conference of Polish Society of Biomechanics "Biomechanics 2025"

Scientific Committe

Sławomir WINIARSKI, Poland, Chairperson
Michalina BŁAŻKIEWICZ-JANECZKO, Poland, Co-Chairperson

Taiji ADACHI, Japan
Katarzyna ARKUSZ, Poland
Bogdan BACIK, Poland
Krzysztof BUŚKO, Poland
Nachiappan CHOCKALINGAM, UK
Adam CZAPLICKI, Poland
Manuel DOBLARÉ, Spain
Jarosław FILIPIAK, Ponad
Jan GAJEWSKI, Poland
Joanna GORWA, Poland
Gu YAODONG, China
Anna HADAMUS, Poland
Christian HELLMICH, Austria
Juha HIJMANS, NL
Antoni JOHN, Poland
Jacek JURKOJĆ, Poland
Tomasz KLEKIEL, Poland
Magdalena KOBIELARZ, Poland
Michał KUCZYŃSKI, Poland
Kornelia KULIG, USA
Tomasz ŁODYGOWSKI, Poland
Ewa MAJCHRZAK, Poland
Jerzy MAŁACHOWSKI, Poland
Andrzej MASTALERZ, Poland
Adam MAZURKIEWICZ, Poland
Karol MILLER, Australia
Grzegorz MILEWSKI, Poland
Robert MICHNIK, Poland
Roozbeh NAEMI, UK
Jolanta PAUK, Poland
Marek PAWLIKOWSKI, Poland
Celina PEZOWICZ, Poland
Maria Ángeles PÉREZ ANSÓN, Spain
Bogdan PIETRASZEWSKI, Poland
Szczepan PISZCZATOWSKI, Poland
Bert van RIETBERGEN, Netherlands
Eugeniusz SAJEWICZ, Poland
Małgorzata SOBERA, Poland
Artur STRUZIK, Poland
Małgorzata SYCZEWSKA, Poland
Arkadiusz SZAREK, Poland
Wojciech ŚWIĘSZKOWSKI, Poland
Jacek WĄSIK, Poland
Wiktoria WOJNICZ, Poland
Wojciech WOLAŃSKI, Poland

6th World Scientific Congress "Quality of Life in Interdisciplinary Approach"

Scientific Committe

Jacek WĄSIK, Poland, Chairperson
Janusz SZOPA, Poland, Co-Chairperson

Štefan BALKÓ, Czech Republic
Elena BENDIKOVA, Slovakia
Ladislav BLÁHA, Czech Republic
Michalina BŁAŻKIEWICZ-JANECZKO, Poland
Olha BORYSOVA, Ukraine
Zbigniew BORYSIUK, Poland
Alena BUKOVA, Slovakia
Grzegorz DWORACKI, Poland
Barbara FRĄCZEK, Poland
Małgorzata GRABARA, Poland
Sergii IERMAKOV, Ukraine
John A. JOHNSON, USA
Janusz KAPUŚNIAK, Poland
Georgiy KOROBEYNIKOV, Ukraine
Cezary KUŚNIERZ, Poland
Justyna KRZEPOTA, Poland
Józef LANGFORT, Poland
Adam MASZCZYK, Poland
Kentaro MATSUMI, Japan
Eligiusz MAŁOLEPSZY, Poland
Julia PAVLOVA, Ukraine
Ingrid RUZBARSKA, Slovakia
Gongbing SHAN, Canada
Andrzej ŚLĘZAK, Poland
Anatolii TSOS, Ukraine
Renata URBAN, Poland
António VENCES DE BRITO, Portugal
Adam ZAJĄC, Poland

Organizing Committee

Jacek Wąsik – Chairperson

Sławomir Winiarski - Co-Chairperson
Dorota Ortenburger - Co-Chairperson
Michalina Błażkiewicz-Janeczko
Tomasz Góra
Agnieszka Mackiewicz
Dariusz Mosler
Anna Nikodem

Programme

<table>
<tr><th colspan="3">22 October 2025, Wednesday</th></tr>
<tr><td>From 14.00</td><td colspan="2">Arrival, accommodation - Strzelnica Family Resort & SPA, ul. Lubliniecka 9, Kochcice, 42-713 Kochanowice</td></tr>
<tr><td>15.00 – 15.45</td><td colspan="2">Invited Lecture: Piotr Rychter “Smart bioresorbable polymer scaffolds with shape memory behavior for minimally invasive surgery”.

COMEF

Piotr Czerwiński “A look beneath the surface. Microcomputed Tomography for 3D investigation of objects' internal structure in Bioengineering”.

Moderators: Michalina Błażkiewicz-Janeczko, Sławomir Winiarski</td></tr>
<tr><td>15.45 – 16.00</td><td colspan="2">Coffe break</td></tr>
<tr><td>16.00 – 17.30</td><td>– Gold Banquet Room –
Engineering Biomechanics

Moderators: Wiktoria Wojnicz, Jacek Jurkojć</td><td>– Conference Room –
Quality of Life

Moderators: Štefan Balkó, Eligiusz Małolepszy</td></tr>
<tr><td></td><td>Sayedmohsen Mortazavi Najafabadi, Dariusz Grzelczyk, Mohammed N. Ashtiani “Reliability of a proprioceptive ankle device in young adults”.</td><td>Georgiy Korobeyniko, Rashid Matkarimov, Lesia Korobeinikova, Markus Raab, Fikrat Kerimov, Olga Goncharova, Ivanna Korobeinikova “Mental state and cognitive performance in persons with different physical active”.</td></tr>
<tr><td></td><td>Filip Andruszkiewicz, Artur Bonik, Lechosław F. Ciupik, Agnieszka Kierzkowska, Edward Słoński “Lattice structures in the design of titanium implants for accelerated fusion”.</td><td>Robert Podstawski, Krzysztof Borysławski, Jadwiga Snarska, Atilla Szabo, Piotr Jurewicz, Ferenc Ihasz “Post-pandemic assessment: COVID-19’s long-term influence on physical activity, motor fitness, and hrmax among female university students”.</td></tr>
<tr><td></td><td>Bartłomiej Zagrodny “Modeling variability and redundancy in the musculoskeletal system using stochastic and pareto-optimal approaches”.</td><td>Natalia Kizilova “Model-based estimation of nanoparticle drug delivery to cancer cells with acoustic streaming”.</td></tr>
<tr><td></td><td>Paweł Borkowski, Andrzej Kucharski, Rafał Rusinek, Robert Zablotni “Measurement and numerical analysis of bone conduction stimulation applied to the otic capsule in the human temporal bone”.</td><td>Adrianna Kosior-Lara, Dorota Ortenburger, Małgorzata Kuchta, Magdalena Korsak-Sabino Belo, Jacek Wąsik “Physical activity avoidance as a predictor of anxiety and sleep quality in women”.</td></tr>
</table>

17.45 – 19.00	**– Gold Banquet Room – Special Hybrid Session: Fidelus and Morecki Award** **Moderators:** *Celina Pezowicz, Sławomir Winiarski, Małgorzata Syczewska*	
	1) Kajetan Ciunelis *"Inter-segmental trunk kinematics in wheelchair athletes: an exploratory IMU analysis".* 2) Jakub Kacprzak *"Kinetic differences between orthodox and southpaw stances in four fundamental boxing punches".* 3) Rafał Borkowski "*The role of lower limb muscle force in fall prevention".*	
19.00 – 20.30	***Dinner***	
21.00 – 22.00	**Social program: Conference dance lesson**	
23 October 2025, Thursday		
7.30 – 9.00	***Breakfast***	
9.00 – 9.15	***Opening ceremony - Gold Banquet Room***	
9.15 – 10.00	**Invited Lecture: Nachiappan Chockalingam** *"Bridging the Gap: Translating Biomechanics Research into Meaningful Advances in Sport, Technology, and Public Health".* ***Tomasz Rusin*** *"Examples of Multicamera DIC Applications in Biomaterials and Biomechanical Research. Introduction to Thermoelastic Stress Analysis (TSA)".* **Moderators:** *Michalina Błażkiewicz-Janeczko, Sławomir Winiarski*	
10.00 – 10.30	Joint photo	
10.30– 11.00	***Coffe break***	
11.00 – 12.00	**– Gold Banquet Room –** **Sports Biomechanics** **Moderators:** *Zbigniew Borysiuk, Monika Błaszczyszyn*	**– Conference Room –** **Quality of Life** **Moderators:** *Cezary Kuśnierz, Georgiy Korobeyniko*
	Justyna Romanek, Tayyaba Nosheen, Jacek Jurkojć, Marta Chmura, Piotr Wodarski *"Assessment of visual cortex activation under varying stimulus dimensionality using fNIRS".* Peter Melek, Peter Žiška, Roman Markovič "*Neural activity during motor learning phases".*	Tomasz Góra, Dariusz Mosler, Robert Podstawski, Jacek Wąsik *"The impact of effective mass on the strength of side and turning kick in Taekwon-do male practitioners".* Julius Evelley, Peter Polan, Martin Vicen, Alena Bukova, Iveta Nagyova "*Association of self-efficacy and pain with quality of life after total joint replacement in osteoarthritis".*

	Dariusz Mosler, Kamil Radecki *"Evaluating 2D video analysis as an alternative to force plate assessment of balance in martial arts athletes".*	Iwona Kochanowska, Justyna Krzak-Roś, Sylwia Szotek, Jarosław Filipiak *"Safer and more biocompatible implants with sol-gel coatings".*
12.00 – 12.15	***Coffe break***	
12.15 – 13.30	**– Gold Banquet Room –** **Rehabilitation Biomechanics** **Moderators:** *Małgorzata Syczewska, Nachiappan Chockalingam*	**– Conference Room –** **Engineering Biomechanics** **Moderators:** *Dariusz Mosler, Grzegorz Juras*
	Sławomir Winiarski, Krzysztof Aleksandrowicz "*Phase-specific gait adaptations in women after total hip replacement: A longitudinal SPM analysis".*	Natalia Kizilova "*Optimal coatings in plants and animals – an approach of nanobiomechanics and nanothermodynamics".*
	Wiktoria Wojnicz, Agnieszka Sobierajska-Rek, Bartłomiej Zagrodny, Michał Ludwicki, Katarzyna Pytka, Joanna Jabłońska-Brudło "*A novel scoring of kinematic and surface electromyography patterns to assess contributions of joint angles and muscle activities of patients with Duchenne muscular dystrophy in ADL tasks".*	Marta Chmura, Piotr Wodarski, Mateusz Janecki, Justyna Romanek, Anna Miller-Banaś, Jacek Jurkojć "*Effects of perturbation-based balance training on postural adjustment mechanisms in basketball players".*
	Aneta Ferenc, Anna Hadamus "*The influence of hip abductor muscle strength on body balance in the frontal plane in the m-CTSIB test".*	Artur Cichański, Tomasz Topoliński, Krzysztof Nowicki "*Accelerated evaluation of trabecular bone fatigue strength using the Locati method and bone microstructure indices".*
	Małgorzata Syczewska, Jakub Michoński, Małgorzata Kalinowska, Ewa Szczerbik, Robert Sitnik, Maciej Jaworski "*Proper identification of body mass distribution modifies the results of the simulation models. Preliminary results".*	*Karolina Radecka, Błażej Cieślik "The use of virtual reality in cardiac rehabilitation: preliminary results".*
13.30 – 14.30	***Lunch***	

14.30 – 15.15	**Invited Lecture: Jerzy Małachowski** *"Numerical aspects of modeling flow through the cerebral artery system".* ***Paweł Woźniak*** *"AVE3D and ONE SHOT From Static to Dynamic: The 4D Revolution in Human Motion Capture".* **Moderators:** *Michalina Błażkiewicz-Janeczko, Sławomir Winiarski*
15.15 – 16.30	**– Conference Room – Meeting of the Polish Society of Biomechanics, PTB**
16.30 – 16.45	***Coffe break***
16.45 – 18.00	**– Multimedia Room –** **Posters Session** **Moderators:** *Michalina Błażkiewicz-Janeczko, Jacek Wąsik*
	1) Justyna Lichosik, Celina Pezowicz, Małgorzata Żak "*Numerical analysis of the effect of lattice strut angle on the mechanical properties of a lumbar fusion cage".* 2) Agnieszka Szpala, Julia Frączek, Małgorzata Kołodziej "*Asymmetry of selected biomechanical parameters in gait in a man with unilateral peroneal nerve palsy".* 3) Artur Struzik, Joanna Broda, Bogdan Pietraszewski, Piotr Wodarski, Katarzyna Jochymczyk-Woźniak, Jacek Jurkojć, Robert Michnik "*Combination of virtual reality and vertical jumps - is it possible? Pilot study".* 4) Katarzyna Nowakowska-Lipiec, Hanna Zadoń, Piotr Szaflik, Steriani Elavsky, Jaroslav Uchytil, Petr Kutáč, Daniel Jandačka "*Comparative analysis of knee joint loading during gait across age groups".* 5) Katarzyna Pytka, Wiktoria Wojnicz, Natalia Szarwińska, Marek Chodnicki, Wiktor Sieklicki "*Pattern recognition from surface electromyography (sEMG)".* 6) Martyna Kosecka, Wiktoria Wojnicz, "*Estimation of activation patterns of surface EMG for application in mechanical engineering and biomedical engineering".* 7) Agnieszka Szust, Gabriela Wielgus, Anna Wybraniec "*Examination of strength properties of the temporomandibular joint disc – preliminary examination".* 8) Patrycja Szczepkowicz, Tomasz Klekiel "*Numerical analysys several cases of lumbar spine stabilizations".* 9) Nikola Chmura, Wanda Forczek-Krakosz, Agnieszka Wojtowicz "*Dual task gait during pregnancy: a case study of biomechanical and psychological changes between the first and third trimester".* 10) Agnieszka Szust, Anna Wybraniec, Mateusz Maj, Joanna Mendera "*Analysis of mandibular bone displacement continuity in customized condylar implants".* 11) Dariusz Mosler "*Custom software for real-time biomechanical analysis using perception neuron 3 IMU sensors: expanding applications beyond animation".*

	12) Mefti Abdmonaim, Zerari Hamza, Joubar Khaled "*The relationship between body image and dimensions of self-confidence among students of the Department of Physical and Sports Sciences and Technologies at Setif 2 University".* 13) Teresa Drozdek-Małolepsza, Eligiusz Małolepszy, Krzysztof Kościański "*Football in the multinational Society of the Stanislavian province 1920-1939".* 14) Myroslav Dutchak, Dymytrii Nikonorov, Georgiy Korobeynikov, Shukurjon Gaziyev "*Coping with stress and mental performance in aging".* 15) Juliia Pavlova, Ivanna Bodnar "*Surveillance of physical activity and fitness in Ukrainian youth: Identifying key objectives and challenges".* 16) Ryszard Asienkiewicz, Jerzy Grzesiak "*Level of physical and motor development of fire brigade officers in the light of selected predictors introduction".* 17) Ryszard Asienkiewicz "*Health behavior of youth at the University of Zielona Góra".* 18) Justyna Adamczyk "*The influence of cesarean section on sensory integration disorders."* 19) Ewa Karpęcka-Gałka, Aleksandra Pięta, Katarzyna Świtała, Barbara Frączek "*Selected aspects of the habitual diet and levels of intestinal permeability markers of Polish alpinists".* 20) Hana Kabešová, Vojtěch Čermuš *"The effect of a compensatory intervention stretching program on youth football players".* 21) Tomasz Rutkowski *"The impact of visceral therapy on symptoms in women with painful menstruation syndrome".* 22) Štefan Balkó, Kateřina Zrnová, Iva Balkó *"The influence of sleep quality on reaction time, agility and concentration in female ice hockey players".* 23) Monika Błaszczyszyn *"The movement pattern of the karate front kick with regard to neuromuscular control".* 24) Teresa Drozdek-Małolepsza *"Physical education and sport in the activity of the "Sokół" Gymnastic Society in the Częstochowa district (1923-1939)".* 25) Anna Nikodem, Izabela Rajzer *"Long-term stability and degradation mechanisms in graphene-PCL scaffolds".* 26) Agnieszka Mackiewicz, Weronika Dylewicz , Justyn Gach, Izabela Janus-Ziółkowska, Agnieszka Noszczyk-Nowak *"Analysis of effort chordae tendineae caused by myxomatous mitral valve disease in canines of large and small breeds".* 27) Rana Can, Furkan Murat Paça, Muhammed Doğukan Zengin, Seyed Houtan Shahidi *"Differences in substrate oxidation and oxygen cost between treadmill and overground running".* 28) Rana Can, Furkan Murat Paça, Muhammed Doğukan Zengin, Seyed Houtan Shahidi *"Field running requires greater energetic cost above ventilatory thresholds despite matched speeds".* 29) Renata Urban *"Manifestations of physical activity among prisoners in Nazi concentration camps during the Second World War".*

	30) Anna Nikodem, Aleksandra Krala *"Asymmetry-driven subchondral bone degeneration in osteoarthritic tibial plateau".* 31) Justyna Krzepota, Tomasz Sacewicz, Aneta Łuć, Marek Cieśluk, Dorota Sadowska *"Analysis of long-term focused attention and reactive stress tolerance among students studying e-sport and physiotherapy: preliminary investigation".* 32) Jakub Kacprzak, Dariusz Mosler, Jacek Wąsik "*Biomechanics of punching - the impact of effective mass and force transfer on strike performance".* 33) Agata Horbacz, Mária Majherová, Ladislav Kručanica *"Physical fitness levels and body composition of elderly women with varying frequencies of physical activity".* 34) Oksana Zamuruieva, Jacek Wąsik "*Prediction of force values of Taekwondo turning with aid of dynamical modeling and Lyapunov-based approach".* 35) Aleksandra Pięta, Katarzyna Świtała, Barbara Frączek *"Acid–base regulation and dietary acid load in handball players following a paleolithic diet".* 36) Javlon Ishtayev, Zakhid Gapparov, Otabek Khasanov, Rano Ishtayeva *"Issues of forming the psychological passport of athletes".* 37) Otabek Khasanov, Zakhid Gapparov, Georgiy Korobeynikov, Lesia Korobeinikova, Javlon Ishtayev *"Interrelation between the mental state and the development level of neurodynamic functions in young football players".* 38) Dávid Kaško, Nora Rybčáková *"Dietary habits and physical activity of university students".* 39) Alena Buková, Dávid Kaško, Petra Melicharová *"BMI or body fat? predictors of aerobic performance".* 30) Magdalena Korsak Sabino Belo, Tomasz Góra, Dorota Ortenburger, Mario Gallego, Alejandro Lesaola, Jacek Wąsik *"Psychological profile of people involved in sports and physical activity: A pilot study".* 31) Tomasz Góra, Jakub Kacprzak, Dorota Ortenburger, Paulina Przepióra, Jowita Karina Wyszomierska, Jacek Wąsik *"The psychosocial effects of Taekwondo training: Longitudinal perspective".* 32) Mariusz Kuberski, Jacek Wąsik, Agnieszka Musiał, Karolina Gabarska *"The influence of 3 years of aerobic swimming training on the body composition of 10-year-old female swimmers".*
19.00 –2.00	***Gala Dinner*** *– Gold Banquet Room*
24 October 2025, Friday	
8.00 – 10.00	***Breakfast***
10.00 – 10.30	***Closing ceremony – Gold Banquet Room***

Key Lectures

Nachiappan Chockalingam

Key Lecture: Bridging the Gap: Translating Biomechanics Research into Meaningful Advances in Sport, Technology, and Public Health

Professor Nachiappan Chockalingamholds academic positions in the UK, Malta, and India, collaborating with researchers worldwide. A Fellow of the International Society of Biomechanics and the Institute of Physics and Engineering in Medicine, he has also been awarded Honorary Fellowships by the Royal College of Physicians and Surgeons of Glasgow and the Royal College of Podiatry.

With a distinguished research portfolio of over 300 manuscripts, alongside numerous abstracts, book chapters, and lectures, Professor Chockalingam is widely recognised by leading scientific societies. He serves on the boards of international scientific organisations, contributes as an editor for multiple journals, and reviews for various academic publications and grant bodies globally.

His current focus is on translational research, particularly in integrating allied health professionals into biomechanics and medical engineering. Passionate about interdisciplinary collaboration and gender equality in research, he actively mentors students and early-career researchers. A key area of his expertise is in Footwear Science, and he currently serves as the Chairperson of the Footwear Biomechanics Group affiliated with the International Society of Biomechanics. His contributions also extend to charitable organisations, supporting global initiatives on healthy ageing and mobility-assistive technology.

Jerzy Małachowski

Key Lecture: Numerical aspects of modeling flow through the cerebral artery system

Prof. dr hab. inż. Jerzy Małachowski graduated from the Military University of Technology in Warsaw. He was awarded the title of Professor in the field of technical sciences in 2019. The area of scientific research and implementation and technological development mainly concerns methods of research and simulation analysis in issues related to security and defense, biomedical engineering, materials and structural mechanics, as well as the implementation and development of genetic algorithms and optimization methods for process control.

Recently, he has held and continues to hold positions on scientific councils and committees (including) as a member of the Mechanics Committee of the Polish Academy of Sciences, chairman of the Scientific Discipline Council for Mechanical Engineering at the Military University of Technology, member of the Council of the Łukasiewicz Research Network Institute – Institute of Aviation (2019-2023), member of the Scientific Council of the Military Medical Institute (2021-2025), member of the Scientific Council of the Institute of Solid State and Applied Physics of the Polish Academy of Sciences (2023-2026), member of the Scientific Excellence Council (term of office 2024-2027), expert of the Ministry of Education and Science for the evaluation of achievements in scientific activity for the years 2017-2021, member of the Council for Innovation in Higher Education and Science at the Ministry of Science and Higher Education (since 2024) and vice-chairman of the College of Deans of Mechanical Faculties of Polish Technical Universities for the term 2020-2024.

Prof. Jerzy Małachowski has supervised nine doctoral students, led numerous projects and participated as a contractor in over 30 such undertakings focused on scientific, development and implementation work financed by, among others, the National Science Centre, the National Centre for Research and Development, the EU (FP6, FP7 and Horizon 2020), EDA (European Defense Agency) and Science for Peace and Security (SPS-NATO). He regularly reviews numerous scientific articles in JCR-listed journals. He has authored more than 700 publications. He has recently conducted and maintains ongoing international collaborations with numerous centres and universities in Europe. He is a recipient of a foundation grant from the NATO Fellowship Programme and the US Research Council, which enabled him to undertake research internships at Florida State University and Indiana State University.

Piotr Rychter

Key Lecture: Smart bioresorbable polymer scaffolds with shape memory behavior for minimally invasive surgery

Piotr Rychter, PhD is a professor at the Faculty of Science and Technology of Jan Długosz University in Czestochowa. Head of Department of Pharmaceutical Sciences. Director of Interdisciplinary Science and Research Centre at Jan Dlugosz University in Czestochowa.
His research interests are focused on the application of biodegradable and biocompatible polymers for environmental and biomedical purposes. The interdisciplinary character of the research combines the ecotoxicological impact of polymers and their degradation products on the environment, controlled-release technology for agrochemicals and drugs, and utilization of wastes containing biodegradable polymers for their further application.

Author/co-author of almost 100 scientific articles and 3 patents. Hirsch Index: 18 (Scopus), 17 (WoS); citations: 1144 (Scopus), 1030 (WoS). Awards: Diploma of the Minister of Science and Higher Education for the invention" Smart bioresorbable scaffolds with shape memory properties", Warsaw, Poland, March 2018. Three gold medals for the invention "Smart bioresorbable scaffolds with shape memory properties" at: 1) International Intellectual Property, Invention, Innovation, and Technology Exposition (IPITEX 2018), Bangkok, Thailand, 2018, 2) International Invention Design Competition, Hong Kong, 2017 and 3) International Warsaw Invention Show, IWIS 2017, Warsaw, Poland, 2017. Silver medal for the invention (patent no. P.424500) „Identifying agent of biodegradable polymeric packages" at International Warsaw Invention Show, IWIS 2018, Warsaw, 2018. Participated in numerous national and international conferences. Investigator/co-investigator of several national and international projects funded by the National Science Centre and The National Centre for Research and Development.

The academic teacher within Erasmus + Programme at: Universita degli Studi di Cagliari, Sardinia (2012); Department of Chemistry and Technology of Drugs, University of Perugia, Italy (2013); Joseph Fourier University, Cermav, CEntre de Recherches sur les MAcromolécules Végétales, Grenoble, France (2014); Department of Pharmaceutical Sciences, University of Perugia, Italy (2022); Centre of Polymer Systems, Thomas Bata University, Zlin, Czech Republic (2022); Polymer Institute of Slovak Academy of Sciences, Bratislava, Slovakia (2023); University of Ferrara, Ferrara, Italy (2024); Technical University of Ostrava, Czech Republic (2024).

Morecki and Fidelus Award

INTER-SEGMENTAL TRUNK KINEMATICS IN WHEELCHAIR ATHLETES: AN EXPLORATORY IMU ANALYSIS

KAJETAN CIUNELIS[1], MICHALINA BŁAŻKIEWICZ[1]

[1]FACULTY OF REHABILITATION, THE JÓZEF PIŁSUDSKI UNIVERSITY OF PHYSICAL EDUCATION IN WARSAW, WARSAW, POLAND

Introduction: Wheelchair basketball classification requires objective trunk control assessment. This study validated a dual-sensor inertial measurement unit (IMU) method for quantifying inter-segmental trunk coordination by measuring agreement between cervical (C7) and thoracic (T8) segments across functional ability levels. The hypothesis posited that athletes with reduced trunk control would demonstrate lower inter-segmental agreement due to compensatory cervical and shoulder movements detectable through C7 measurements.

Methods: Sixty-six wheelchair users (55 basketball players, 11 other sports) were assessed using IMU sensors at C7 and T8 during standardized movements (flexion, extension, lateral flexion, rotation) in four ergonomic conditions. Inter-segmental agreement was quantified using intraclass correlation coefficients ICC(2,1) for each movement type. Participants were categorized into four functional groups based on clinical assessment performed by a physiotherapist (Spearman's r=0.94 with official wheelchair basketball classification).

Results: Higher-functioning athletes (Groups 3-4) demonstrated superior inter-segmental agreement (ICC 0.86-0.90) compared to lower-functioning groups (1-2, ICC 0.44-0.57, $p<0.001$). Effect size analysis revealed medium-to-large differences (Cohen's d=0.70-0.93). However, receiver operating characteristic analysis demonstrated poor discriminative capacity (AUC=0.52), indicating limited utility as an isolated classification metric.

Conclusions: Dual-sensor IMU assessment successfully quantifies inter-segmental trunk coordination with medium-to-large effect sizes between functional groups. However, poor discriminative capacity (AUC=0.52) demonstrates that the method cannot currently serve as a classification aid in disability sport. Greater measurement variability in lower-functioning groups suggests that the IMU method captures characteristics of reduced trunk control, yet lacks sufficient diagnostic accuracy for individual athlete assessment. While the method provides objective coordination quantification, its clinical utility remains limited to research applications until discriminative power improves substantially.

KEYWORDS: wheelchair athletes; trunk kinematics; inertial measurement unit (IMU)

KINETIC DIFFERENCES BETWEEN ORTHODOX AND SOUTHPAW STANCES IN FOUR FUNDAMENTAL BOXING PUNCHES

JAKUB KACPRZAK[1], DARIUSZ MOSLER[1], JACEK WĄSIK[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

Introduction: Boxing stance may influence the kinetics of fundamental punches by altering limb roles and the contribution of the kinetic chain. This study examined differences in punching force and fist acceleration between orthodox and southpaw stances across four techniques: jab, cross, lead hook, and rear hook.

Material and method: Thirty trained male boxers performed five maximum-force repetitions of each punch in both stances. Punching force was recorded using an AMTI MC12-2K force plate, while fist acceleration was measured with a Noraxon Ultium EMG sensor. Statistical analyses included Wilcoxon signed-rank and Kruskal–Wallis tests with effect size estimation.

Results: The jab produced significantly greater force in southpaw (1503.8 ± 389.9 N) compared to orthodox (1345.4 ± 333.5 N; $p < 0.001$), whereas the cross (1958.9 ± 500.8 N vs. 1686.5 ± 458.8 N; $p < 0.001$) and rear hook (2216.4 ± 501.2 N vs. 2034.3 ± 473.3 N; $p < 0.05$) were stronger in orthodox. Lead hook force showed no stance-related difference, although its acceleration was higher in southpaw (215.9 ± 107.3 vs. 197.3 ± 110.3 m/s^2; $p = 0.028$). Aggregated comparisons revealed no significant stance effect on total force for straight or hook punches, though straight punches displayed slightly higher acceleration in orthodox (68.5 ± 41.5 vs. 65.4 ± 46.7 m/s^2; $p = 0.032$). Across both stances, hooks consistently generated greater forces and accelerations than straight punches (all $p < 0.001$).

Conclusions: These findings indicate that stance does not confer a universal biomechanical advantage but modifies punching performance in a technique-specific manner. Bilateral training may therefore enhance technical versatility and preparation for opponents of different orientations.

KEYWORDS: boxing; biomechanics; southpaw stance; punching force; acceleration

THE ROLE OF LOWER LIMB MUSCLE FORCE IN FALL PREVENTION

RAFAŁ BORKOWSKI[1], MICHALINA BŁAŻKIEWICZ[1]

[1]FACULTY OF REHABILITATION, THE JÓZEF PIŁSUDSKI UNIVERSITY OF PHYSICAL EDUCATION IN WARSAW, WARSAW, POLAND

Introduction: According to the WHO, falls are one of the most common causes of injury and disability worldwide, with approximately 30% of people over the age of 65 experiencing falls. Trips are one of the most common causes of falls, accounting for 21% of all incidents. As the ability to generate muscle strength decreases with age, the study aimed to determine the maximum values of lower limb muscle strength generated in response to trips.

Material and methods: Twenty-one young (21.38 ± 1.32 years), healthy, physically active women walked at a speed of 1.2 m/s on the GRAIL system dual-lane treadmill. After 30 s of free walking every 10 seconds, the speed of the left treadmill line was reduced by 0.5 ~ 0.6 m/s for 0.82 s during the Pre-Swing phase of the gait cycle. Using OpenSim software, the peak values of muscle forces were found during free gait and the recovery step. The percentage changes in peak muscle force values were calculated. Cluster analysis was performed to divide the obtained differences into three clusters.

Results: Significant changes in peak force values were observed for 28 of the 33 analyzed muscles. The largest changes exceeded 100% for the tensor fascia lata, iliopsoas, and gluteus maximus muscles. Other changes ranged from 78.39% to 9.19%.

Conclusions: Significantly higher muscle strength values were observed after tripping than during free walking. In the context of age-related muscle atrophy affecting mainly type II fast-twitch fibers, it can be assumed that reduced muscle strength may be one of the factors predisposing to falls. Focusing strength training on muscles that need to generate the highest force might minimize the risk of falls.

KEYWORDS: gait, perturbations, Motek system

Abstracts

TABLE OF CONTENTS FOR INTERNATIONAL CONFERENCE OF POLISH SOCIETY OF BIOMECHANICS "BIOMECHANICS 2025"

TABLE OF CONTENTS FOR 6TH WORLD SCIENTIFIC CONGRESS "QUALITY OF LIFE IN INTERDISCIPLINARY APPROACH"

Abstracts

International Conference of Polish Society of Biomechanics "Biomechanics 2025"

RELIABILITY OF A PROPRIOCEPTIVE ANKLE DEVICE IN YOUNG ADULTS

SAYEDMOHSEN MORTAZAVI NAJAFABADI[1], DARIUSZ GRZELCZYK[1], MOHAMMED N. ASHTIANI[2]

[1]ŁÓDŹ UNIVERSITY OF TECHNOLOGY, DEPARTMENT OF AUTOMATION, BIOMECHANICS AND MECHATRONICS, ŁÓDŹ, POLAND

[2]FACULTY OF MEDICAL SCIENCES, TARBIAT MODARES UNIVERSITY, TEHRAN, IRAN

Introduction: Proprioception, which includes position sensation, motion sense, and weight/effort sense, is a crucial component of motor control, which depends on visual, vestibular, and somatosensory inputs. By computing intraclass correlation coefficients (ICC) for sense of motion, active, and passive position sensors, this study aims to assess the reliability of a constructed device.

Material and methods: Twenty young students (average height 173.55±6.3 cm, weight 73.35±9.2 kg, age 26.85±6.1 years) participated after confirming they had no diabetes or musculoskeletal/neurological issues. The device evaluates ankle proprioception using two platforms: an active platform powered by a stepper motor and a passive platform equipped with a rotary potentiometer. For motion sense tests, the active platform rotates abruptly in dorsiflexion or plantarflexion at 0.5°/s, and participants press a button as soon as they sense the movement; these tests are repeated six times per direction. For active position sense, participants learn four positions (A, B, C, and D, each 2° apart) and then identify them when the platform moves to these positions at random. In the passive method, after training at three target positions (6°, 10°, and 14°), participants actively move to these positions without motor aid, with accuracy measured by the potentiometer. All tests are performed with the participant's eyes closed.

Results: In both dorsiflexion and plantarflexion, the reliability of the sense of motion was 0.954 and 0.964, respectively. For active position sense, ICC(3,1) were moderate for positions A (0.447), B (0.553), and C (0.617) but poor for position D (0.311). In contrast, results were shown by the reliability of the passive method, which was 0.986, 0.994, and 0.997 for target positions of 6°, 10°, and 14°, respectively.

Conclusions: The AAMA device, developed at Łódź University of Technology, accurately measures proprioceptive movement sense with high reliability, making it suitable for biomechanics research.

KEYWORDS: Ankle joint, Proprioception, Proprioceptive Acuity, Intraclass correlation coefficient

PROPER IDENTIFICATION OF BODY MASS DISTRIBUTION MODIFIES THE RESULTS OF THE SIMULATION MODELS. PRELIMINARY RESULTS

MAŁGORZATA SYCZEWSKA[1], JAKUB MICHOŃSKI[2], MAŁGORZATA KALINOWSKA[1], EWA SZCZERBIK[1], ROBERT SITNIK[3], MACIEJ JAWORSKI[1]

[1]CHILDREN'S MEMORIAL HEALTH INSTITUTE, WARSAW, POLAND

[2]PHILAB, WARSAW, POLAND

[3]FACULTY OF MECHATRONICS, WARSAW UNIVERSITY OF TECHNOLOGY, WARSAW, POLAND

Introduction: Body models in musculoskeletal analyses predominately use body mass distribution among segments based on anatomy specific for young, healthy men or based on regression equations and anthropometric measurements. Patients' body proportions and anatomy often differ substantially from that of the young men. This study aimed to assess the impact of the more personalized body mass distribution among segments on the results of the simulations.

Material and methods: Data from one subject were used for this study. The subject underwent instrumented motion analysis (VICON system) performing various functional tasks: types of gait (with simulation of abnormal patterns) and running. The 3D structured light body scans and densitometric scan were used for the reconstruction of their body segment's volumes and mass distribution. These data were used for OpenSim simulations to calculate lower limb moments and forces in two conditions: with conventional body mass distribution, generic for OpenSim model, and personalized from 3D and denitometric scans.

Results: The results from the simulations showed the differences depending on the segments volumes and mass distribution.

Conclusions: From our results, it can be seen that the body mass distribution can influence the simulation outcome, but the nature of the force and moments changes is preserved. Normal gait with self-selected speed is low demanding and low dynamic activity. These preliminary results show that the impact of the personalization of the segment inertial properties on the simulation should be explored in the future.

KEYWORDS: mass distribution, simulation, motion

ACKNOWLEDGMENTS: This study was performed within INERTBODY research project financed by CMHI

NUMERICAL ANALYSIS OF THE EFFECT OF LATTICE STRUT ANGLE ON THE MECHANICAL PROPERTIES OF A LUMBAR FUSION CAGE

JUSTYNA LICHOSIK[1], CELINA PEZOWICZ[1], MAŁGORZATA ŻAK[1]

[1]WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY, FACULTY OF MECHANICAL ENGINEERING, DEPARTMENT OF MECHANICS, MATERIALS AND BIOMEDICAL ENGINEERING, WROCŁAW, POLAND

Introduction: The purpose of this study was to numerically analyse the effect of the angle of the support rods forming micropores in the mesh filling in intervertebral implants and the differences between the used materials (Ti6Al4V, PEEK).

Material and methods: Models of mesh filling, which are biomimetic representations of the alignment of collagen bundles in the intervertebral disc (30˚,60˚) or the alignment of bone beams in vertebral bodies (90˚), were developed. The above meshes were filled with the base of the implant, and additional reinforcement was proposed in one of the designs. Analyses were performed for both isolated mesh fragments and implants filled with modelled meshes. The models were loaded with an axial force of 50N (for mesh fragments) and 1500N (for implants).

Results: The distribution of reduced stresses according to the Huber - von Mises hypothesis and total displacements were evaluated. Analysis of the specimens and implants showed similar stress values and significantly different displacement values between the two materials. The implant with rod alignment at 30˚ showed the highest displacement values for both Ti6Al4V (0.035 mm) and PEEK (1.10 mm). The highest stress values were observed in the model with a bar angle of 30˚ - 980 MPa (Ti6Al4V) and 973 MPa (PEEK).

Conclusions: The simulations showed the presence of local stress concentrations in areas that could indicate a potential risk of implant failure. With the exception of the model with a bar angle of 30˚, all variants showed comparable stress values, , suggesting a limited effect of bar angle on stress distribution. The highest displacement values were identified on the upper surface of the implant, which may indicate a tendency for local collapse of the filling in these areas. The design with additional reinforcement showed the lowest displacement values, which may favourably influence the course of osteointegration and the stability of the implant.

KEYWORDS: numerical simulations, intervertebral implants, mechanical properties, biomechanics

ASYMMETRY OF SELECTED BIOMECHANICAL PARAMETERS IN GAIT IN A MAN WITH UNILATERAL PERONEAL NERVE PALSY

AGNIESZKA SZPALA[1], JULIA FRĄCZEK[1], MAŁGORZATA KOŁODZIEJ[1]

[1]WROCŁAW UNIVERSITY OF HEALTH AND SPORT SCIENCES, WROCŁAW, POLAND

Introduction: The aim of the study was to assess the values of selected biomechanical parameters (dynamic, kinematic and muscle activity) in gait in a man with unilateral peroneal nerve palsy.

Material and methods: The subject was a 37-year-old male (body weight = 89 kg, height = 177 cm), diagnosed with left peroneal nerve palsy at the age of 2. Since the age of 7, he has undergone regular rehabilitation, and since the age of 30, he has been training in triathlon. Surface electromyography was used to measure the activity of the tibialis anterior, medial head of the gastrocnemius (m.GAS), and peroneus longus muscles of both lower limbs. Pressure-sensitive insoles measured ground reaction forces (GRF) during the stance phase. Kinematic data were collected using the MyoMotion inertial motion capture system, allowing analysis of joint angles at the hip, knee, and ankle during both stance and swing phases. The subject was instructed to walk a distance of approximately 200 meters at a self-selected (preferred) walking speed. Analysis of variance was conducted using Statistica software, with a significance level of $\alpha = 0.05$.

Results: Significantly lower GRF values were recorded in the left limb, with the greatest asymmetry (36.54%) observed at heel strike ($p < 0.001$). Kinematic data showed notable asymmetry, especially in the ankle joint during the swing phase, with a 13.25° difference ($p < 0.001$). Muscle activity on the affected side was significantly higher ($p < 0.001$), with the greatest asymmetry (63.32%) observed in the m.GAS during the stance phase.

Conclusions: Increased muscle activity in the left lower limb, accompanied by significantly lower GRF values and reduced ankle joint range of motion, suggests the presence of muscular compensation as a result of regular rehabilitation.

KEYWORDS: electromyography, ground reaction force, movement analysis

LATTICE STRUCTURES IN THE DESIGN OF TITANIUM IMPLANTS FOR ACCELERATED FUSION

FILIP ANDRUSZKIEWICZ[1], ARTUR BONIK[1], LECHOSŁAW F. CIUPIK[1], AGNIESZKA KIERZKOWSKA[1], EDWARD SŁOŃSKI[1]

[1]LFC LTD. MEDICAL, ZIELONA GÓRA, POLAND

Introduction: Looking for compromises between durability and functionality of titanium implants for bone fusion is an important stage in the development of a medical device. Advanced engineering software and the development of manufacturing techniques, primarily 3D printing, provide designers with more and more options. The work consisted of selecting/optimising the geometric parameters and bio-porosity of the design, fabrication of a titanium implant model by 3D-EBM (Electron Beam Melting), and research evaluation of selected parameters relevant to biomechanics of stabilisation and osseointegration.

Material and methods: fusion implant models with different lattice parameters, defined by varying pore size and beam thickness, which were fabricated using 3D-EBM additive technology, were used for the study. Computer tomography (CT v|tome|x 240GE) was used for morphometric and comparative evaluation, while mechanical strength was assessed by static compression test (Mini Bionix-MTS).

Results: Several types of 3D structures were developed, ranging from lattice with periodic-regular structure, through random-organic lattice, to hybrid lattice that is a combination of the above. The optimized TrabeQcell® structures were similar in structure to human bone, and had 2-3 times the strength needed to safely carry loads in the area of dysfunction.

Conclusions: Advanced engineering software and 3D manufacturing technologies are essential in the design of modern medical devices for accelerated fusion. They open up new opportunities to morphometrically approximate nature, mimicking biology while securing biomechanical function.

KEYWORDS: experimental research, titanium implant, 3D-EBM printing, fusion, 3D structures

ACKNOWLEDGMENTS: The results of the research presented in the article were carried out as part of a project co-financed by the European Union with funds from the European Regional Development Fund under the Intelligent Development Operational Program, 2014-2020 (No. POIR.01.01.01-00-0377/16).

COMBINATION OF VIRTUAL REALITY AND VERTICAL JUMPS - IS IT POSSIBLE? PILOT STUDY

ARTUR STRUZIK[1], JOANNA BRODA[1], BOGDAN PIETRASZEWSKI[1], PIOTR WODARSKI[2], KATARZYNA JOCHYMCZYK-WOŹNIAK[2], JACEK JURKOJĆ[2], ROBERT MICHNIK[2]

[1]DEPARTMENT OF PHYSIOLOGY AND BIOMECHANICS, WROCŁAW UNIVERSITY OF HEALTH AND SPORT SCIENCES, WROCŁAW, POLAND

[2]DEPARTMENT OF BIOMECHATRONICS, FACULTY OF BIOMEDICAL ENGINEERING, SILESIAN UNIVERSITY OF TECHNOLOGY, GLIWICE, POLAND

Introduction: Virtual reality (VR) technology has developed rapidly in recent years. However, there is still no effective application of jumping tasks in VR. The countermovement jump (CMJ) is a popular and simple test used to assess the ability to perform high-powered movements. The effectiveness of the CMJ is not only indicated by the jump height achieved, but also by the propulsive power.
The aim of this study is to identify whether the CMJ height and power in propulsive phase change in VR compared to real conditions.

Material and methods: The study was conducted on a group of 17 female students who do not engage in regular physical activity. Each participant performed 15 single vertical CMJs with arm swing (5 jumps in real conditions, 5 jumps in VR with a closed scenery – small room, and 5 jumps in VR with an open scenery – desert, in random order), each to the maximum possible height. Measurements were performed using AMTI HPS400600 force plate with Noraxon MR3 software and HTC Vive Pro Full Kit VR goggles. The VR application with the sceneries used was created in the Unity3D engine.

Results: The participants achieved the CMJ height of 0.25±0.04 m and the average power in propulsive phase of 1269±307 W in real conditions. No significant differences were found between real conditions, VR - closed scenery and VR - open scenery for CMJ height and propulsive power.

Conclusions: The study group achieved similar values of CMJ height and propulsive power in the three conditions tested (real conditions, VR - closed scenery and VR - open scenery). Therefore, it is possible to achieve near to maximal CMJ height and considerable power value in VR, with VR goggles. However, different results can be expected in groups with high jumping abilities and in male groups, which requires further research.

KEYWORDS: CMJ, countermovement jump, force plate, power, VR goggle

PHASE-SPECIFIC GAIT ADAPTATIONS IN WOMEN AFTER TOTAL HIP REPLACEMENT: A LONGITUDINAL SPM ANALYSIS

SŁAWOMIR WINIARSKI[1], KRZYSZTOF ALEKSANDROWICZ[2,3]

[1]DEPARTMENT OF PHYSIOLOGY AND BIOMECHANICS, WROCŁAW UNIVERSITY OF HEALTH AND SPORT SCIENCES IN WROCŁAW, WROCŁAW, POLAND

[2]UNIVERSITY CENTER FOR PHYSIOTHERAPY AND REHABILITATION, FACULTY OF PHYSIOTHERAPY, WROCŁAW MEDICAL UNIVERSITY, WROCŁAW, POLAND

[3]INSTITUTE OF HEART DISEASES, UNIVERSITY HOSPITAL IN WROCŁAW, WROCŁAW, POLAND

Introduction: Total Hip Replacement (THR) remains a cornerstone intervention for patients with advanced hip osteoarthritis, yet post-operative gait recovery is often incomplete. Despite the widespread use of THR, gait asymmetries and reduced mobility persist for many months, impacting functional independence. While previous research confirms gradual improvements, little is known about when the most clinically significant changes occur or which kinematic variables are most affected during recovery. Goal: This study aimed to investigate temporal and biomechanical changes in gait among women undergoing monitored rehabilitation following unilateral THR. Using Statistical Parametric Mapping (SPM), we identified specific phases of gait most responsive to recovery and evaluated the clinical implications for rehabilitation protocols. Research questions: During which rehabilitation periods are the most significant changes in gait patterns observed? Which joint movements show the greatest variability and functional adaptation over time?

Material and methods: A longitudinal study design was used involving 32 women (mean age: 65.3 ± 9.4 years) undergoing primary cementless THR. Gait data were collected preoperatively and at 6 weeks, 3 months, 6 months, and 12 months postoperatively using a BTS Smart-E motion analysis system. Kinematic and spatio-temporal parameters were analysed. Repeated measures ANOVA was used for general trends; post-hoc 1D SPM{t} tests examined differences across time points in joint angles including pelvic tilt, hip flexion-extension, and knee mechanics.

Results: Spatio-temporal parameters improved significantly over time: walking speed increased from 0.42 to 0.72 m/s; stride length from 0.85 to 1.15 m; and step length from 0.32 to 0.48 m. Cycle time decreased from 1.50 to 1.22 s, indicating more efficient gait. The greatest changes occurred between 6 weeks and 6 months post-surgery. SPM analysis revealed the most pronounced kinematic changes during stance and pre-swing phases in hip and knee flexion-extension, pelvic tilt, and obliquity. These patterns suggest early neuromuscular recalibration and functional reloading as key phases for intervention.

Conclusions: The findings support the implementation of targeted rehabilitation interventions during the first 3 to 6 months following THR. While improvements were consistent across all periods, patients did not achieve full symmetry or normative values, underscoring the need for continued support. SPM offers high-resolution insights into joint behaviour, revealing subtle changes not detectable through conventional methods. These results advocate for phase-specific, data-driven rehabilitation strategies to enhance recovery and reduce compensatory movement risks.

KEYWORDS: Total Hip Replacement, Gait Analysis, Rehabilitation, Postoperative Recovery

ACKNOWLEDGMENTS: The authors would like to thank the technical staff of the Laboratory of Biomechanical Analysis from AWF Wrocław for their support during data collection. We also acknowledge the departmental resources provided by the Wrocław Medical University.

MODELING VARIABILITY AND REDUNDANCY IN THE MUSCULOSKELETAL SYSTEM USING STOCHASTIC AND PARETO-OPTIMAL APPROACHES

BARTŁOMIEJ ZAGRODNY[1]

[1]POLITECHNIKA ŁÓDZKA, WYDZIAŁ MECHANICZNY, ŁÓDŹ, POLAND

Introduction: The musculoskeletal system operates under dynamic and variable conditions influenced by environmental changes, load variations, and neural control. Traditional mathematical models often neglect this variability, relying on fixed input parameters and boundary conditions, which fail to capture the non-repetitive nature of movement, force fluctuations, and tremor-like behaviours. This study aims to address these limitations by incorporating stochastic processes and multi-criteria Pareto optimization into rheological muscle models.

Material and methods: A rheological model of the muscular system was developed, incorporating stochastic disturbances modelled as stationary processes to simulate real-world variability. Numerical simulations were conducted for two dynamic tasks: internal force generation and displacement. They were used for model calibration, and results were validated against experimental data. Additionally, a Pareto-optimal problem was formulated to describe the cooperation between mono- and bi-articular muscles in the sagittal plane. Theoretical equations were derived, constraints introduced, and gait analysis was used for experimental verification.

Results: The model successfully replicated both literature-based and experimental data. Simulations revealed characteristic sine-type frequency patterns and higher-frequency stochastic perturbations. The Pareto-based analysis demonstrated the inherent uncertainty and redundancy in muscle coordination, explaining the lack of perfect movement reproducibility. Small but consistent variations in gait cycles were observed and linked to the physiological flexibility of muscle cooperation.

Conclusions: The proposed solution effectively captures the variability and redundancy of the musculoskeletal system. It can simulate different system configurations and perturbation effects, closely mirroring real-world behaviour. The Pareto-optimal framework provides a theoretical basis for understanding muscle coordination indeterminacy, supporting the notion that each movement cycle may differ within a constrained solution space.

KEYWORDS: Muscle Cooperation, Stochastic Modeling, Rheological Model, Pareto Optimization, Musculoskeletal Redundancy

A NOVEL SCORING OF KINEMATIC AND SURFACE ELECTROMYOGRAPHY PATTERNS TO ASSESS CONTRIBUTIONS OF JOINT ANGLES AND MUSCLE ACTIVITIES OF PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY IN ADL TASKS

WIKTORIA WOJNICZ[1], AGNIESZKA SOBIERAJSKA-REK[2], BARTŁOMIEJ ZAGRODNY[3], MICHAŁ LUDWICKI[3], KATARZYNA PYTKA[1], JOANNA JABŁOŃSKA-BRUDŁO[2]

[1]FACULTY OF MECHANICAL ENGINEERING AND SHIP TECHNOLOGY, GDAŃSK UNIVERSITY OF TECHNOLOGY, GDAŃSK, POLAND

[2]DEPARTMENT OF REHABILITATION MEDICINE, FACULTY OF HEALTH SCIENCES WITH INSTITUTE OF MARITIME AND TROPICAL MEDICINE, MEDICAL UNIVERSITY OF GDAŃSK, GDAŃSK, POLAND

[3]MECHANICAL ENGINEERING FACULTY, ŁÓDŹ UNIVERSITY OF TECHNOLOGY, ŁÓDŹ, POLAND

Introduction: Duchenne muscular dystrophy (DMD) is a progressive disease and its progress is identified by tests that include performance of motions referring to activities of daily living (ADL). That is why detailed analysis of upper limb biomechanics (kinematics and muscle activities) should be done to accurately identify a stage of DMD progress and to set a proper rehabilitation strategy. The aim of this study was to create a tool (a novel scoring of kinematic and surface electromyography patterns) that help clinicians to identify an inter-joint coordination and occurrence of compensatory movement of patients with DMD by considering the whole track of each tested ADL motion.

Material and methods: In this study we tested in clinical conditions 5 teenager/adolescent non-ambulant patients with DMD and a control group composed of 12 healthy teenager/adolescent boys. A protocol of testing involved three functional vertical motions, four functional horizontal motions at waist level, and two functional complex motions. To collect kinematic data and EMG data we used a motion capture system (OptiTrack Flex 13) and EMG system (Noraxon MyoTrace400). A novel scoring of kinematic and surface electromyography patterns was proposed to assess contribution of four joint angles of an upper limb (elbow flexion-extension, shoulder rotation, shoulder flexion-extension and abduction-adduction) and four superficial muscle activities (trapezius, lateral triceps brachii, anterior deltoid, and biceps brachii) in each tested performance by considering the whole track of each tested ADL motion (https://doi.org/10.1016/j.clinbiomech.2025.106542).

Results: Results were calculated to assess: 1) kinematic synergy of two joint angles over time; 2) accumulated joint synergy of four joint angles over time; 3) predominant type of control of accumulated joint synergy of four joint angles over time; 4) accumulated EMG synergy of four superficial muscles over time.

Conclusions: Proposed novel scoring was able to identify individual movement strategies of tested patients with DMD. This novel scoring can by used in clinical conditions to assess motion' coordination and appearing compensations.

KEYWORDS: DMD, EMG, Kinematic data, Multi-regression, Cross-correlation

ACKNOWLEDGMENTS: We would like to thank our colleagues taking part in the development of this project: Professor MD Dominika Szalewska (Medical University of Gdańsk) and PhD Marek Chodnicki (Gdańsk University of Technology). The calculations were carried out at the Academic computer Centre in Gdańsk (TASK), Poland.

ASSESSMENT OF VISUAL CORTEX ACTIVATION UNDER VARYING STIMULUS DIMENSIONALITY USING FNIRS

JUSTYNA ROMANEK[1], TAYYABA NOSHEEN[1], JACEK JURKOJĆ[1], MARTA CHMURA[1], PIOTR WODARSKI[1]

[1]DEPARTMENT OF BIOMECHATRONICS, FACULTY OF BIOMEDICAL ENGINEERING, SILESIAN UNIVERSITY OF TECHNOLOGY, GLIWICE, POLAND

Introduction: The 8 Hz flickering checkerboard is a well-established visual stimulus used in neuroimaging, including fNIRS studies. While most research has focused on 2D presentations, relatively few studies have examined how VR environments affect visual cortex activation. Based on previous findings that immersive settings enhance attentional processing and sensory integration, it is expected that VR presentation will elicit stronger visual cortex responses.

Material and methods: Healthy adult participants viewed an 8 Hz flickering black-and-white checkerboard under two conditions: (1) on a monitor and (2) using HTC Pro Eye goggles. Brain activity was recorded with functional near-infrared spectroscopy (fNIRS), using short-distance detectors to reduce interference from superficial blood flow.
A set of custom hemodynamic indicators was used to capture cortical responses. These included maximum oxyhemoglobin (Max HbO), minimum deoxyhemoglobin (Min HbR), and the difference between them at peak activation (ΔHb). Additional parameters such as the time to reach peak HbO (Time to Peak), area under the ΔHb curve (Area to Max HbO), deviation from baseline ($\Delta Hb - \Delta Hbt_0$), and relative change from baseline ($\Delta Hb / \Delta Hbt_0$) were also analyzed, where ΔHbt_0 refers to the HbO - HbR difference during the baseline period.

Results: Significant differences in visual cortex activation were observed between 2D and 3D conditions ($\alpha = 0.05$). VR induced stronger hemodynamic responses, especially in Max HbO, ΔHb, and Area to Max HbO, suggesting more intense neural activity. Time to Peak remained similar across conditions, indicating comparable response timing.

Conclusions: These results support the hypothesis that 3D VR stimuli induce stronger and more distinct neural activation patterns compared to their 2D counterparts. These results may provide a basis for the use of VR in cognitive neuroscience research, with potential applications in clinical diagnostics, neurorehabilitation, and immersive therapeutic interventions.

KEYWORDS: virtual reality, fNIRS, visual cortex, brain activation, neurorehabilitation

ACKNOWLEDGMENTS: The publication was co-financed from Project No. FESL.10.25-IZ.01-07E7/23.

MEASUREMENT AND NUMERICAL ANALYSIS OF BONE CONDUCTION STIMULATION APPLIED TO THE OTIC CAPSULE IN THE HUMAN TEMPORAL BONE

PAWEŁ BORKOWSKI[1], ANDRZEJ KUCHARSKI[2], RAFAŁ RUSINEK[3], ROBERT ZABLOTNI[3]

[1]THE FACULTY OF POWER AND AERONAUTICAL ENGINEERING, WARSAW UNIVERSITY OF TECHNOLOGY, WARSAW, POLAND

[2]DEPARTMENT OF OTOLARYNGOLOGY HEAD AND NECK SURGERY, MEDICAL UNIVERSITY OF LUBLIN, LUBLIN, POLAND

[3]DEPARTMENT OF APPLIED MECHANICS, LUBLIN UNIVERSITY OF TECHNOLOGY, LUBLIN, POLAND

Introduction: The main path of sound transmission to the human ear is air conduction. When it does not work correctly, the bone conduction (BC) implant can improve hearing. The main goal of BC stimulation is to excite vibrations in the otic capsule located inside the temporal bone. A typical implantation site is the mastoid process; however, the closer an implant is to the cochlea, the force giving sufficient excitation level decreases. In the case of an implant attached to the otic capsule, the cochlear response depends on the direction of the stimulating force. This study aimed to compare two directions of BC stimulation applied closely to the inner ear using experimental measurements (laser Doppler vibrometry) and numerical simulation (finite element method).

Material and methods: The temporal bone was unfrozen before the experiment and placed in malleable putty. The excitation system included a shaker, a nylon rod, and the force sensor with a pin glued to the petrous temporal bone above the upper semicircular canal. The angle between the two stimulation directions was 15 degrees. The vibrometer measured the stimulating force and amplitudes of vibrations at the stapes footplate, cochlear promontory, and points located on the outer surface of the bone for eighteen frequencies from the hearing range of 0.1 - 10 kHz. The numerical model in the ANSYS program included the temporal bone, putty, and excitation system.

Results: The forces measured for both stimulation directions were nearly identical, while the velocity amplitudes differed by a few dB. The movement of the otic capsule relative to the outer surface of the temporal bone became significant for medium and high frequencies.

Conclusions: The results confirmed that the petrous part of the temporal bone moves relative to the skull during bone conduction stimulation, and the stimulation direction plays a role.

KEYWORDS: temporal bone, otic capsule, bone conduction, finite element analysis, laser Doppler vibrometry

EFFECTS OF PERTURBATION-BASED BALANCE TRAINING ON POSTURAL ADJUSTMENT MECHANISMS IN BASKETBALL PLAYERS

MARTA CHMURA[1], PIOTR WODARSKI[1], MATEUSZ JANECKI[1], JUSTYNA ROMANEK[1], ANNA MILLER-BANAŚ[1], JACEK JURKOJĆ[1]

[1]DEPARTMENT OF BIOMECHATRONICS, FACULTY OF BIOMEDICAL ENGINEERING, SILESIAN UNIVERSITY OF TECHNOLOGY, POLAND

Introduction: Maintaining postural stability in dynamic conditions requires rapid and coordinated activation of postural muscles. Anticipatory postural adjustments (APA) and compensatory postural adjustments (CPA) play a critical role in preparing the body for expected and unexpected disturbances and restoring balance afterward. While proprioceptive training is widely used in rehabilitation and sport, its effects on neuromuscular and biomechanical postural responses in athletes remain underexplored. The aim of this study was to evaluate the effects of perturbation-based proprioceptive training on muscle activity and balance reactions in female basketball players.

Material and methods: Five athletes from the AZS Silesian University of Technology basketball team (mean age: 21.8 ± 4 years) participated in the study. Postural responses were assessed using surface electromyography (EMG), inertial measurement units (IMU), and a stabilographic platform measuring center of pressure (COP). Tests were conducted before and after a four-week proprioceptive training program, which included perturbation-based exercises during standing and walking using a treadmill system with VR integration. Perturbations were delivered forward and backward, with and without warning signals. Muscle activity and COP dynamics were analyzed across three phases: early (EPA), anticipatory (APA), and compensatory (CPA) adjustments.

Results: Post-training results showed increased EMG activity of the tibialis anterior and gastrocnemius medialis during APA under warning conditions, and greater knee flexion in response to forward perturbations. A significant increase in COP velocity during CPA was observed after training, indicating improved compensatory reactions. A strong correlation between EMG activity in EPA and COP velocity in CPA was found, along with additional trends linking knee flexion and COP dynamics.

Conclusions: The findings suggest that proprioceptive training using perturbation can enhance both anticipatory and compensatory postural mechanisms. This approach may support injury prevention and postural control optimization in high-performance athletes.

KEYWORDS: postural adjustments, electromyography, postural stability, proprioception, basketball players

COMPARATIVE ANALYSIS OF KNEE JOINT LOADING DURING GAIT ACROSS AGE GROUPS

KATARZYNA NOWAKOWSKA-LIPIEC[1], HANNA ZADOŃ[1], PIOTR SZAFLIK[1], STERIANI ELAVSKY[2], JAROSLAV UCHYTIL[2], PETR KUTÁČ[2], DANIEL JANDAČKA[2]

[1]DEPARTMENT OF BIOMECHATRONICS, FACULTY OF BIOMEDICAL ENGINEERING, SILESIAN UNIVERSITY OF TECHNOLOGY, POLAND

[2]DEPARTMENT OF HUMAN MOVEMENT STUDIES, UNIVERSITY OF OSTRAVA, CZECH REPUBLIC

Introduction: Walking is a fundamental human movement, and gait patterns evolve with age due to changes in motor control and movement dynamics. These changes can influence musculoskeletal loading, particularly at the knee joint. The aim of this study was to compare knee reaction forces in different age groups of inactive individuals during walking.

Material and methods: Numerical simulations were conducted using the AnyBody Modelling System, based on kinematic and dynamic data from a previous experimental study [1]. The study included 100 inactive individuals (50 females and 50 males), with 20 participants (10 females and 10 males) in each of the following five age groups: 18–25 years, 26–35 years, 36–45 years, 46–55 years, and 56–65 years. Participants were classified as inactive if they did not run or meet public health recommendations for physical activity. Walking speed was comparable across age groups. For each participant, six gait cycles were simulated and the resultant knee joint reaction forces were normalised to body weight.

Results: Knee joint loading varied with age. During the first half of the stance phase (0–30% of the gait cycle), older adults (aged 56–65) exhibited higher knee joint forces compared to younger adults (aged 18–25), regardless of gender. In terminal stance (30–50% of gait cycle), older women had lower knee loads than younger women, while older men exhibited higher loads than younger men.

Conclusions: The simulation results suggest that knee loading during walking may vary with age. These findings may have implications for age-specific musculoskeletal health and injury prevention.

[1] Jandačka D. et al. (2020), Running and Physical Activity in an Air-Polluted Environment: The Biomechanical and Musculoskeletal Protocol for a Prospective Cohort Study 4HAIE, Int. J. Environ. Res. Public Health, 17: 9142.

KEYWORDS: Anybody Modeling System, knee loads; ageing; walking

ACKNOWLEDGMENTS: The simulations were based on data collected in the EU-funded LERCO project (CZ.10.03.01/00/22_003/0000003) via the Operational Programme Just Transition as well as under ERDF/ESF project 4HAIE „Healthy Aging in Industrial Environment–Program4“ (CZ.02.1.01/0.0/0.0/16_019/0000798.

BIOMECHANICS OF PUNCHING—THE IMPACT OF EFFECTIVE MASS AND FORCE TRANSFER ON STRIKE PERFORMANCE

JAKUB KACPRZAK[1], DARIUSZ MOSLER[1], JACEK WĄSIK[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

Introduction: This study investigates the biomechanical determinants of punching efficiency in boxing, with a focus on the concept of effective mass—the portion of an athlete's body mass that actively contributes to the force of a punch.

Material and methods: Thirty trained male boxers executed four punching techniques (jab, cross, lead hook, and rear hook) while their punch force and fist acceleration were measured using an AMTI force plate and Noraxon Ultium EMG sensors. Effective mass was computed as the ratio of peak force to fist acceleration, and impulse dynamics were assessed to understand the total force applied over time.

Results: demonstrated that straight punches (jab and cross) yielded significantly higher effective mass values than hooks, despite hooks showing greater peak force. The cross exhibited the highest effective mass (31.17 ± 16.20 kg), followed by the jab (30.39 ± 15.09 kg), indicating superior efficiency in transferring body mass during linear strikes. Hooks, although forceful, were biomechanically less efficient due to greater rotational complexity and reduced contact duration. Regression analysis confirmed that effective mass and impulse/fist acceleration were strong predictors of punching force, while body mass, muscle mass, and training experience showed no significant effect. Interestingly, a moderate correlation was found between body fat percentage and punching force, suggesting a potential role in mass distribution and stability.

Conclusions: These findings underscore the importance of technique, kinetic chain coordination, and joint stiffness at impact in optimizing force transfer. Training approaches should emphasize precise biomechanics over raw physical attributes to enhance striking performance. The study also highlights the need for further research into real-fight conditions and varied athlete populations to broaden applicability.

KEYWORDS: boxing; biomechanics; effective mass; punching force; kinetic analysis

PATTERN RECOGNITION FROM SURFACE ELECTROMYOGRAPHY (SEMG)

KATARZYNA PYTKA[1], WIKTORIA WOJNICZ[1], NATALIA SZARWIŃSKA[1], MAREK CHODNICKI[1], WIKTOR SIEKLICKI[1]

[1]GDAŃSK UNIVERSITY OF TECHNOLOGY, FACULTY OF MECHANICAL ENGINEERING AND SHIP TECHNOLOGY, GDAŃSK, POLAND

Introduction: The aim of the study is to establish EMG patterns of muscle activations.

Material and methods: The surface electromyography (sEMG) and acceleration (ACC) data were obtained through studies conducted on 30 healthy individuals. Eight sensors of the EMG DELSYS system were used in this study. Sensors had been attached to four superficial muscles on the right and left upper limbs. Each subject performed isometric exercises in three forearm positions. Each forearm was positioned at approximately 90° at elbow joint, with an external load.

Results: Using postprocessed data, twenty three models were applied for pattern recognition from the sEMG data by using MATLAB: Tree (decision trees) and SVM (support vector machine), K-NN (K-Nearest Neighbors), QD (Quadratic Discriminant), LD (Linear Discriminant), ELR (Efficient Logistic Regressions). The first task involves distinguishing between relaxation state and isometric contraction state performed under the giving load. On the base of test results we obtained that accuracy of each model is ranging between 96-100%.

Conclusions: These outcomes are used for further studies.

KEYWORDS: EMG, pattern recognition, classification algorithms

PREDICTION OF FORCE VALUES OF TAEKWONDO TURNING WITH AID OF DYNAMICAL MODELING AND LYAPUNOV-BASED APPROACH

OKSANA ZAMURUIEVA[1], JACEK WĄSIK[2]

[1]LESYA UKRAINKA VOLYN NATIONAL UNIVERSITY, LUTSK, UKRAIN

[2]INSTITUTE OF PHYSICAL CULTURE SCIENCES OF JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

Introduction: This reserch presents a combined experimental and modeling approach to analyze and to predict Taekwondo kick force from experimental data obtained by inertial measurement unit (IMU) sensors, providing a cost-effective alternative to traditional force plates in sports biomechanics taking into account base experimental results.

Material and methods: A Lyapunov-based approach was developed to estimate Taekwondo kick force with aid of MATLAB-based experimental data processing algorithms. At the same time, both qualitative and quantitative assessments are provided, as well as a forecast of the state of these characteristics in future time intervals. The consistency between the experimental findings and model predictions validates the use of Lyapunov-based analysis in capturing key features of dynamics of kick force. These insights enhance our understanding of kick force nature and demonstrates the potential of dynamical models combined with experimental data to predict Taekwondo kick forces.

Results: Results highlighted the feasibility of predicting force values without relying on a force plate, developed model approach could enhance the accessibility of field studies conducted outside laboratory settings.

Conclusions: As a direction for future research, the modeling framework will be extended to incorporate nonlinear dynamics or data-driven switching laws to further improve its predictive capabilities.

KEYWORDS: modeling, analysis,Taekwon-do, biomechanics, sport

ACKNOWLEDGMENTS: This work was produced in the framework of Visegrad Scholarship Program, grant (Application for fellowship) number 62510059.

ESTIMATION OF ACTIVATION PATTERNS OF SURFACE EMG FOR APPLICATION IN MECHANICAL ENGINEERING AND BIOMEDICAL ENGINEERING

MARTYNA KOSECKA[1], WIKTORIA WOJNICZ[1]

[1]FACULTY OF MECHANICAL ENGINEERING AND SHIP TECHNOLOGY, GDAŃSK UNIVERSITY OF TECHNOLOGY, GDAŃSK, POLAND

Introduction: The use of surface electromyography signals in mechanical and biomedical engineering is a rapidly growing area of research, with applications in prosthetic control, rehabilitation, and ergonomy. The main goal of this study was to identify muscle activation patterns by using Machine Learning algorithms. In the scope go this study we studied routine tasks performed by cashiers during their work at the checkout.

Material and methods: EMG data were collected from six healthy subjects using the 8 sensors of Delsys Trigno Wireless EMG System. The recordings captured upper limb muscle activity while executing tested movements. Data acquisition and preprocessing were performed using EMGworks software, followed by advanced analysis in MATLAB. A neural network was designed to classify movement patterns based on post-processed and normalized signal features.

Results: The metrics calculated in the study included classification accuracy, confusion matrix, correlation coefficient, and mean squared error. The evaluation of neural network performance was primarily based on the MSE, calculated separately for the training and testing phases.

Conclusions: The obtained results demonstrate the potential of application of neural networks in the recognition of sEMG signal patterns for real-time rehabilitation and ergonomic applications. Future work will focus on expanding the dataset, optimizing network architectures, and exploring integration with real-time feedback systems.

KEYWORDS: sEMG, Pattern Recognition, Neural Network

ACKNOWLEDGMENTS: I would like to thank Ms. Klaudia Libiszewska and Ms. Weronika Kubok for their valuable support during the course of the study.

OPTIMAL COATINGS IN PLANTS AND ANIMALS – AN APPROACH OF NANOBIOMECHANICS AND NANOTHERMODYNAMICS

NATALIA KIZILOVA[1]

[1]WARSAW UNIVERSITY OF TECHNOLOGY, INSTITUTE OF AERONAUTICS AND APPLIED MECHANICS, WARSAW, POLAND

In the last decades, much attention was paid to the study of the 'secrets' of the outer surfaces or coating of the plant leaves, stems and flowers; the exoskeleton of beetles and other insects, shells, mollusks and other small animals. The very first wave of experimental and theoretical studied was inspired by the lotus leaf effect that is a combination of superhydrophobicity, self-cleaning and some other physical phenomena. Now the dataset of the optimal (in the meaning of some optimization criteria) surfaces/coatings includes the super sticky gecko feet, super efficient heat absorbing butterfly wings, the shark skin with super low drag coefficient, the desert beetles that able to condense water from the hot dry air, and many other examples.

In this study, the main common approaches to the nature-inspired surfaces are summarized, and the most important mechanisms are determined as (i) a specific micto&nano roughtess of the surface, (ii) a combination of hydrophilic and hydrophobic materials with common interfaces, (iii) fractal geometry, and some others. As it is known, at the micro and nanoscales: (1) the constitution laws differ from the meso/macro scale laws due to additional first- and second-gradient terms, (2) the boundary conditions for the fluid flow equations include the first- and second-order velocity slip and temperature jump terms, (3) the surface/interface phenomena contribute significantly to the Gibbs surface energy compared to the bulk phenomena that is an important issue of nanothermodynamics.

Based on the (1)-(3) physical approaches the natural surfaces/coating have been examined with the minimum surface energy and the biomechanical lightweight design using the Pareto frontiers. It is shown, the same geometry and material design optimization principles are used in different fractal-type micro&nano scale roughness in plants and animals. The evolutionary optimized solutions provide a multicriteria optimization. The conclusion is very important for engineering applications.

KEYWORDS: Nanobiomechanics, Nature-inspired design, Optimal structures in nature

EXAMINATION OF STRENGTH PROPERTIES OF THE TEMPOROMANDIBULAR JOINT DISC – PRELIMINARY EXAMINATION

AGNIESZKA SZUST[1], GABRIELA WIELGUS[1], ANNA WYBRANIEC[1]

[1]POLITECHNIKA WROCŁAWSKA, WYDZIAŁ MECHANICZNY, KATEDRA MECHANIKI INŻYNIERII MATERIAŁOWEJ I BIOMEDYCZNEJ, WROCŁAW, POLAND

Introduction: The temporomandibular joint (TMJ) disc is classified as a hinge-type synovial joint, facilitating hinge (rotation) movements in a single plane alongside translational (gliding) motions. Temporomandibular joint dysfunctions (TMD) can be congenital, developmental, or acquired, resulting from factors such as cervical muscle contractures, postural abnormalities, or malocclusion. Most existing research utilizes animal models, notably porcine specimens, due to the high anatomical similarity between porcine and human TMJ structures, rendering pigs a suitable model for TMJ biomechanical and morphological studies.

Materials and methods: The experimental specimens comprised TMJ discs extracted from porcine subjects aged 4 to 6 months. Post-extraction, the discs were preserved via cryopreservation in an appropriate cryogenic medium until testing. Prior to biomechanical assessment, each sample underwent visual inspection for mechanical damage or defects that could compromise test validity. Compression tests were performed on the TMJ discs submerged in an aqueous solution of 90% NaCl maintained at 37.5°C within a dedicated testing chamber. The discs were subjected to uniaxial compression at their central region, applying force until a relative deformation of approximately 80% of the initial disc height was achieved, resulting in a measurable reduction in height.

Results: Dimensional analysis involved measuring the width and height of the discs pre- and post-compression to quantify geometric alterations induced by load application. The dimensionless energy dissipation coefficient (Ψ) was calculated to evaluate the energy loss during cyclic loading, serving as an indicator of the disc's capacity to absorb and dissipate mechanical energy during deformation, thereby providing insight into its fracture resistance and dynamic behavior. Analysis of this coefficient facilitated assessment of the material's viscoelastic properties under repetitive loading conditions.

Conclusions: The primary objectives of this study were to quantify the compressive force corresponding to specific deformations and to characterize the load-displacement relationship of the TMJ disc material. Key parameters derived included the material's compliance coefficient (Sc) and the dimensionless energy dissipation coefficient (Ψ). The experimental findings are consistent with previously published data on TMJ disc biomechanics, supporting the validity of the porcine model in TMJ mechanical investigations.

KEYWORDS: temporomandibular joint disc, dimensionless energy dissipation factor, susceptibility

NUMERICAL ANALYSYS SEVERAL CASES OF LUMBAR SPINE STABILIZATIONS

PATRYCJA SZCZEPKOWICZ[1], TOMASZ KLEKIEL[1]

[1]UNIVERSITY OF ZIELONA GÓRA, ZIELONA GÓRA, POLAND

The aim of this study is to investigate the impact of selected interspinous stabilization methods on the effectiveness of treating intervertebral disc herniation at the L4–L5 level of the human spine and to propose alternative surgical treatment plans. Geometric models incorporating the proposed interspinous stabilizers were developed based on MRI scans and subsequently subjected to numerical analysis under identical boundary conditions. The study enabled an analysis of the stresses and strains occurring in individual components of the lumbar spine. The results indicated that the use of the 12 mm DIAM implant did not produce the desired therapeutic effect, whereas the "C" type implant demonstrated the most significant positive influence on the L4–L5 intervertebral disc herniation.

KEYWORDS: Interspinous stabilization, Intervertebral disc herniation, L4–L5 lumbar spine, Numerical analysis, Surgical treatment alternatives

DUAL TASK GAIT DURING PREGNANCY: A CASE STUDY OF BIOMECHANICAL AND PSYCHOLOGICAL CHANGES BETWEEN THE FIRST AND THIRD TRIMESTER

NIKOLA CHMURA[1], WANDA FORCZEK-KRAKOSZ[2], AGNIESZKA WOJTOWICZ[3]

[1]DOCTORAL SCHOOL, UNIVERSITY OF PHYSICAL CULTURE IN KRAKÓW, KRAKÓW, POLAND

[2]DEPARTMENT OF BIOMECHANICS, UNIVERSITY OF PHYSICAL CULTURE IN KRAKÓW, KRAKÓW, POLAND

[3]DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF PHYSICAL CULTURE IN KRAKÓW, KRAKÓW, POLAND

Introduction: Pregnancy leads to dynamic physiological and psychological changes that affect both musculoskeletal and cognitive-emotional functioning. Biomechanical gait adaptations—such as reduced step length, slower walking speed, and prolonged stance phase—are commonly observed. Simultaneously, increased anxiety and reduced attentional resources may impact mobility, particularly in dual-task situations that combine motor and cognitive demands. This case study aimed to compare gait performance, attention, anxiety, and physical activity in a pregnant woman during the first and third trimesters under single- and dual-task conditions.

Material and methods: A 27-year-old healthy primigravida woman was assessed at ~12 and ~35 weeks of gestation. Gait analysis was performed using the Vicon Nexus system with 39 reflective markers (Plug-in Gait model). Two conditions were tested: (1) single-task walking at a comfortable pace and (2) dual-task walking with a concurrent cognitive task (DIVA test). Gait parameters (cadence, walking speed, step width, stride time, stance phase, etc.) were recorded. Psychological assessments included the State-Trait Anxiety Inventory (STAI-I, STAI-II), Health Behavior Inventory (IZZ), and International Physical Activity Questionnaire (IPAQ).

Results: Under single-task conditions, only minor gait changes were observed between trimesters (slightly increased cadence, walking speed, and step width). In contrast, dual-task walking in the third trimester showed more marked adaptations: reduced cadence and speed, increased stance time and step width, suggesting compensatory adjustments for balance. The DIVA test indicated reduced attentional performance, with increased omission errors. STAI-I scores revealed higher state anxiety in the third trimester, while trait anxiety remained stable. Health behaviors and physical activity were consistently high, though slightly reduced in late pregnancy.

Conclusions:Dual-task conditions reveal significant cognitive-motor adaptations in pregnancy, especially in late gestation. These findings emphasize the importance of assessing both biomechanical and psychological factors to ensure safety and mobility in pregnant women.

KEYWORDS: pregnancy, dual-task gait, cognitive-motor interference

ACCELERATED EVALUATION OF TRABECULAR BONE FATIGUE STRENGTH USING THE LOCATI METHOD AND BONE MICROSTRUCTURE INDICES

ARTUR CICHAŃSKI[1], TOMASZ TOPOLIŃSKI[1], KRZYSZTOF NOWICKI[1]

[1]BYDGOSZCZ UNIVERSITY OF SCIENCE AND TECHNOLOGY, FACULTY OF MECHANICAL ENGINEERING, BYDGOSZCZ, POLAND

Intoduction: S-N curves describing fatigue properties are determined in the whole bone test, but mainly on cortical bone or trabecular bone samples. Bone fatigue tests are usually performed with periodically varying stresses with a sine waveform at a frequency of 2Hz for fatigue limit of 106 cycles. Test performed in such conditions is lengthy and costly. The work presents an accelerated method for estimating the fatigue limit using a single trabecular bone sample, whose microstructural parameters were determined using microCT.

Materials and methods: In order to verify the proposed method experimentally, two groups of human trabecular bone samples were tested: the first group (n=42) was tested under monotonic loading, and the second group (n=61) was tested under cyclic loading. In the course of strength tests carried out under monotonic loading conditions, the first group of samples was used to determine the compressive strength US. Fatigue testing for the second group of samples was carried out using the Locatii method, with a gradual increase in load amplitude. The fatigue limits of the trabecular bone were determined in accordance with the hypothesis of linear accumulation of fatigue damage based on the parameters of the reference S-N curve taken from the literature.

Results: Based on the fatigue limits, S-N curves were determined. These curves were used to calculate the USS-N compressive strength corresponding to the fatigue limit for the number of cycles N=1. Calculation dependencies linking US with BV/TV and BMD indicators were also formulated. A Kolmogorov-Smirnov statistical test was performed to check the consistency of the distribution of the calculated USS-N with the experimental US, yielding D=0.19 (p=0.314). The conformity of the BV/TV distributions, both experimental and calculated, was also tested statistically, and the Kolmogorov-Smirnov test result was D=0.286 (p=0.065). A similar analysis performed for BMD yielded a result of D=0.238 (p=0.185).

KEYWORDS: bone fatigue, accelerated test, trabecular bone, bone structure indices

ANALYSIS OF MANDIBULAR BONE DISPLACEMENT CONTINUITY IN CUSTOMIZED CONDYLAR IMPLANTS

AGNIESZKA SZUST[1], ANNA WYBRANIEC[1], MATEUSZ MAJ[1], JOANNA MENDERA[1]

[1]WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY, FACULTY OF MECHANICAL ENGINEERING, DEPARTMENT OF MECHANICS, MATERIALS AND BIOMEDICAL ENGINEERING, WROCŁAW, POLAND

Introduction: The optimal function of the temporomandibular joints, which serve as the sole articulations connecting the mandible to the cranial bones, is essential for the overall performance of the masticatory system. Considering various pathological and traumatic factors, it is estimated that up to 40% of the population may experience temporomandibular joint disorders and associated functional impairments. Most cases can be effectively managed with appropriate pharmacological treatment and rehabilitative therapies; in more complex situations, surgical intervention may be indicated.

Materials and methods: The study used polyurethane mandibular models (SYNBONE 8596), commercial condylar process reconstructive implants, and two additional original models created via additive manufacturing techniques, specifically 3D printing. During experimental evaluations, the models were subjected to mechanical loads following the Armstrong protocol, applying a force of 270 N. Displacement data were captured using a Digital Image Correlation (DIC) system. Complementary analytical assessments were conducted employing the finite element method (FEM).

Results: The displacement patterns obtained through both experimental procedures and numerical simulations demonstrated consistency, validating the accuracy of the proposed models. The displacement results for the physical model and the numerical polyurethane model showed strong concordance. However, comparisons between the numerical polyurethane model and the numerical anatomical model revealed variations in displacement magnitudes of up to 100%. Experimental findings indicated that incorporating a commercial implant increased the overall system stiffness by approximately 70–80% relative to the reference model. The alternative modelling approach proposed by the authors resulted in differences of around 20%.

Conclusions: A uniform distribution of stresses within the surrounding tissues, including the bone, suggests a beneficial impact on the biomechanical integrity of the system. Although the implant may cause localized increases in displacement, its presence enhances mandibular biomechanics and aids in restoring proper temporomandibular joint function. These insights can inform future implant design improvements and facilitate better customization to meet individual patient requirements.

KEYWORDS: temporomandibular joint, condylar implant, experimental model, DIC

CUSTOM SOFTWARE FOR REAL-TIME BIOMECHANICAL ANALYSIS USING PERCEPTION NEURON 3 IMU SENSORS: EXPANDING APPLICATIONS BEYOND ANIMATION

DARIUSZ MOSLER[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCE, COLLEGIUM MEDICUM, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

Introduction: IMU-based motion capture systems such as Perception Neuron 3 (Noitom) are increasingly used in sports science and rehabilitation. While these systems offer the technical capability for detailed biomechanical analysis, the original software is primarily designed for animation and does not support calculation of specific parameters relevant to human movement research and practice. The aim of this work was to extend the functionality of Perception Neuron 3 sensors beyond motion capture for animation, enabling advanced biomechanical assessments.

Material and methods: Custom Python software was developed to process raw data from Perception Neuron 3 IMU sensors. The workflow includes the calculation of joint angular velocity using quaternion-based algorithms, estimation of jump height from vertical acceleration and flight time, and extraction of spatiotemporal gait parameters through detection of gait events. The software is suitable for both batch and real-time data analysis, providing graphical and tabular outputs.

Results: The developed tools were applied to movement tasks including vertical jumps, walking trials, and martial arts techniques. The angular velocity analysis module was specifically used to examine the dynamics of martial arts movements, enabling detailed quantification of joint rotational speed during kicks and strikes. Additionally, the software generated jump height estimations and gait parameters such as cadence and step length. These outputs can be used for further interpretation or integrated with other biomechanical modeling tools.

Conclusions: By developing dedicated analysis software, the practical use of Perception Neuron 3 systems has been expanded beyond their original application in animation. The presented tools enable accessible, field-ready biomechanical analysis for sports science and rehabilitation.

KEYWORDS: Inertial measurement unit (IMU), Biomechanical analysis, Perception Neuron, Angular velocity, Gait analysis

SAFER AND MORE BIOCOMPATIBLE IMPLANTS WITH SOL-GEL COATINGS

IWONA KOCHANOWSKA[1,2], JUSTYNA KRZAK-ROŚ[3], SYLWIA SZOTEK[3], JAROSŁAW FILIPIAK[3]

[1]HIRSZFELD INSTITUTE OF IMMUNOLOGY AND EXPERIMENTAL THERAPY POLISH ACADEMY OF SCIENCES, WROCŁAW, POLAND

[2]COLLEGIUM MEDICUM JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[3]DEPARTMENT OF MECHANICS, MATERIALS SCIENCE AND ENGINEERING AT WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY, WROCŁAW, POLAND

The development of advanced implant materials requires surface modifications that not only provide durability but also guarantee biological safety and compatibility. While metallic biomaterials such as 316L stainless steel remain widely used, their potential release of toxic ions necessitates protective surface layers. Sol-gel derived coatings offer a versatile solution, enabling control over structural, mechanical, and especially biological properties.

In this study, silica-based (SiO_2) coatings doped with fluorine and chlorine were synthesized on 316L stainless steel substrates using the sol-gel dip-coating method and subjected to heat treatments at 50°C, 300°C, and 500°C. Structural analyses (SEM, profilometry) confirmed coating continuity and tunable surface roughness, while mechanical testing (four-point bending) showed excellent adhesion and resistance to cyclic loading.

The most significant findings were obtained from biological assays. In vitro cultures of murine fibroblasts demonstrated that all coatings were non-cytotoxic and supported high levels of cell viability and proliferation. Moreover, subtle but meaningful differences were observed depending on dopant type and thermal processing. Fluorine- and chlorine-doped coatings influenced fibroblast morphology and population density, with chlorine-doped layers annealed at lower temperatures showing particularly favorable outcomes. These results highlight the coatings' ability to actively promote bioacceptance rather than merely serving as passive diffusion barriers.

Overall, sol-gel coatings provide a reproducible and adaptable approach for improving the biological performance of metallic implants. By combining mechanical stability with strong bioactivity, such surface modifications hold promise for the development of next-generation implants with enhanced integration and long-term clinical success.

KEYWORDS: sol-gel coatings, implant materials, surface modification, biocompatibility, cells proliferation

ACKNOWLEDGMENTS: The author wishes to express sincere gratitude to the research teams of Wrocław University of Science and Technology for their trust and for the opportunity to be involved in such an interesting and forward-looking project. Participation in this study has been a valuable scientific experience and an inspiration for future research.

THE INFLUENCE OF HIP ABDUCTOR MUSCLE STRENGTH ON BODY BALANCE IN THE FRONTAL PLANE IN THE M-CTSIB TEST

ANETA FERENC[1], ANNA HADAMUS[1]

[1]DEPARTMENT OF PHYSIOTHERAPY FUNDAMENTALS, FACULTY OF DENTAL MEDICINE, MEDICAL UNIVERSITY OF WARSAW, POLAND

Introduction: The strongest pelvic stabilizers, both in double-leg and single-leg stance positions, are the gluteus medius, gluteus minimus, and tensor fasciae latae. Therefore, they can significantly influence human balance. The aim of this study was to determine the relationship between the strength and time parameters of the hip abductor muscles, assessed under isometric and isokinetic conditions, and the ability to maintain balance in healthy individuals.

Material and methods: The study involved 96 healthy individuals (59 women and 37 men) aged 19-59. Lower limb dominance was assessed using the Waterloo Questionnaire. Balance was assessed using the BIODEX Balance System with the m-CTSIB (Modified Clinical Test of Sensory Interaction in Balance) protocol. This included standing with eyes open/closed on a hard and foam surfaces. Muscle strength testing was performed on the Humac Norm system under isometric conditions (3 repetitions of 5 seconds each) and isokinetic conditions (5 repetitions at 60°/s and 10 repetitions at 180°/s). Statistical analysis was performed using R statistical software (R Core Team 2021). The level of statistical significance was set at $p<0.05$.

Results: The stability index on a stable surface with eyes open showed the highest correlation with the strength and time parameters, and the relationships between these parameters were mostly negative, with low to moderate strength (R values ranging from -0.47 to -0.20). The parameters for which positive relationships with the sway and stability indices were observed were the time to reach maximum torque and the time required to change direction (R values ranging from 0.20 to 0.32).

Conclusions: 1. The time to reach peak torque and the time required to change direction during eccentric abductor muscle work have a significant impact on frontal plane balance indices. 2. The strength parameters of the tested muscles did not significantly affect lateral sway in the mCTSIB test.

KEYWORDS: mCTSIB, body balance, muscle strength

LONG-TERM STABILITY AND DEGRADATION MECHANISMS IN GRAPHENE-PCL SCAFFOLDS

ANNA NIKODEM[1], IZABELLA RAJZER[2]

[1]DEPARTAMENT OF MECHANICS, MATERIALS AND BIOMEDICAL ENGINEERING, FACULTY OF MECHANICAL ENGINEERING, WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY, WROCŁAW, POLAND

[2]DEPARTAMENT OF MECHANICAL ENGINEERING FUNDAMENTALS, FACULTY OF MECHANICAL ENGINEERING AND COMPUTER SCIENCE, UNIVERSITY OF BIELSKO-BIAŁA, BIELSKO-BIAŁA, POLAND

Introduction: Biodegradable materials used in implantology inevitably undergo breakdown in the body, which affects tissue healing. Polycaprolactone (PCL) is widely applied in regenerative medicine due to its biocompatibility, mechanical strength, and slow resorption. However, its hydrophobicity and limited stiffness may restrict tissue integration. Incorporation of graphene has been shown to improve scaffold strength, modify degradation kinetics, and enhance biological interactions. The aim of this study was to evaluate the long-term behaviour of PCL/graphene scaffolds during 54 months of incubation in phosphate-buffered saline (PBS).

Materials and methods: Porous scaffolds were fabricated using 3D printing, with defined amounts of graphene incorporated into the PCL matrix. Samples were stored in PBS at 37 °C for up to 54 months. Mass loss and degradation products were assessed according to ISO 10993. Scaffold microstructure was analysed using scanning electron microscopy (SEM) and high-resolution microCT, allowing volumetric and pore architecture evaluation. Differential imaging techniques enabled precise tracking of changes over time. All analyses were performed in triplicate.

Results and discussion: Pure PCL scaffolds degraded slowly, mainly through surface erosion. Changes included embrittlement, localized fractures, and moderate density alterations, while internal regions remained largely preserved. In contrast, PCL/graphene scaffolds showed faster and more extensive degradation. After 34 months, structural displacements were evident, progressing to fractures and strut collapse. Mass loss reached ~9% by 41 months and exceeded 30% after 54 months. Pure PCL showed only 3% and 12% loss at the same time points. These results indicate that graphene not only accelerates surface erosion but also promotes internal weakening and volumetric failure. Despite potential acidification, medium pH remained stable due to regular exchange.

Conclusions: Graphene incorporation significantly accelerates PCL scaffold degradation, enhancing both surface and bulk breakdown. This effect may reduce long-term stability but offers opportunities to tailor scaffold resorption rates for specific tissue engineering applications.

KEYWORDS: graphene scaffolds, biodegradation, microtomography

ASYMMETRY-DRIVEN SUBCHONDRAL BONE DEGENERATION IN OSTEOARTHRITIC TIBIAL PLATEAU

ANNA NIKODEM[1], ALEKSANDRA KRALA[1]

[1]DEPARTMENT OF MECHANICS, MATERIALS AND BIOMEDICAL ENGINEERING, FACULTY OF MECHANICAL ENGINEERING, WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY, WROCŁAW, POLAND

Introduction: The musculoskeletal system relies on the interplay of bone, cartilage, ligaments, and muscles to maintain stability and mobility. Bone, a highly dynamic tissue, constantly adapts its structure through remodeling driven by mechanical cues. In osteoarthritis (OA), this balance is lost: cartilage degenerates, subchondral bone thickens or weakens, and joint biomechanics become compromised. Malalignment of the lower limb, such as varus deformity, further disturbs the load axis, concentrating forces medially and unloading lateral compartments. This leads to divergent adaptive pathways—reinforcement under overload and rarefaction under underload. The present work sought to elucidate these site-specific changes in osteoarthritic tibial plateaus by integrating high-resolution imaging with mechanical characterization.

Materials and methods: Tibial plateau specimens (n = 7) were collected during total knee arthroplasty for advanced OA with varus alignment. Radiographic parameters (LDFA, MPTA, HKA, plateau axis) were documented. Cylindrical samples were embedded in acrylic resin and analyzed using microCT (SkyScan 1172, Bruker) for trabecular architecture, SEM (Phenom ProX) for ultrastructural features, and fluorescence microscopy for mineralization patterns. Microhardness testing quantified hardness and Young's modulus.

Results and discussion: Clear compartmental differences emerged. Medial condyles, consistently overloaded, showed complete cartilage loss, trabecular thickening, increased density, and higher mineralization. By contrast, lateral condyles exhibited thinner trabeculae, greater porosity, and reduced density, reflecting stress shielding. SEM revealed a complex interplay of calcified cartilage, cement lines, osteons, and vascular canals. Fluorescence microscopy confirmed region-dependent mineralization. Mechanical testing indicated heterogeneity in hardness, with the medial regions demonstrating increased stiffness, likely reflecting pathological mineral accumulation.

Conclusions: Subchondral bone in OA remodels in strikingly opposite directions: overloaded regions become sclerotic and stiff, while unloaded regions lose mass and resilience. This asymmetric adaptation underscores the mechanobiological essence of OA and highlights the need for implant solutions tailored not only to anatomy but also to the altered biomechanics of the diseased joint.

KEYWORDS: osteoarthritis, subchondral bone, remodelling, microtomography

ANALYSIS OF EFFORT CHORDAE TENDINEAE CAUSED BY MYXOMATOUS MITRAL VALVE DISEASE IN CANINES OF LARGE AND SMALL BREEDS

AGNIESZKA MACKIEWICZ[1], WERONIKA DYLEWICZ[1], JUSTYN GACH[2], IZABELA JANUS-ZIÓŁKOWSKA[2], AGNIESZKA NOSZCZYK-NOWAK[2]

[1]UNIVERSITY OF ZIELONA GORA, FACULTY OF ENGINEERING AND TECHNOLOGY SCIENCES, ZIELONA GÓRA, POLAND

[2]WROCŁAW UNIVERSITY OF ENVIRONMENTAL AND LIFE SCIENCES, FACULTY OF VETERINARY MEDICINE, WROCŁAW, POLAND

Introduction: Chordae tendineae (CT) are responsible for the mechanical functions of the mitral valve. Myxomatous valve degeneration (MMVD) causes a significant loss of the mechanical properties of the valve and its components, especially CT, causing them to rupture.
The aim of the study was to demonstrate how the size of the atrioventricular apparatus depends on the breed of canine and whether it affects the likelihood of CT rupture, as well as to determine whether there is a tendency for CT to be located in areas most vulnerable to rupture.

Material and methods: Autopsy material was collected from 22 canines for the study. The study was divided into three stages:

- observational and histological studies consisting of collecting protocols and available imaging studies of mitral valve functionality.
- biomechanical studies of dissected chordae tendineae from hearts.
- numerical studies of the mitral valve, introducing boundary conditions (papillary muscle displacement) and material characteristics from biomechanical studies.

Results and Conclusions: Heart structures were assessed using the 4-point Whitney scale, which allows the degree of degeneration to be determined. In individuals diagnosed with MMVD, unevenly degenerated CT were observed within the heart. Histological studies with hematoxylin-eosin staining ultimately verified whether the dogs were correctly classified into MMVD/non-MMVD groups. The CT structure of individuals without cardiac changes was compact, with parallel fibers and no or small spaces between them. In the case of CT, non-parallel, wavy fibers were observed, often with large spaces between them and varying fiber diameters. Strength tests allowed the stress-strain characteristics of the CT to be determined. No clear tendency towards reduced CT strength was observed in small breeds compared to large breeds, for the group of canines with MMVD and without MMVD. However, significant differences were noted in CTs samples taken from the marginal part of the valve leaflets compared to those taken from the central part. In large breeds, regardless of the detected degree of fibrosis, the strength of these CTs was higher than that of CTs from small canines. The numerical models developed showed a tendency for marginally located CTs to rupture, most often in the area of the papillary muscle attachment, which was confirmed by mechanical and echocardiographic studies.

KEYWORDS: Mechanical Properties, Effort, Chordae Tendineae, Mitral Heart Valve, Canine

ACKNOWLEDGMENTS: The National Science Center MINIATURE 6 (DEC 2022/06/X/ST8/01465): Numerical analysis of effort chordae tendineae caused by myxomatous mitral valve disease in dogs of large and small breeds 2022/2023, head of project Agnieszka Mackiewicz.

EVALUATING 2D VIDEO ANALYSIS AS AN ALTERNATIVE TO FORCE PLATE ASSESSMENT OF BALANCE IN MARTIAL ARTS ATHLETES

DARIUSZ MOSLER[1], KAMIL RADECKI[1]

[1]FACULTY OF KINESIOLOGY AND HEALTH PREVENTION, JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, POLAND

Introduction: Maintaining balance is fundamental in martial arts, influencing postural stability, technical execution, and injury prevention. The standard tool for balance assessment is the force plate, but its high cost and technical requirements limit accessibility. A low-cost alternative is two-dimensional (2D) video analysis, which may be practical in sports training. This study aimed to evaluate the usefulness of 2D video analysis compared with a force plate in martial arts athletes.

Material and methods: Data included 86 observations from 15 athletes performing single-leg stance at three difficulty levels on both legs. Each observation contained center of pressure (COP) path length and velocity recorded simultaneously by an AMTI force plate and a video-based algorithm. The trial variable was used to derive separate factors for leg and difficulty.

Results: COP paths from the force plate were longer (mean 1814.1 mm) and more consistent (coefficient of variation ≈ 40%) than video-derived values (mean 1041.2 mm, CV ≈ 79%). COP velocity was also higher for the force plate (58.5 mm/s) than for video (33.6 mm/s). Correlations between video and force plate outcomes were moderate (Pearson and Spearman $r \approx 0.50–0.52$, $p < 0.001$). Bias was smaller for the right leg ($p = 0.061$) and decreased with task difficulty: the hardest stance reduced the difference by −383.8 mm for length and −13.1 mm/s for velocity compared with the easiest stance ($p = 0.040$ and 0.027).

Conclusions: Two-dimensional video analysis is not a valid quantitative substitute for three-axis force plate assessment in research or clinical practice. However, for recreational use, it may provide low-cost, qualitative feedback on balance trends.

KEYWORDS: Postural balance, Martial Arts, Test Validity, video analysis

Abstracts

6th World Scientific Congress

“Quality of Life in Interdisciplinary Approach”

THE RELATIONSHIP BETWEEN BODY IMAGE AND DIMENSIONS OF SELF-CONFIDENCE AMONG STUDENTS OF THE DEPARTMENT OF PHYSICAL AND SPORTS SCIENCES AND TECHNOLOGIES AT SETIF 2 UNIVERSITY

MEFTI ABDMONAIM[1], ZERARI HAMZA[1], JOUBAR KHALED[1]

[1]UNIVERITY SETIF 2 ALGERIA

This study aimed to explore the relationship between body image and dimensions of self-confidence among students of Physical Education and Sports Sciences at the University of Setif 2. The researcher used the descriptive methoud, utilizing a sample of 88 students specializing in Physical Education and Sports Sciences. To collect data, the researcher used a body image scale and a self-confidence dimensions scale. Statistical analysis was conducted using SPSS software. The results revealed strong and statistically significant positive correlations between body image and lingustic fluency, independence, the pysiological dimensio, and the psychological dimensions. These findings underscore the importance of a positive body image in enhancing the overall well-being of students.

KEYWORDS: Body Image, Self-Confidence, Physical Education and Sports Sciences Students

FOOTBALL IN THE MULTINATIONAL SOCIETY OF THE STANISLAVIAN PROVINCE 1920-1939

TERESA DROZDEK-MAŁOLEPSZA[1], ELIGIUSZ MAŁOLEPSZY[1,2], KRZYSZTOF KOŚCIAŃSKI[3]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCE, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[2]DEPARTMENT OF SOCIAL POLICIES, SOCIAL WORK AND TOURISM, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[3]DEPARTMENT OF PEDAGOGY, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

The aim of the study was to present the sport of football in the multinational society of the Stanislaw Province in the years 1920-1939. The territory of the Stanislavan Province was located in the south-eastern part of the Second Republic of Poland. The sports clubs and associations of the Stanislav Voivodeship with a football section were part of the Lviv Regional Football Association (OZPN), and from 1934 they were part of the Stanislavov OZPN. The Stanislavovskiy OZPN included, among others, the Stanislavovskiy and Pokuckiy sub-districts. The development of organisational structures had a positive impact on the development of sport in the area. Football developed among the Polish, Ukrainian and Jewish populations living in the Stanislav region. Sports clubs and associations active among the Polish, Jewish and Ukrainian populations (from 1930) took part in the competitions of the Lviv OZPN and later the Stanislav OZPN league. The 1920s and 1930s saw an increase in the number of clubs and associations with a football section. The increase in the number of clubs contributed to a rise in the level of football in the Stanislav province. The best football teams in the Stanislavian province were Revera Stanislav, Pogoń Stryj and Strzelec-Górka Stanislav. These teams competed for promotion to the national league. Their sporting successes included the Stanislav team reaching the final of the Polish Cup competition and the Strzelec-Górka Stanislav team reaching the semi-finals of the Polish Junior Championship in 1939.

KEYWORDS: Poland, Stanislavow Voivodship, interwar period, sport, football

MENTAL STATE AND COGNITIVE PERFORMANCE IN PERSONS WITH DIFFERENT PHYSICAL ACTIVE

GEORGIY KOROBEYNIKOV[1,2], RASHID MATKARIMOV[2], LESIA KOROBEINIKOVA[1,2], MARKUS RAAB[3], FIKRAT KERIMOV[2], OLGA GONCHAROVA[2], IVANNA KOROBEINIKOVA[3,4]

[1]NATIONAL UNIVERSITY OF UKRAINE ON PHYSICAL EDUCATION AND SPORT, KYIV, UKRAINE

[2]UZBEK STATE UNIVERSITY OF PHYSICAL EDUCATION AND SPORTS, TASHKENT, UZBEKISTAN

[3]GERMAN SPORT UNIVERSITY COLOGNE, INSTITUTE OF PSYCHOLOGY, COLOGNE, GERMANY

[4]INSTITUTE OF PSYCHOLOGY OF THE NATIONAL ACADEMY OF EDUCATIONAL SCIENCES OF UKRAINE, KYIV, UKRAINE

Introduction: Modern humanity is characterized by the growth of negative factors that affect health and quality of life. On the one hand, technologies for improving the quality of life are developing, but on the other hand, this leads to a decrease in physical activity and an increase in somatic diseases among the population. Physical inactivity is a big problem of our time. Some studies show that physical activity improves not only physical condition, but also mental well-being. However, there is no relevant data on the relationship between mental state and cognitive performance with physical activity. Our hypothesis is that physically active people have better mental health and cognitive abilities than sedentary people.

Material and methods: A total of 20 physically active persons (male, age 25.24; SD=2.62 years) and 20 sedentary persons (male, age 26.72; SD=2.28) were examined. We obtained informed consent from all participants to conduct the research in accordance with the ethical standards of the Declaration of Helsinki, as approved by local Biomedical Research Ethics Committees. The following methods of mental state, cognitive performance, and statistical analysis were used.

Results: Our studies have revealed tension in the psycho-emotional state due to physical inactivity. An increase in anxiety was also observed due to low physical activity in sedentary people. Physically active people have improved visual perception and processing of non-verbal information.

Conclusions: The results can be used to justify a preventive approach to improving mental and cognitive health. Physical activity affects the psycho-emotional state, which in turn improves cognitive performance.

KEYWORDS: mental state, cognitive performance, physical activity, sedentary persons

COPING WITH STRESS AND MENTAL PERFORMANCE IN AGING

MYROSLAV DUTCHAK[1], DYMYTRII NIKONOROV[1], GEORGIY KOROBEYNIKOV[1,2], SHUKURJON GAZIYEV[2]

[1]NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, KYIV, UKRAINE

[2]UZBEK STATE UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, CHIRCHIK, UZBEKISTAN

Introduction: Aging is characterized by a decrease in mental abilities in aging people. It has been found that aging is associated with increased fatigue and deterioration of cognitive functions, especially memory and thinking. However, some physiological adaptive reactions occur that prevent the destabilization of the aging process, especially under stressful influences. According to the adaptation theory of ageing, all the period from fertilization to death of human may be viewed as etagenesis, including ontogenesis, ageing and gerontogenesis. We may suppose that mental mechanisms of ageing are determined with balance between ageing and stress coping ability processes.

Purpose: to study copy with stress and mental performance in aging.

Material and methods: A total of 28 elderly people (50-60 years old) were examined. Mental activity was assessed using a test of visual perception and information processing. The reaction to perceptual stress was studied.

Results: As a result, the aging process was accelerated due to a decrease in visual perception and information processing. At the same time, some persons showed better indicators of mental abilities. This is due to the activation of coping mechanisms with stress resistance. Also, persons with a high level of stress resistance showed stabilization of visual perception and the ability to process information.

Conclusions: With age, the decline in mental performance increases the stress of the stressful information environment on a person. As a result of the negative impact of aging, the effectiveness of mental activity decreases. The decline in visual perception and the ability to process information with age triggers stress-coping mechanisms.

KEYWORDS: coping with stress, aging, mental performance

SURVEILLANCE OF PHYSICAL ACTIVITY AND FITNESS IN UKRAINIAN YOUTH: IDENTIFYING KEY OBJECTIVES AND CHALLENGES

JULIIA PAVLOVA[1], IVANNA BODNAR[1]

[1] IVAN BOBERSKYJ LVIV STATE UNIVERSITY OF PHYSICAL CULTURE, LVIV, UKRAINE

Introduction: Currently, Ukraine lacks a national surveillance system for physical activity and physical fitness among children and youth. This gap impedes the tracking of activity levels, the assessment of citizens' fitness, and the development of improved educational programs aimed at enhancing health. Moreover, without such a system, it is difficult to identify individuals at risk of diseases caused by insufficient physical activity, posing significant challenges for public health and national defense.

Objective: The aim of this study was to define the objectives and functions of a surveillance system for physical activity and fitness in children and youth.

Material and methods: The study was conducted in several phases using a mixed-methods approach to gather expert opinions. The research instrument combined static and dynamic components, which enabled the analysis of existing national documents and the assessment of the current situation with consideration of regional specifics. Quality control was ensured both empirically (through analysis of the questionnaire context) and procedurally (by engaging a core research team and implementing iterative feedback cycles with experts). A total of 16 experts from six regions participated, including three professors, 13 associate professors, and 10 department heads specializing in physical education. The questionnaire, which comprised open and closed questions, addressed the peculiarities of testing physical fitness and explored avenues for its further improvement, including the identification of primary testing objectives, the structural elements of the system, and the selection of appropriate tests.

Results: The study identified five key task groups for a youth physical fitness testing system: (a) surveillance of physical fitness trends; (b) fostering the physical, cognitive, and affective potential of children and youth; (c) collecting data to support recommendations; (d) aiding educators in physical education; and (e) enhancing health and quality of life among children and youth.

Conclusions: A surveillance system could effectively address a wide range of challenges in physical education, although its implementation may only partially fulfill educational needs. Strengthening this system by incorporating factors related to lifestyle and the environment is recommended.

KEYWORDS: physical activity, fitness, monitoring, children, youth

POST-PANDEMIC ASSESSMENT: COVID-19'S LONG-TERM INFLUENCE ON PHYSICAL ACTIVITY, MOTOR FITNESS, AND HRMAX AMONG FEMALE UNIVERSITY STUDENTS

ROBERT PODSTAWSKI[1], KRZYSZTOF BORYSŁAWSKI[2], JADWIGA SNARSKA[3], ATILLA SZABO[4], PIOTR JUREWICZ[5], FERENC IHASZ[4]

[1]HUMAN WELLNESS RESEARCH LABORATORY, DEPARTMENT OF PHYSIOTHERAPY, UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN, OLSZTYN, POLAND

[2]INSTITUTE OF HEALTH, ANGELUS SILESIUS UNIVERSITY OF APPLIED SCIENCES IN WAŁBRZYCH, WAŁBRZYCH, POLAND

[3]DEPARTMENT OF GENERAL SURGERY, SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN, OLSZTYN, POLAND

[4]FACULTY OF HEALTH AND SPORT SCIENCES, SZÉCHENYI ISTVÁN UNIVERSITY, GYŐR, HUNGARY

[5]INDEPENDENT RESEARCHER, OLSZTYN, POLAND

Introduction: The long-term relationships between COVID-19 and anthropometric and physiological characteristics as indicators of health status have not been extensively studied to date. Aim: The aim of this study was to examine the relationships between COVID-19 and the HRmax values achieved by female university students during maximal physical effort, the participants' physical activity (PA) levels and anthropometric and physiological characteristics ten months after the end of the COVID-19 pandemic.

Material and methods: The study involved 82 female university students aged 19.0-28.0 years. Half of the study population had a history of COVID-19. The participants' body composition was evaluated in a bioelectrical impedance analysis. The students' PA levels were assessed with the International Physical Activity Questionnaire, and their HRmax values were measured during the 12-minute Cooper test on a rowing ergometer (12-MCTRE).

Results: Healthy students (G1) were characterized by the highest PA levels. Physical activity levels were lower in students who had a history of COVID-19 but had not been hospitalized (G2), and lowest in students who had been hospitalized due to COVID-19 (G3). Healthy controls were also characterized by significantly lower body mass, the body mass index (BMI), waist-to-hip ratio, and visceral fat levels, as well as lower values of body fat mass, fat free mass, and skeletal muscle mass ($p < 0.001$). The highest HRmax (175 bpm) was noted in group G1 students, and it significantly exceeded the values in groups G2 (by 7 bpm) and G3 (by 15 bpm). Ten months after the end of the COVID-19 pandemic, female students who had been hospitalized due to COVID-19 were characterized by significantly lower levels of PA and motor fitness, as well as less favorable body composition parameters (class 1 obesity).

Conclusions: These observations may explain the lower HRmax values in group G3 women than in healthy controls.

KEYWORDS: young women, pandemic, somatic parameters, motor fitness, young women

LEVEL OF PHYSICAL AND MOTOR DEVELOPMENT OF FIRE BRIGADE OFFICERS IN THE LIGHT OF SELECTED PREDICTORS INTRODUCTION

RYSZARD ASIENKIEWICZ[1], JERZY GRZESIAK[2]

[1]INSTITUTE OF SPORTS, TOURISM AND NUTRITION, UNIVERSITY OF ZIELONA GÓRA, POLAND

[2]PHYSICAL EDUCATION AND SPORTS DEPARTMENT, UNIVERSITY OF ZIELONA GÓRA, POLAND

Introduction and aim: Assessment of morpho-functional differentiation of firefighters in the aspect of selected social and environmental factors.

Material and methods: The material was collected in 2017 among 70 officers of the State Fire Service in Zielona Góra. Based on the measurements of height and weight, the BMI and Rohrer indices were calculated. The level of motor skills of the respondents was determined based on mandatory physical fitness tests, which include a 50 m run, pull-ups, and a 1000 m run. Information on the social and environmental variables of the respondents was collected by means of a survey. In the statistical analysis of the material, univariate and multivariate methods were used.

Results: On average, the tallest, lightest and slimmest are firefighters up to 29 years of age, living in cities, who have higher education. They are also characterized by an average higher level of motor skills. A single-factor analysis of variance showed that the level of education of the examined person, the nature of work, the frequency of physical activity and the duration of physical activity are of significant importance for the development of firefighters from Zielona Góra. The analysis of principal components shows that the largest share in explaining the variability of somatic features of firefighters is, in order, the standardized Rohrer indices, BMI and body mass, while for motor features the standardized speed, arm strength and endurance

Conclusions: 1.The results of the variance analysis tests confirmed the maintenance of the gradient in the distinguished categories of social and environmental variables. 2.Principal component analysis confirms that the greatest share in explaining the variability of the level of physical and motor development of Zielona Góra firefighters is held by traits with greater eco-sensitivity to the impact of exogenous factors.

KEYWORDS: firefighters, somatic and motor development, social and environmental predictors

HEALTH BEHAVIOR OF YOUTH AT THE UNIVERSITY OF ZIELONA GÓRA

RYSZARD ASIENKIEWICZ[1]

[1]INSTITUTE OF SPORT, TOURISM AND NUTRITION, UNIVERSITY OF ZIELONA GÓRA, POLAND

Introduction and aim: To learn and compare the declared health behaviors of male and female students of the University of Zielona Góra from urban and rural environments.

Material and methods: The material was collected in the academic year 2022/2023 among 116 male and 112 female first-year students of physical education at the University of Zielona Góra. The work used the diagnostic survey method, the survey technique, while the research tool was a standardized survey questionnaire (IZZ, Juczyński). Based on the declared health behaviors of the respondents, the general index of the intensity of health behaviors was calculated on the sten scale. The relationship between the size of the inhabited environment and the degree of intensity of health behaviors was made using the Chi-square test.

Results: Physical education students from rural environments, compared to their peers from cities, achieved higher averages in the categories of behaviors: proper eating habits, preventive behaviors and health practices, while lower values in the category of positive mental attitude. Based on the sten scale (determining the degree of intensity of health behaviors), it was found that the majority of the surveyed male and female students from both compared living environments are characterized by an average degree of health behaviors.

Conclusions: 1.Male and female students from cities and villages are characterized by average health behaviors. 2.Youth from rural environments are more likely to exhibit pro-health behaviors than those from urban environments. 3.A significant correlation was noted between the place of residence and the degree of health intensities.

KEYWORDS: academic youth, health behaviors

MODEL-BASED ESTIMATION OF NANOPARTICLE DRUG DELIVERY TO CANCER CELLS WITH ACOUSTIC STREAMING

NATALIA KIZILOVA[1]

[1]WARSAW UNIVERSITY OF TECHNOLOGY, INSTITUTE OF AERONAUTICS AND APPLIED MECHANICS, WARSAW, POLAND

Acoustic Cluster Therapy (ACT) is a promising approach for ultrasound (US)-mediated drug (nanoparticles, NPs) delivery to cancer cells by cavitation of small or large microbubbles (MBs) and acoustic streaming produced by the bubble cavitation that provides fast delivery of the NPs to the cancer cells and enables the removal of tumors without surgery. Despite a series of successful reports, a general therapeutic methodology still absent, and usually only a small part of the injected NPs penetrate the capillary walls due to sonoporation, moved and accumulated in tumors causing their death.

The common problems of the ACP are individual geometry, shape and size of tumor, complex non-uniform networks of capillaries, and tumor heterogeneity with rigid collagen fibers of low permeability for NPs.

In this study, quantitative estimations of physiological, biomechanical and physical factors related to the NPs delivery to a heterogeneous tumor by acoustical streaming are systematized. The acoustic radiation forces; US interaction with tissues, cells, MB and NPs; shear waves in the tissues; biomechanical and thermal effects are considered. A novel model of the non-uniform tumor (T) with healthy cells (H), collagen bundles (C) and capillaries is proposed as a compact set of Krogh cylinders (a capillary surrounding tissues) with layers of collagen between them. Incompressible Navier-Stokes equations for the blood flow with MBs loaded by NPs through the capillaries coupled with momentum equations for viscoelastic vessel wall, collagen bundles, healthy and tumor cells are solved numerically. The minimal concentrations of NPs and MPs for a given tissue characterized by a set of the volume ratios C/(T+H), H/T, mean distance between the capillaries and the blood flow rate needed for successful therapy were determined. The results were validated by a dataset of clinical measurements. The model and method are proposed for improvement of the ACT based on the patient-specific model.

KEYWORDS: Biomechanics of Tumor Growth, Acoustic Cluster Therapy, Microcirculation

THE INFLUENCE OF CESAREAN SECTION ON SENSORY INTEGRATION DISORDERS

JUSTYNA ADAMCZYK[1]

[1]AKADEMIA MEDYCZNA NAUK STOSOWANYCH I HOLISTYCZNYCH, WARSAW, POLAND

Introduction: The growing popularity of cesarean section has become a cause for concern in many countries. Among patients using sensory therapy, an increased number of people who were born by caesarean section is observed. The phenomenon is becoming more common and more therapists are paying attention to this factor. Despite this, no studies have been conducted to illustrate the scale of the phenomenon. The aim of the study was to investigate the influence of cesarean section on sensory integration processes.

Material and methods: The analysis was based on diagnoses made at the Child Development Center "Zgrane Dzieciaki" in Ząbki. The study included 50 children: 25 born naturally and 25 born by caesarean section. All children, regardless of the type of delivery, underwent age-appropriate testing. The youngest child was 2 years and 4 months old, the oldest 9 years old. The analysis compared the basic sensory systems(vestibular, proprioception, tactile, auditory, visual, olfactory, tonic labyrinthine reflex, asymmetric tonic neck reflex, symmetric tonic neck reflex, motor planning skills, muscle tone). The diagnostic process consisted of several stages: 1) interview with parents, 2) clinical observation, 3) Southern California tests, 4) post-rotation nystagmus test.

Results: Data from tests, trials, observations and questionnaire were analyzed and included in the descriptive diagnosis of sensory integration processes. The result of the Student's T-test indicates that delivery by cesarean section had an impact on the occurrence of sensory integration disorders. Proprioceptive disorders occurred in all the examined subjects, as did vestibular disorders; vestibular disorders were diagnosed in all children born by caesarean section and in 48% of children born naturally; auditory system disorders occurred in 76% of children born by caesarean section and in 80% of children born naturally; visual system disorders occurred in 48% of children born by caesarean section and in 72% of children born naturally; olfactory system disorders were found in 44% of children born by caesarean section and in 36% of children born naturally; TOB was diagnosed in 76% of children in both groups; ATOS was diagnosed in 75% of children born by caesarean section and in 72% of children born naturally; STOS occurred in 36% of children born by caesarean section and in 40% of children born naturally; motor planning was observed in all children born by caesarean section and in 80% of children born naturally; Motor dysfunction was detected in all children born by cesarean section and in 80% of those born by natural birth.

Conclusions: The conducted studies and statistical calculations have shown that surgical delivery may affect the proper processing of sensory stimuli. The tactile system, muscle tension and motor planning are particularly susceptible to abnormalities. The results show that cesarean delivery can have adverse effects on children's sensory perception, sensory integration ability, neuropsychiatric development, and infant-mother relationship. However, there remain shortcomings in existing research methods, study content, study groups, and study interpretation. Future research should improve research methods, expand study content, and refine grouping of infants born by cesarean section. Exploration of neural mechanisms is also needed, as well as research aimed at suggesting effective interventions to reduce the number of cesarean sections without a specific clinical indication.

KEYWORDS: sensory integration, caesarean section, motor development, basic sensory systems

ASSOCIATION OF SELF-EFFICACY AND PAIN WITH QUALITY OF LIFE AFTER TOTAL JOINT REPLACEMENT IN OSTEOARTHRITIS

JULIUS EVELLEY[1], PETER POLAN[2], MARTIN VICEN[2], ALENA BUKOVA[1], IVETA NAGYOVA[3]

[1]INSTITUTE OF PHYSICAL EDUCATION AND SPORT, PJ SAFARIK UNIVERSITY, KOSICE, SLOVAKIA

[2]DEPARTMENT OF MUSCULOSKELETAL AND SPORTS MEDICINE, FACULTY OF MEDICINE, PJ SAFARIK UNIVERSITY, KOSICE, SLOVAKIA

[3]DEPARTMENT OF SOCIAL AND BEHAVIOURAL MEDICINE, FACULTY OF MEDICINE, PJ SAFARIK UNIVERSITY, KOSICE, SLOVAKIA

Introduction: Osteoarthritis (OA) is a chronic joint disease that causes pain, disability, and growing burden due to increasing obesity rates and aging population. In terminal stages, it is frequently treated with total joint replacement (TJR). Low self-efficacy has been considered as a risk factor for disability and reduced quality of life (QoL). The main aim of this study is to investigate the association of SE, pain, and functional outcomes with physical (PCS) and mental (MCS) components of QoL one year after TJR controlling for sex, age, education, and household income.

Marerial and methods: Sample consisted of 377 patients (mean age 64.2±9.03 years) one year after TJR due to end-stage OA of the knee (58.6%, 38.9% male), and hip (41.4%, 57% male). Self-efficacy was assessed by Arthritis Self-Efficacy Scale; pain by Visual Analogue Scale, functional outcomes by Oxford Knee Score/Harris Hip Score, and QoL by Short Form-36 Health Survey. Multiple regression analysis was used to analyse the data.

Results: Total explained variance was 62.5% for PCS and 50.3% for MCS in total sample. Higher self-efficacy (β=.26, p≤.001 and β=.43, p≤.001) together with lower pain (β=-.27, p≤.001 and β=-.24, p≤.001), and better functional outcomes (β=.41, p≤.001, and β=.20, p≤.01) were significantly associated with better PCS and MCS, respectively.

Conclusions: The stronger patients' beliefs were in their capabilities to manage OA related challenges, the better was their mental and physical component of QoL. The results of this study may be beneficial in educational seminars to support patients during rehabilitation, as well as in enhancing clinician training in patient communication. [Grant support: APVV-22-0587].

KEYWORDS: self-efficacy, pain, quality of life, osteoarthritis, arthroplasty

NEURAL ACTIVITY DURING MOTOR LEARNING PHASES

PETER MELEK[1], PETER ŽIŠKA[1], ROMAN MARKOVIČ[1]

[1]ARMED FORCES ACADEMY OF GENERAL MILAN RASTISLAV ŠTEFÁNIK, LIPTOVSKÝ MIKULÁŠ, SLOVAKIA

Psychology and neural activity in motor learning is still a very attractive theme for researchers, psychologists and educators all around the world. In study we will collect the most important scientific works from these two psychological concepts (Flow state and Motor learning). This work relies on research by Mihály Csíkszentmihályi, Richard Schmidt, James Jerome Gibson and more top scientists in areas of motor learning and flow state. We consider these still variable and flexible concepts as very important for the education process in physical training, physical education and wellness.

This article includes information about human brain neural activity during different phases of motor learning. Also present connection between neural activity in flow state and motor learning process. The survey is divided into four parts. Starts by cognitive phase (generalization), which includes brain neuron irradiation. Describes neural activity process during the first phase of motor learning. Includes brain sectors and parts which are involved during first steps of learning new motor abilities. Followed by associative and autonomous phases (automatization and stabilization). Also describes neural processes in the human brain and focuses on differences between these motor learning phases. Structure of presentation ends with a motor learning process in the expert phase (creative association), which predicts high level of physical ability and motor skills, and opens the mind for individual creative energy. This phase has a very near condition to flow state, which is the object of our next research.

We will use structured interviews and questionnaires to achieve knowledge and form recommendations useful for school practice. Main result is to create a more exact structure of motor learning and flow state in special conditions and form recommendations for trainers, teachers and experts in the area of education and physical fitness.

KEYWORDS: neural activity, motor learning, flow, physical fitness,

SELECTED ASPECTS OF THE HABITUAL DIET AND LEVELS OF INTESTINAL PERMEABILITY MARKERS OF POLISH ALPINISTS

EWA KARPĘCKA-GAŁKA[1], ALEKSANDRA PIĘTA[2], KATARZYNA ŚWITAŁA[3], BARBARA FRĄCZEK[2,4]

[1]DOCTORAL SCHOOL OF PHYSICAL CULTURE SCIENCES, UNIVERSITY OF PHYSICAL CULTURE IN KRAKOW, KRAKOW, POLAND

[2]DEPARTMENT OF SPORTS MEDICINE AND HUMAN NUTRITION, INSTITUTE OF BIOMEDICAL SCIENCES, UNIVERSITY OF PHYSICAL CULTURE IN KRAKOW, KRAKOW, POLAND

[3]FACULTY OF PHYSICAL EDUCATION, GDAŃSK UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, GDAŃSK, POLAND

[4]DEPARTMENT OF SPORTS DIETETICS, GDAŃSK UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, GDAŃSK, POLAND

Introducion and aim: The purpose of this study is to investigate selected aspects of habitual diet and levels of intestinal permeability markers in a group of Polish mountaineers.

Material and methods: The study included 17 men aged 30.29 ± 5.8 years characterized by long climbing experience (10 ± 5 years) in sport climbing and mountaineering. The study included a quantitative analysis of the alpinists' diet and the determination of zonulin and alpha-1-antitrypsin levels in fecal samples using the ELISA technique.

Results: Less than half of the group covered their energy needs in accordance with the recommendations. Most climbers (70.59%) met the carbohydrate requirement, however, the fiber supply was not provided at an adequate level in 23.53% of individuals. All climbers met the requirements for protein and fats. More than one-fifth (23.53%) of them exceeded the normative values for fats, while 5.88% for protein. Mountaineers did not provide adequate amounts of selenium and iodine, as well as vitamins D and K. Fecal zonulin values were elevated in 35.29% of the climbers tested, while fecal alpha-1-antitrypsin values were normal in all subjects. Individuals engaged in climbing and alpine activities are at risk of energy restriction and/or low energy availability. The climbers mostly provided adequate amounts of macro- and micronutrients with their diets. In most of the climbers studied, intestinal permeability was adequate, although elevated zonulin values were observed in some individuals with normal AAT concentrations.

Conclusions: These preliminary findings indicate the need for nutritional education and further studies in larger cohorts.

KEYWORDS: intestinal permeability, zonulin, alpha-1-antitrypsin, alpinists, diet

THE EFFECT OF A COMPENSATORY INTERVENTION STRETCHING PROGRAM ON YOUTH FOOTBALL PLAYERS

HANA KABEŠOVÁ[1], VOJTĚCH ČERMUŠ[1]

[1]JAN EVANGELISTA PURKYNĚ UNIVERSITY IN ÚSTÍ NAD LABEM, FACULTY OF EDUCATION DEPARTMENT OF PHYSICAL EDUCATION AND SPORT, ÚSTÍ NAD LABEM, CZECH REPUBLIC

Introduction: The research verifies the effectiveness of stretching exercises in terms of developing flexibility in youth football players. The aim of this work is to determine the influence of a 6-week compensatory program with static stretching on the level of flexibility in the youth category of the FK Hvězda Cheb club.

Material and methods: Twenty six aged 16 – 18 were randomly divided into two groups. The first group used the compensatory program with static stretching (EX, n = 13), the second group was only control and did not undergo any intervention (CO, n = 13). The training program was applied to experimental group three time a week for six weeks. The flexibility of legs was measured by a Sit and reach test, Lying leg extension test, Thigh adductor test, Hip flexor test – Thomas test always before and after the intervention period. Based on the results of the Shapiro-Wilk test, analysis was conducted using a paired t-test, t-test for independent samples, chi-square test and McNemar test.

Results: After the application of the training program, there was a significant improvement in the level of joint mobility by test Sit and reach in experimental group (p=0.048). Players in the experimental group did not achieve better post intervention measurement results than players in the control group without intervention on test Lying leg extension test by right leg (p=0.655), Lying leg extension test by left leg (0.210), Thigh adductor test – 90 degree leg angle (p=1.000), Thigh adductor test – straight back (p=1.000), Thigh adductor test – birding tips (p=0.705), Thigh adductor test – outstretched legs (p=0.414), Thomas test – m. iliopsoas right (p=1.000), m. ilipsoas left (p=0.317), m. quadriceps right (p=0,763), m. quadriceps left (p=0,655), m. tensor fascia latae right (p=0.366), m. tensor fascia latae left (p=0.705).

Conclusions: The effect of the compensatory intervention program in youth football plyers had a slightliy positive effect on the players´ results, but this effect was not statistically significant. It was statistically significant only in the sit and reach test.

KEYWORDS: flexibility, stretching, exercises

PHYSICAL ACTIVITY AVOIDANCE AS A PREDICTOR OF ANXIETY AND SLEEP QUALITY IN WOMEN

ADRIANNA KOSIOR-LARA[1], DOROTA ORTENBURGER[2], MAŁGORZATA KUCHTA[3], MAGDALENA KORSAK-SABINO BELO[1], JACEK WĄSIK[2]

[1]DEPARTMENT OF NURSING, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[2]INSTITUTE OF PHYSICAL CULTURE SCIENCES, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[3]INSTITUTE OF TECHNOLOGY, STATE UNIVERSITY OF APPLIED SCIENCES IN RACIBORZ, RACIBORZ, POLAND

Introduction: The purpose of this study was to assess the relationship between women's attitudes toward intense physical exertion and subjectively perceived feelings of helplessness and symptoms of premature waking. Special attention was paid to the relationship between physical activity avoidance, anxiety and sleep quality.

Material and methods: The study included 75 randomly selected women from Poland, aged 34-61 years (M = 53.11 ± 5.38), mostly married women with higher education. The STAI to assess anxiety, the International Physical Activity Questionnaire (IPAQ) were used. Cluster analysis, stepwise regression and Spearman correlation analysis were used for statistical evaluation. Statistical significance was taken at $p < 0.05$.

Results: Significant differences were found between clusters in terms of physical activity levels, with no significant differences in anxiety levels. Avoidance of intense physical activity was a significant predictor of higher state anxiety ($B = 0.568$; $p < 0.001$). Wakefulness frequency and body mass showed no significant association with anxiety levels. Sleep disturbances were associated with higher levels of anxiety, and correlations suggested associations between anxiety, lifestyle and education.

Conclusions: Avoidance of intense exercise is significantly associated with higher levels of state anxiety in women, independent of other variables. Subjective attitudes toward exercise are more important for psychological well-being than activity level alone. The results indicate the need to consider psychological factors - such as anxiety and sense of efficacy - in promoting women's mental and physical health.

KEYWORDS: Keywords: physical activity avoidance, anxiety, sleep quality, women’s health, psychological well-being, state anxiety, exercise attitudes, lifestyle factors

THE IMPACT OF VISCERAL THERAPY ON SYMPTOMS IN WOMEN WITH PAINFUL MENSTRUATION SYNDROME

TOMASZ RUTKOWSKI[1]

[1]UNIVERSITY OF JAN DŁUGOSZ IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

Introduction: Dysmenorrhea is a common gynecological condition that significantly impairs women's quality of life. Traditional treatment methods, including pharmacotherapy, are often insufficient or associated with adverse effects. Visceral therapy, a manual technique aimed at improving the mobility of internal organs and fascial tension, may offer an effective alternative. The aim of this study was to assess the impact of visceral therapy on menstrual pain intensity and quality of life in women with primary dysmenorrhea.

Material and methods: The study included 34 women aged 20–30 years suffering from menstrual pain of ≥5 on the NRS scale. Participants were randomly assigned to the study group (n=19), who received three sessions of visceral therapy, or to the control group (n=15). Assessments were conducted before and after the intervention using the NRS scale, a modified MEDI-Q questionnaire, and the DISTRESS scale. Lifestyle factors such as diet and substance use were also analyzed.

Results: The study group showed statistically significant reductions in pain (NRS decrease by 28.02%; $p=0.0017$; $d=0.85$), general symptoms (MEDI-Q decrease by 15.67%; $p<0.001$; $d=1.53$), and stress (DISTRESS decrease by 40.79%; $p<0.001$; $d=1.65$). No significant changes were observed in the placebo group. Moderate positive correlations were found between coffee and tobacco use and increased pain severity.

Conclusions: Visceral therapy significantly reduces menstrual pain intensity and improves patients' quality of life. It may serve as a valuable complement or alternative to pharmacological treatment. Lifestyle factors, particularly caffeine and tobacco consumption, may influence symptom severity and should be considered in treatment planning. Further studies with larger samples and long-term follow-up are needed.

KEYWORDS: Visceral Therapy, dysmenorrhea, gynecological condition

THE INFLUENCE OF SLEEP QUALITY ON REACTION TIME, AGILITY AND CONCENTRATION IN FEMALE ICE HOCKEY PLAYERS

ŠTEFAN BALKÓ[1], KATEŘINA ZRNOVÁ[1], IVA BALKÓ[1]

[1]JAN EVANGELISTA PURKYNE UNIVERSITY IN USTI NAD LABEM, ÚSTÍ NAD LABEM, CZECH REPUBLIC

Introduction: Quality sleep plays a key role in the regeneration and optimization of sports performance. In ice hockey, as a high-intensity sport, this area is particularly important. The aim of this study is to determine whether sleep quality can affect the results of selected tests in female ice hockey players aged 23.3 years ± 4.5 years.

Material and methods: The research group consisted of 25 female players of the highest competition in the Czech Republic, whose sleep quality was assessed using a standardized questionnaire according to the Pittsburgh Sleep Quality Index (PSQI) and a smart watch that also evaluates the average heart rate. The Fitro reaction system was used to determine reaction time. The Fitro agility test was used to monitor the visual-motor reaction of the participants. The d2-r questionnaire was used to determine concentration of attention. The measurement was carried out twice with one week rest period.

Results: Data analysis showed that players with good and poor sleep quality achieved similar results in reaction time, agility and attention tests, with no significant differences between the groups. Differences were found only in heart rate, where players with poor sleep quality showed higher values. However, this difference in heart rate was not associated with better or worse performance in the tests.

Conclusions: The findings may contribute to a better understanding of the relationship between sleep, regeneration and sports performance and may serve as a basis for optimizing the training process and regeneration strategies in ice hockey.

KEYWORDS: sports performance, CNS, information processing

THE MOVEMENT PATTERN OF THE KARATE FRONT KICK WITH REGARD TO NEUROMUSCULAR CONTROL

MONIKA BŁASZCZYSZYN[1], JACEK KACZMARSKI[1], CEZARY KUŚNIERZ[1], ZBIGNIEW BORYSIUK[1]

[1]FACULTY OF PHYSICAL EDUCATION AND PHYSIOTHERAPY, OPOLE UNIVERSITY OF TECHNOLOGY, OPOLE, POLAND

Introduction: The front kick, one of the strongest and fastest kicks, is among the most commonly used techniques in martial arts, including karate. This study aimed to analyze the movement pattern of the mae-geri kick in advanced-level Kyokushin karate practitioners compared to an intermediate-level control group.

Material and methods: The study group [N = 28] consisted of advanced-level Kyokushin karate practitioners (3rd kyu and higher, N = 13), and the control group consisted of intermediate-level practitioners (6th to 4th kyu, N = 15). A wireless surface electromyography system was used to record bioelectrical activity in the joints, and an inertial measurement unit was used to measure joint angles. Before the study began, the maximum voluntary contraction was determined for each muscle tested. Each participant performed three consecutive kicks in three conditions: before warm-up, after warm-up, and after a shadow fight. In each condition, participants performed three kicks in the air and three kicks on a kick pad.

Results: Bioelectrical analysis revealed that intermediate-level practitioners used the soleus muscle more than advanced practitioners during the front kick (48.92% vs. 35.94% before the warm-up kick, $p = 0.042$). After the warm-up, both groups began to use the soleus muscle more intensively during the front kick (intermediate: 48.92% vs. 61.72% MVC, $p = 0.046$; advanced: 35.94% vs. 48.69% MVC, $p = 0.045$). The results showed that after the warm-up, the advanced group's activity in the medial gastrocnemius muscle increased compared to before the warm-up (58.23% vs. 39.20% MVC, $p = 0.016$).

Conclusions: The level of advancement of karate practitioners affects the bioelectrical activity of the muscles involved in the mae-geri kick. Combined EMG and IMU systems can identify trends and reveal correct movement patterns in Kyokushin karate training.

KEYWORDS: EMG, neuromuscular control, kinematics, biomechanical analysis

PHYSICAL EDUCATION AND SPORT IN THE ACTIVITY OF THE "SOKÓŁ" GYMNASTIC SOCIETY IN THE CZĘSTOCHOWA DISTRICT (1923-1939)

TERESA DROZDEK-MAŁOLEPSZA[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCE, JAN DLUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

The aim of this article is to present physical education and sport in the activity of the "Sokół" Gymnastic Society (TG "Sokół") in the Częstochowa District during the years 1923–1939. The Częstochowa District of "Sokół" was established in mid-1923. The Częstochowa District included "Sokół" nests (branches) from the following counties: Częstochowa, Radomsko, and Wieluń. Physical education and sport were among the most important areas of the society's activity.

"Sokół" provided personnel training for physical education and sport by organizing dedicated courses through various structures of the society. "Sokół" members also participated in other physical education and sports courses, including those organized by the District Corps Command in Łódź. Sports infrastructure was a crucial issue. Some of the "Sokół" nests had their own sports facilities. Among the sports disciplines, gymnastics and track and field (athletics) were the most widely practiced. Sokół members also engaged in football (soccer), team sports (basketball, volleyball, handball), cycling, table tennis, tennis, and shooting sports. Sokół members participated in sports competitions within the "Sokół" organization as well as in tournaments, primarily at the local and regional levels, though without achieving major successes. The Sokół members attached great importance to participating in the trials to earn the State Sports Badge.

KEYWORDS: Keywords: "Sokół" Gymnastic Society, physical education and sport, Sokół district

DIFFERENCES IN SUBSTRATE OXIDATION AND OXYGEN COST BETWEEN TREADMILL AND OVERGROUND RUNNING

RANA CAN[1], FURKAN MURAT PAÇA[1], MUHAMMED DOĞUKAN ZENGIN[1], SEYED HOUTAN SHAHIDI[1]

[1]FACULTY OF SPORTS SCIENCES, DEPARTMENT OF SPORTS COACHING, ISTANBUL GEDIK UNIVERSITY, ISTANBUL, TURKEY

Introduction: The accuracy of laboratory treadmill protocols in reflecting the energetic and metabolic demands of outdoor running remains debated. This study, therefore, compared maximal oxygen uptake ($\dot{V}O_2max$), ventilatory thresholds (VT1 and VT2), running economy (RE), cost of transport (Cr), and substrate utilization in trained endurance athletes during treadmill and field conditions.

Material and methods: Twelve competitive male runners (21.3 ± 2.4 years; 176.2 ± 6.8 cm; 67.8 ± 5.9 kg; body fat 11.8 ± 3.2%) who trained ≥5 sessions weekly and held federation licenses completed three laboratory sessions and one field trial. In the laboratory, athletes underwent anthropometric testing, a ramp-incremental treadmill protocol at 1% grade to establish $\dot{V}O_2max$, and a stepwise running economy trial (3-min stages, 8–15 $km \cdot h^{-1}$). The field session replicated this step protocol on a 400-m track, with GPS pacing. Breath-by-breath gas exchange was recorded using a portable metabolic analyzer, and substrate oxidation was derived from stoichiometric equations.

Results: Results showed no significant differences in absolute or relative $\dot{V}O_2max$ between treadmill and field (62.4 ± 4.8 vs. 63.5 ± 5.2 $mL \cdot kg^{-1} \cdot min^{-1}$; $p = 0.28$). VT1 occurred at comparable velocities (10.3 vs. 10.5 $km \cdot h^{-1}$; $p = 0.16$), while VT2 was reached at a significantly higher speed in the field (13.5 vs. 13.1 $km \cdot h^{-1}$; $p = 0.02$), corresponding to 90.8% versus 88.6% of $\dot{V}O_2max$ ($p = 0.01$). RE and Cr were significantly elevated outdoors from 12 $km \cdot h^{-1}$ onward (Δ = +1.7–2.9 $mL \cdot kg^{-1} \cdot min^{-1}$; Δ = +7.1–11.6 $mL \cdot kg^{-1} \cdot km^{-1}$; $p < 0.01$). Bland–Altman analysis confirmed proportional bias, showing increasing differences at higher velocities. Carbohydrate oxidation was also higher outdoors at 12–13 $km \cdot h^{-1}$ (+6–8 $g \cdot min^{-1}$; $p < 0.05$).

Conclusions: These results suggest treadmill and field running are comparable at sub-threshold intensities, but beyond VT2, outdoor running imposes significantly greater energetic and metabolic demands. Laboratory testing may therefore underestimate real-world costs, reinforcing the importance of incorporating field assessments for endurance athlete evaluation and training prescription.

KEYWORDS: Running Economy, Cost of Transport, Ventilatory Thresholds, Maximal Oxygen Consumption, Energy Utilization

FIELD RUNNING REQUIRES GREATER ENERGETIC COST ABOVE VENTILATORY THRESHOLDS DESPITE MATCHED SPEEDS

RANA CAN[1], FURKAN MURAT PAÇA[1], MUHAMMED DOĞUKAN ZENGIN[1] , SEYED HOUTAN SHAHIDI[1]

[1]FACULTY OF SPORTS SCIENCES, DEPARTMENT OF SPORTS COACHING, ISTANBUL GEDIK UNIVERSITY, ISTANBUL, TURKEY

Introduction: This study aimed to compare maximal oxygen uptake ($\dot{V}O_2max$), ventilatory thresholds (VT1, VT2), running economy (RE), cost of transport (Cr), and substrate utilization between treadmill and outdoor running in trained endurance athletes.

Material and methods: Twelve male endurance-trained athletes (age: 21.3 ± 2.4 years; height: 176.2 ± 6.8 cm; body mass: 67.8 ± 5.9 kg), each training ≥5 sessions per week and holding federation licenses, completed three laboratory visits and one field trial. Laboratory testing included anthropometric assessment, a ramp-incremental treadmill test (1% grade) to determine $\dot{V}O_2max$, and a stepwise economy test (3-min stages, 8–15 $km \cdot h^{-1}$). The field test was conducted on a 400-m outdoor track with identical pacing verified by GPS. Gas exchange was measured breath-by-breath using a portable metabolic analyzer. Running economy and cost of transport were calculated from steady-state $\dot{V}O_2$, while fat and carbohydrate oxidation were estimated using stoichiometric equations.

Results: Absolute and relative $\dot{V}O_2max$ were comparable across settings (Lab: 62.4 ± 4.8 vs. Field: 63.5 ± 5.2 $mL \cdot kg^{-1} \cdot min^{-1}$, p = 0.28). VT1 did not differ significantly (Lab: 10.3 vs. Field: 10.5 $km \cdot h^{-1}$, p = 0.16). However, VT2 occurred at a higher speed outdoors (13.5 vs. 13.1 $km \cdot h^{-1}$, p = 0.02), equating to 90.8% versus 88.6% of $\dot{V}O_2max$ (p = 0.01). Running economy and cost of transport were significantly greater in the field from 12 $km \cdot h^{-1}$ onward (Δ = +1.7–2.9 $mL \cdot kg^{-1} \cdot min^{-1}$ for RE; Δ= +7.1–11.6 $mL \cdot kg^{-1} \cdot km^{-1}$ for Cr; p < 0.01, dz = 0.61–0.91). Bland–Altman plots confirmed proportional bias, with increasing divergence at higher speeds. Additionally, carbohydrate oxidation was significantly elevated outdoors at 12–13 $km \cdot h^{-1}$ (+6–8 $g \cdot min^{-1}$, p < 0.05).

Conclusions: Treadmill and field running elicit similar physiological responses at sub-threshold intensities. However, beyond VT2, outdoor running imposes significantly greater energetic and metabolic demands. These findings suggest that treadmill testing underestimates real-world race conditions, reinforcing the importance of incorporating field assessments for accurate training prescription and performance evaluation in endurance athletes.

KEYWORDS: Energy Utilization, Maximum Oxygen Uptake, Energy Demand, Endurance Runner

THE USE OF VIRTUAL REALITY IN CARDIAC REHABILITATION: PRELIMINARY RESULTS

KAROLINA RADECKA[1], BŁAŻEJ CIEŚLIK[1,2]

[1]DEPARTMENT OF KINESIOLOGY AND HEALTH PREVENTION, JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[2]HEALTHCARE INNOVATION TECHNOLOGY LAB, IRCCS SAN CAMILLO HOSPITAL, VENEZIA, ITALY

Introduction: Cardiovascular diseases (CVD) rank as the primary cause of death globally. Numerous psychological disorders and psychosocial factors have been linked to the onset and progression of cardiovascular diseases. Among these, depression significantly diminishes the quality of life in cardiac patients and is recognized as an independent risk factor for severe cardiovascular events. At the same time, a growing number of scientific reports have been looking at the use of virtual reality (VR) to treat mental health problems. The aim of this study was to compare the effectiveness of standard cardiac rehabilitation with cardiac rehabilitation combined with virtual therapy in reducing levels of depression, kinesiophobia, and stress in CVD patients.

Material and methods: In our study, we examined 15 patients who were randomly divided into two groups: control group (n=7) receiving four weeks of standards cardiac rehabilitation with three daily exercise sessions and experimental group (n=8) following the same protocol plus eight additional VR-based therapeutic sessions. Mental state parameters were measured using the Perceived Stress Scale (PSS-10), Tampa Scale of Kinesiophobia (TSK), Patient Health Questionnaire (PHQ-9) and Short Form Health Survey (SF-36). We evaluated the patients' functional status using a R.A.M.P. treadmill test. During the test, we measured resting and exercise heart rate (HR), systolic (SBP) and diastolic (DBP) blood pressure. We also assessed the metabolic equivalent of task (MET) to quantify the energy cost of activity relative to resting.

Results: In the experimental group, significant differences were revealed in DBPrest (p=0,05) and MET (p=0,02) among the physiological parameters, as well as in psychological parameters, including PSS-10 (p=0.05) and PHQ-9 (p=0.03). No statistically significant changes were observed in the control group.

Conclusions: In our patient group, adding virtual reality to cardiac rehabilitation seemed to help reduce psychological distress and improve physical function. However, more research with a larger group of patients is needed to be sure of its effectiveness.

KEYWORDS: cardiac rehabilitation; virtual reality; physical activity; depression; mental state

THE IMPACT OF EFFECTIVE MASS ON THE STRENGTH OF SIDE AND TURNING KICK IN TAEKWON-DO MALE PRACTITIONERS

TOMASZ GÓRA[1], DARIUSZ MOSLER[1], ROBERT PODSTAWSKI[2], JACEK WĄSIK[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[2]DEPARTMENT OF PHYSIOTHERAPY, UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN, OLSZTYN, POLAND

Introduction: One of the key factors in improving the striking power of martial arts athletes is the ability to effectively utilize body mass. This can enhance movement technique and, consequently, increase combat efficiency. Therefore, the aim of this study was to investigate the impact of effective mass on the force of side and turning kicks in the context of lateralization.

Material and methods: The study involved four adult ITF Taekwon-do athletes (International Taekwon-do Federation). Acceleration and force data were collected using a wireless IMU sensor (Noraxon), synchronized with a piezoelectric force plate.

Results: The median peak force was 2661.53 N for the turning kick and 4596.15 N for the side kick, with foot accelerations of 150.56 m/s^2 for the turning and 74.34 m/s^2 for the side kick. The calculated median effective mass accounted for 20.12% of body mass during the turning kick and 73.09% during the side kick. Statistical analysis revealed no significant differences between the right and left leg in the obtained kinetic variables ($p > 0.05$).

Conclusions: The findings suggest that the side kick generates higher average force values compared to the turning kick. The observed correlation between the three variables indicates that greater effective mass corresponds to higher force and lower foot acceleration, which is consistent with previous research. Furthermore, the absence of lateralization in kicking limbs aligns with results reported in other studies.

KEYWORDS: turning kick, side kick, taekwon-do, effective mass

MANIFESTATIONS OF PHYSICAL ACTIVITY AMONG PRISONERS IN NAZI CONCENTRATION CAMPS DURING THE SECOND WORLD WAR

RENATA URBAN[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, UNIVERSITY OF SZCZECIN, SZCZECIN, POLAND

Introduction: The first Nazi concentration camps were established in 1933, initially within the Third Reich and after the outbreak of World War II, also in the occupied territories, mainly in Poland. Initially, they were places of isolation for the anti-Hitler opposition and those who opposed the emerging regime. The first camp to be established was in Dachau, followed by camps in Oranienburg, Berlin, Königsberg, Sachsenhausen, Buchenwald, Mauthausen and a special camp for women in Ravensbrück. After the outbreak of war the nature and role of concentration camps changed dramatically. Both old and newly established camps, including Stutthof, Auschwitz, Neuengamme, Gross-Rosen, Bergen-Belsen and Majdanek, became camps for the mass extermination of the population.

Material and methods: A search for sources was carried out in the Archive of New Records, the Military Historical Bureau – Central Military Archives (Warsaw), the National Library and the Library of the Museum of Sport and Tourism (Warsaw). Historical research methods were used, mainly analysis and source criticism.

The aim: Determining the forms, role and significance of physical activity carried out by prisoners in Nazi concentration camps during the Second World War and analysing the motivation for physical exercise among prisoners.

Results: The source research has confirmed that prisoners were engaged in various forms of physical activity in several Nazi concentration camps. The most common activities were football, boxing and athletics. Engaging in physical activity required enormous determination on the part of the prisoners. It was also extremely difficult due to the lack of sports equipment and facilities.

Conclusions: Any physical activity undertaken by concentration camp prisoners during the Second World War was only beneficial to their health for a short time after their imprisonment. It quickly became apparent that extremely hard labour, which was devastating to the body and extremely limited food rations were not conducive to physical exertion. However, physical activity and even sport found their place in concentration camps. They served completely different purposes. Boxing tournaments and football matches were a form of entertainment for Nazi torturers but for prisoners they were often a fight for their lives.

KEYWORDS: physical activity, concentration camps, Third Reich, sport

ANALYSIS OF LONG-TERM FOCUSED ATTENTION AND REACTIVE STRESS TOLERANCE AMONG STUDENTS STUDYING E-SPORT AND PHYSIOTHERAPY: PRELIMINARY INVESTIGATION

JUSTYNA KRZEPOTA[1], TOMASZ SACEWICZ[2], ANETA ŁUĆ[3,4], MAREK CIEŚLUK[5], DOROTA SADOWSKA[6]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, UNIVERSITY OF SZCZECIN, SZCZECIN, POLAND
[2]DEPARTMENT OF BIOMECHANICS AND ANATOMY, FACULTY OF PHYSICAL EDUCATION AND HELTH IN BIAŁA PODLASKA, JÓZEF PIŁSUDSKI UNIVERSITY OF PHYSICAL EDUCATION IN WARSAW, BIAŁA PODLASKA, POLAND
[3]VICE PRESIDENT, PPHIU DOMBUD LTD. (CURRENT AFFILIATION)
[4]DIRECTOR AT THE REGIONAL RESEARCH AND DEVELOPMENT CENTER, FACULTY OF PHYSICAL EDUCATION AND SPORT IN BIAŁA PODLASKA, JÓZEF PIŁSUDSKI UNIVERSITY OF PHYSICAL EDUCATION IN WARSAW, BIAŁA PODLASKA, POLAND (AFFILIATION AT THE TIME OF THE RESEARCH)
[5]INSTITUTE OF PSYCHOLOGY DEPARTMENT OF SOCIAL AND DEVELOPMENTAL PSYCHOLOGY, UNIVERSITY OF SZCZECIN, SZCZECIN, POLAND
[6]INSTITUTE OF SPORT – NATIONAL RESEARCH INSTITUTE, WARSAW, POLAND

Aim: The aim of the study was to assess differences in long-term focused attention and reactive stress among students studying esports and physiotherapy.

Material and methods: The study involved 67 students (21.88 years ± 2.14) studying esports (n=40) and physiotherapy (n=27). The body height (cm) of the participants was (181.84±6.68) and their body mass (kg) (78.21±14.42). In the survey, students were asked to declare how much time per week they devote to esports training /gaming. The following tests were used to measure selected psychomotor abilities: SIGNAL – a test of attention and visual search, and DT – a test of determination, both belonging to the Vienna Test System. The study was conducted using two approaches. Initially, a statistical analysis was conducted comparing students with regard to their field of study. In the second stage, analyses were carried out comparing students based on the number of hours they declared. The Mann-Whitney U test was used to compare parameters between groups.

Results: Despite the fact that esports students spend significantly more time per week (27.83h±20.6) than physiotherapy students (5.69h±5.83) on esports training/gaming ($p \leq 0.001$), no statistically significant differences between the groups were found in the Signal and DT results. However, significant differences were observed in the Signal test results when divided according to the median declared number of hours spent weekly on esports training /gaming. While the number of omitted alarms was significantly higher in the group of students spending ≤10 hours, the value of this parameter was significantly lower in the group spending >10 hours per week ($p=0.028$). Differences were also observed in focused attention ($p=0.028$) and correct reactions ($p=0.024$). For these variables, higher values were observed in the >10 hours group. No statistically significant differences were observed between the >10 hours and ≤10 hours groups in the results of DT test.

Conclusions: The time spent on esports training/gaming, regardless of the field of study, significantly differentiates the analyzed variables. This means that individual involvement in gaming activities affects psychomotor skills Consequently, it can be assumed that the practice of esports/gaming training may be a significant factor influencing cognitive abilities.

Keywords: esport, gaming, students, focused attention, reactive stress tolerance

PHYSICAL FITNESS LEVELS AND BODY COMPOSITION OF ELDERLY WOMEN WITH VARYING FREQUENCIES OF PHYSICAL ACTIVITY

AGATA HORBACZ[1], MÁRIA MAJHEROVÁ[2], LADISLAV KRUČANICA[1]

[1]PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE, INSTITUTE OF PHYSICAL EDUCATION AND SPORT, SLOVAKIA

[2]FACULTY OF HUMANITIES AND NATURAL SCIENCES IN PREŠOV, DEPARTMENT OF PHYSICS, MATHEMATICS AND TECHNOLOGY, SLOVAKIA

The aim of this study was to examine differences in physical fitness levels and body composition between groups of elderly women with varying frequencies of physical activity. The sample comprised 70 elderly women divided into two groups: (a) higher frequency (TJ group; n = 30; mean age = 74 years), who engaged in moderate-intensity exercise for 60 minutes once per week; and (b) lower frequency (U3 group; n = 40; mean age = 70 years), who engaged in moderate-intensity exercise for 90 minutes once every two weeks. Body composition was assessed using bioelectrical impedance analysis (BIA) with the InBody 230 device, yielding measures of body fat (kg and %) and skeletal muscle mass (kg). Physical fitness was evaluated using four tests from the Senior Fitness Test (SFT) battery, assessing upper and lower limb strength, aerobic capacity, and dynamic balance. Additional data on physical activity levels and quality of life were collected via questionnaire. Questionnaire responses indicated that participants had no major diseases that would preclude study participation. The TJ group reported higher subjective well-being than the U3 group. Correspondingly, the TJ group demonstrated significantly better performance on the SFT compared with the U3 group, particularly in upper and lower limb strength and aerobic capacity tests. These findings support the hypothesis that higher-frequency physical activity is associated with enhanced physical fitness in elderly women. Future studies should incorporate pre- and post-intervention assessments following structured fitness programmess, alongside evaluations of nutritional habits, to establish comprehensive recommendations for healthy aging.

KEYWORDS: older women, exercise frequency, bioelectrical impedance, Senior Fitness Test

ACID–BASE REGULATION AND DIETARY ACID LOAD IN HANDBALL PLAYERS FOLLOWING A PALEOLITHIC DIET

ALEKSANDRA PIĘTA[1], KATARZYNA ŚWITAŁA[2], BARBARA FRĄCZEK[1,2]

[1]DEPARTMENT OF SPORTS MEDICINE AND HUMAN NUTRITION, INSTITUTE OF BIOMEDICAL SCIENCES, UNIVERSITY OF PHYSICAL CULTURE IN CRACOW, CRACOW, POLAND

[2]DIETETICS IN SPORTS AND RECREATION, GDAŃSK UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, GDAŃSK, POLAND

Introduction: The Paleolithic diet, rich in meat, fish, eggs, fruits, and vegetables but excluding dairy and grains, may affect systemic acid–base regulation as well as renal and hepatic function. The aim of this study was to evaluate the effect of a Paleolithic diet on acid–base balance, dietary acid load, and kidney and liver function in professional handball players.

Material and methods: Twenty-five professional handball players were assigned to two groups for an 8-week intervention: an experimental group (n=14) following a Paleolithic diet (PD) and a control group (n=11) adhering to a rational, balanced diet (CD). Based on individual energy and nutrient requirements, all-day food rations for both diets were designed for each athlete and prepared by a catering company. The two diet did not differ in total energy content, but the PD was lower in carbohydrates (30.3% vs. 48.7%) and higher in protein (23.2% vs. 20.1%) and fat (46.5% vs. 31.2%) compared with the CD. Potential renal acid load (PRAL) was calculated according to the equation proposed by Remer and Manz (1995) and net endogenous acid production (NEAP) was estimated using the formula developed by Frassetto et al. (1998). Selected indicators of acid-base balance, electrolyte status, and liver and kidney function were measured at baseline and after 4 and 8 weeks.

Results: No significant between-group differences were observed in blood acid–base or biochemical parameters over time. Significant time-dependent changes were observed in serum sodium, total calcium and magnesium, and a group × time interaction was found only for eGFR. The PD group had lower intakes of calcium and sodium but higher potassium than CD, resulting in substantially lower PRAL (11.6 ± 4.9 vs 32.0 ± 16.8 mEq/d) and NEAP (49.8 ± 3.5 vs 57.9 ± 12.1 mEq/d). PD participants also consumed more alkaline-forming products (1737.7 ± 59.4 vs 1572.4 ± 86.1 g), whereas CD consumed more acid-forming (1247.2 ± 194.9 vs 924.3 ± 73.1 g).

Conslusions: Blood acid–base status and biochemical markers remained within the normal range and did not change significantly in either group. Substantial reductions in dietary acid load, as assessed by PRAL and NEAP, were achieved through higher intake of alkaline-forming products and lower intake of acid-forming products. Adherence to the Paleolithic diet did not adversely affect acid–base balance, kidney or liver function.

KEYWORDS: Paleo diet, acid- base balance, dietary acid load, athletes

ISSUES OF FORMING THE PSYCHOLOGICAL PASSPORT OF ATHLETES

JAVLON ISHTAYEV[1], ZAKHID GAPPAROV[1], OTABEK KHASANOV[1], RANO ISHTAYEVA[1]

[1]UZBEK STATE UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, TASHKENT, UZBEKISTAN

Introduction: In modern sports, the psychological readiness of athletes has become just as important as their physical, technical, and tactical preparation. The increasing intensity of training processes, the growing competitiveness in international competitions, and the psychological pressure of achieving high results require athletes to develop strong mental stability and emotional resilience. In this context, the concept of a psychological passport of an athlete emerges as an innovative and effective tool for monitoring and enhancing psychological characteristics.

Purpose: The purpose of this research is to develop and substantiate the psychological passport of athletes as an effective diagnostic and monitoring tool that allows for a comprehensive evaluation of their mental qualities, emotional stability, motivation, and coping mechanisms in training and competition.

Material and methods: The study was conducted among athletes of different sports disciplines (individual and team sports) aged between 16 and 25 years. A total of N = 200 athletes participated, representing various levels of sports mastery (from novice to elite). Psychodiagnostic Testing: Spielberger–Khanin Anxiety Inventory – to assess situational and personal anxiety levels. Cattell's 16-PF Questionnaire – to evaluate personality traits relevant to sports performance. V.F. Sopov's Motivation Scale – to study athletes' motivational states and goals. Hand Test and Luscher Color Test – to examine emotional regulation and stress tolerance. Mathematical and Statistical Analysis:

Results: The analysis of psychological diagnostics revealed several important tendencies that underline the necessity of forming psychological passports for athletes. Anxiety Indicators: According to the Spielberger–Khanin scale, 42% of athletes demonstrated a high level of situational anxiety before competitions, while 37% showed elevated personal anxiety. These findings confirm that a considerable part of athletes experiences psychological tension that may negatively affect performance. Motivational Characteristics: V.F. Sopov's motivational scale showed that the majority of athletes (65%) were driven primarily by achievement motivation, while 20% revealed mixed motives (achievement and avoidance of failure), and 15% were dominated by external motivational factors (coach pressure, rewards). Athletes with strong internal motivation demonstrated higher stability and better competition results. Personality Traits (Cattell's 16PF): Athletes scoring high on emotional stability, self-control, and independence tended to perform more consistently in stressful situations. Conversely, those with lower levels of self-control and higher sensitivity were more prone to errors under competitive pressure.

Conclusions: The conducted research confirmed that psychological characteristics such as anxiety, motivation, self-regulation, attention, and emotional stability play a decisive role in the effectiveness of athletes' training and competitive performance. The development of a psychological passport provides an integrative and systematic assessment of these characteristics, enabling coaches and sports psychologists to create individualized training and correctional programs. The proposed methodological approach allows for timely identification of risk factors such as high situational anxiety, insufficient motivation, or low stress tolerance, which may negatively affect sports results.

Key words: Sport psychology, psychological passport, athletes, anxiety, motivation

INTERRELATION BETWEEN THE MENTAL STATE AND THE DEVELOPMENT LEVEL OF NEURODYNAMIC FUNCTIONS IN YOUNG FOOTBALL PLAYERS

OTABEK KHASANOV[1], ZAKHID GAPPAROV[1], GEORGIY KOROBEYNIKOV[1], LESIA KOROBEINIKOVA[1], JAVLON ISHTAYEV[1]

[1]UZBEK STATE UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, TASHKENT, UZBEKISTAN

Introduction: This article scientifically analyzes the psychophysiological characteristics, functional mobility of nervous processes, simple visual-motor reaction times, and reaction times to moving objects of young soccer players.

Purpose: The purpose of this article is to study the mental state and neurodynamic characteristics of young soccer players, as well as to determine how psychophysiological aspects are interrelated in the development of their athletic abilities.

Material and methods: The study examined 13-year-old footballers, assessing their psychophysiological characteristics using Multipsychometer-05 software. Neurodynamic traits were evaluated using a series of tests, including the Lüscher colour test to assess psycho-emotional state. The data were analysed using statistical software in accordance with standard mathematical requirements.

Results: Three key indicators were assessed: working capacity, fatigue and anxiety. These factors are interrelated. Working capacity was 12.0 in the satisfactory group versus 6.0 in the unsatisfactory group (maximum 15). Fatigue was 2.5 versus 6.0 (maximum 12), reflecting age and puberty. Anxiety, the first stage of stress (Selye), was 1.5 versus 4.0 (maximum 12).
Deviation from the autogenic norm was 13.0 versus 26.5 (maximum 28), indicating negative states. The concentricity index, which indicates a weaker nervous system, was 7.0 versus 11.0, while the eccentricity index, which indicates a stronger nervous system, was 11.5 versus 3.0 (maximum 12)—an important factor in team sports.
The vegetative coefficient was 17.0 versus 17.5 (maximum 30), showing slight sympathetic dominance. The Lüscher test revealed heteronomy/autonomy: 7.0 and 10.5 in the satisfactory group versus 5.5 and 7.0 in the unsatisfactory group (maximum 12).

Conclusions*:* Analysis showed that, in young footballers, excitatory processes outweigh inhibitory ones, with individual activation levels shaping playing styles. Their low psychophysiological indicators suggest that coaches may undervalue the development of thinking skills.

Key words: young soccer players, psychophysiological characteristics, nervous system, individual approaches

DIETARY HABITS AND PHYSICAL ACTIVITY OF UNIVERSITY STUDENTS

DÁVID KAŠKO[1], NORA RYBČÁKOVÁ[1]

[1]INSTITUTE OF PHYSICAL EDUCATION AND SPORT, PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE, KOŠICE, SLOVAKIA

Introduction: The aim of the study was to assess the relationship between dietary habits and physical activity among university students, as well as to identify behavioural patterns affecting their lifestyle and health. University students often experience irregular nutrition, high intake of energy-dense food, and decreased physical activity, which may negatively influence their physical and mental well-being.

Material and methods: The research was carried out through an anonymous online questionnaire consisting of 22 items combining the Food Frequency Questionnaire (FFQ) and self-designed questions on lifestyle and exercise. The sample comprised 113 students of Pavol Jozef Šafárik University in Košice (77 females, 36 males). Data were collected from April 6–9, 2025 and processed using descriptive statistics.

Results: Diet: 70% of respondents ate 2–3 main meals daily, while only 40% consumed fruits and vegetables every day. Fast food was eaten at least once per week by 48% of students, and sweets or sugary drinks daily by 32%. Only 36% achieved adequate water intake (≥ 2 L/day). Emotional eating occurred in 40% of respondents, more often among women ($p < 0.05$). Physical activity: 65% of students participated in vigorous physical activity, but only 10% exercised daily. Men were more likely to engage in strength-based training, while women preferred aerobic activities. On average, students reported 6–8 hours of sedentary behaviour per day. Attitudes: 74% of respondents expressed motivation to improve both their diet and physical activity, and 58% reported adapting their diet to their exercise routine.

Conclusions: The study revealed moderate physical activity levels but insufficient diet quality among university students. Frequent consumption of sweets and fast food, combined with prolonged sedentary time, suggests a need for structured preventive programs at universities. These findings underline the importance of educational strategies that integrate nutrition and exercise promotion to foster long-term health-oriented behaviour.

Keywords: nutrition, sedentary behaviour, hydration, lifestyle, prevention

BMI OR BODY FAT? PREDICTORS OF AEROBIC PERFORMANCE

ALENA BUKOVÁ[1], DÁVID KAŠKO[1], PETRA MELICHAROVÁ[1]

[1]PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE, INSTITUTE OF PHYSICAL EDUCATION AND SPORT, KOSICE, SLOVAKIA

Introduction: Body composition, particularly the proportion of adipose tissue, is a critical determinant of physical fitness and health. Although body mass index (BMI) is widely used to assess overweight and obesity, it fails to distinguish between fat and lean mass, limiting its predictive value for aerobic fitness. The aim of this study was to examine whether body fat percentage (%BF) is a more accurate predictor of aerobic fitness than BMI in a population of female university students.

Material and methods: The study sample consisted of 42 subjects (age 21.0 ± 3.9 years; height 169.3 ± 6.4 cm). Body composition was assessed by the use of bioelectrical impedance analysis (InBody 230), recording the values of %BF and BMI. Aerobic fitness was assessed by the Beep test, expressed as the number of completed shuttle runs until two consecutive misses. Implausible results were excluded, and duplicate measurements were reduced to the first record. Statistical analyses included Pearson's and Spearman's correlations, linear regression models, and partial correlation controlling for covariates like BMI, age, and height.

Results: Mean values were %BF 28.0 ± 7.0%, BMI 22.8 ± 3.8 kg/m^2, and Beep test 30.3 ± 12.0 lengths. A significant negative correlation was found between %BF and Beep test performance ($r = -0.518$; 95% CI −0.710 to −0.254; $p = 0.0004$; Spearman $\rho = -0.475$; $p = 0.0015$). The association between BMI and performance was weaker and not statistically significant ($r = -0.287$; $p = 0.065$). Partial correlation confirmed %BF as an independent predictor after controlling for covariates ($r = -0.468$).

Conclusions: Body fat percentage is a stronger and more reliable predictor of aerobic fitness compared to BMI in female university students, supporting the inclusion of detailed body composition assessments in fitness evaluations and preventive health programs.

Funding: This study was supported by the scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences under the Grant No.1/0424/25. Aerobic Training and its Impact on Gut Microbiota in the Female Population.

Keywords: body composition, adiposity, physical performance, university population, bioelectrical impedance

PSYCHOLOGICAL PROFILE OF PEOPLE INVOLVED IN SPORTS AND PHYSICAL ACTIVITY: A PILOT STUDY

MAGDALENA KORSAK SABINO BELO[1,], TOMASZ GÓRA[1], DOROTA ORTENBURGER[1], MARIO GALLEGO[2], ALEJANDRO LESAOLA[2], JACEK WĄSIK[1]

[1]JAN DLUGOSZ UNIWERSITY IN CZĘSTOCHOWA, POLAND

[2]UNIVERSIDAD DE CASTILLA LA MANCHA (UCLM), FACULTY OF SPORT SCIENCES AND PHYSICAL EDUCATION, SPAIN

Introduction: In Sports Science and Psychology research, combining qualitative and quantitative methods represents a significant approach that enables a deeper understanding of various phenomena in this field. Additional qualitative work is also required to gain a better understanding of the relationship between psychological factors and specific elements of the sporting environment and sport outcomes. One of the important questions is what are the characteristic features that seem to favor achieving success in individual disciplines as well as in team sports?

Material and methods: The combination of quantitative qualitative and methods is useful understanding of the complexity of sports phenomena. There were 43 participants, age range 19–37 years. Including 16 participants reported being involved in team sports, 27 were individual athletes. A 5-point scale of our own design was used.

Results: A few types characteristic promoting effectiveness in team games and individual sports were identified. Importance factors in performance: intrinsic and extrinsic motivation, anxiety concentration, teamwork, will to fight, ambition, confidence discipline, physical fitness, reaction time, tactical awareness, emotional control, goal setting and mixed factors.

Conclusions: More (percentage-wise) different characteristics and key properties were identified related to team sports. However, this research is still in its pilot phase - research will continue. By combining quantitative data on with qualitative insights into athletes psychological factors and perceptions, can draw more comprehensive conclusions. For example, quantitative data might indicate improved performance, while qualitative insights could reveal potential challenges, such as stress caused by constant pressure.

Keywords: sport, success factors, difficulties

THE PSYCHOSOCIAL EFFECTS OF TAEKWONDO TRAINING: LONGITUDINAL PERSPECTIVE

TOMASZ GÓRA[1,2], JAKUB KACPRZAK[2,3], DOROTA ORTENBURGER[1,2], PAULINA PRZEPIÓRA[3], JOWITA KARINA WYSZOMIERSKA[4], JACEK WĄSIK[1]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[2]STUDENCKIE KOŁO NAUKOWE AKTYWNOŚĆ-KULTURA-ZDROWIE, JAN DŁUGOSZ UNIWERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[3]DOCTORAL SCHOOL, JAN DŁUGOSZ UNIWERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[4]STOCKHOLM UNIVERSITY, SVEDEN

Introduction: Taekwon-do is a Korean martial art and sport. Its psychosocial benefits for its trainees being studied extensively. Contemporary research suggests that Taekwon-do is not only as a form of self-defence, sports disciplines, and a leisure activity but also a form healthy lifestyle. In order to obtain proper effects, appropriate duration of trainings, intensity and frequency are necessary. The aim of this paper is to present the research answering if and how Taekwon-do have an influence on the elements on the level of healthy behaviours and the psychosocial aspects.

Material and methods: The research covered the group of 46 Taekwon-do ITF athletes (age:19-35). Standardized Inventory of Health Behaviours and our designed method ere applied. The presented research measures particular health behaviour based on the frequency of revealed behaviour types. The research was conducted by those who are familiar with the community of people practicing Taekwon-do.

Results: The correlation between Taekwon-do practice time and ability to do prolonged exercise was observed ($p<0.05$). All adepts noticed an increased ability to long lasting varied efforts. Three types of psychosocial benefits were identified ($p<0.05$).

Conclusions: The obtained results indicate that practicing Taekwon-do have an influence on everyday health-promoting behaviour, and the relation, social activity. But, in order to obtain proper effects, appropriate duration of trainings, intensity and frequency are necessary. When the trainings are regular, the effects cumulate. The presented research was of an explorative character. The obtained data allow to make hypotheses that require further verification.

Keywords: martial art, behaviors, psychosocial benefits

THE INFLUENCE OF 3 YEARS OF AEROBIC SWIMMING TRAINING ON THE BODY COMPOSITION OF 10-YEAR-OLD FEMALE SWIMMERS

MARIUSZ KUBERSKI[1], JACEK WĄSIK[1], AGNIESZKA MUSIAŁ[2], KAROLINA GABARSKA[3]

[1]INSTITUTE OF PHYSICAL CULTURE SCIENCES, JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

[2]SOCIAL, GENETIC AND DEVELOPMENTAL PSYCHIATRY CENTRE, INSTITUTE OF PSYCHIATRY, PSYCHOLOGY & NEUROSCIENCE, KING'S COLLEGE LONDON, LONDON, UNITED KINGDOM

[3]STUDENT SCIENTIFIC CLUB "ACTIVITY-CULTURE-HEALTH" OF THE COLLEGIUM MEDICUM OF DR. WŁADYSŁAW BIEGAŃSKI JAN DŁUGOSZ UNIVERSITY IN CZĘSTOCHOWA, CZĘSTOCHOWA, POLAND

Introduction: The aim of the study was to evaluate the effect of a three-year swimming training program on body fat measurements in adolescent girls, without prior selection for increasing childhood obesity.

Material and methods: Two groups of 10-year-old girls were analyzed. The experimental group consisted of 14 female swimmers (body mass: 34.99 ± 2.77 kg; height: 146.00 ± 3.05 cm). The control group consisted of 14 girls (body mass: 37.93 ± 6.02 kg; height: 145.55 ± 3.88 cm) who participated only in mandatory physical education classes. The study lasted three years, with measurements taken every six months. Body fat was measured by skinfold thickness at four anatomical sites: above the biceps; above the triceps; below the inferior angle of the scapula; and above the superior iliac crest. Based on these measurements, percentage body fat was calculated.

Results: Statistical analysis showed that despite the lack of pre-selection, there was no significant difference in body fat percentage between groups at the beginning of the study – 18.62% vs 24.85%. This difference persisted until the final measurement after three years, when it became statistically significant – 17.31% vs 27.14% ($F= 37.44$, $p < 0.05$).

Discussion: Our results indicate that three years of swimming training in adolescent girls resulted in a reduction in body fat percentage, which may contribute to improved health in girls who swim. Initially, body fat percentage had a strong negative effect on VO2max, particularly in the experimental group, which may indicate a negative impact on swimming performance.

Conclusions: Swimming can be an effective way to prevent obesity in girls during puberty. Coaches should consider the slimness of candidates for swimming.

Keywords: body composition, swimming training, adolescent girls