# THE PODIUM INSTITUTE CONFERENCE
## ON SPORTS MEDICINE & TECHNOLOGY 2025

**25TH & 26TH SEPTEMBER 2025**

Richard Doll Lecture Theatre,
Old Road Campus, University of Oxford

UNIVERSITY OF OXFORD

THE PODIUM INSTITUTE
FOR SPORTS MEDICINE & TECHNOLOGY

THE PODIUM INSTITUTE
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# THE PODIUM INSTITUTE FOR SPORTS MEDICINE & TECHNOLOGY

*The Podium Institute for Sports Medicine and Technology is the world's first independent academic institute focused on the safety and lifelong health of youth and grassroots as well as professional athletes. Its purpose is to inspire and forge evidence-based changes in sport and physical education, and to develop innovative and scalable technologies to monitor, analyse and ultimately prevent sport injury across the 22 million adults and 3 million children who participate in sport annually across the UK, as well as the hundreds of millions who partake in amateur and professional sport internationally.*

*The Institute combines Oxford's longstanding tradition in sports and education with the very best of cross-disciplinary scientific, medical, and technological research. It forms part of the Institute of Biomedical Engineering – which has a 15-year track-record of combining medicine and technology to achieve adoption and healthcare impact – and draws on world-leading expertise across the medical and technological sciences, including clinical neurosciences, orthopaedics, experimental psychology, population health, and biomedical, electrical, mechanical and information engineering. The Podium Institute represents an ambitious long-term partnership between the University of Oxford and the NGO and registered charity Podium Analytics, and the coming together of leaders across sport, science, academia, technology, and business to spearhead a new approach to the issue of sports-related injury for athletes of all ages.*

*The initial work of the Institute is focused on traumatic injuries such as concussion, serious musculoskeletal injuries as well as sudden cardiac death and the psychological factors that lead to injury. Our aim is the practical adoption, within 5 years, of impactful evidence-based changes for sport safety, not just for male elite adult athletes but for sports participants of all genders and ages across professional, grassroots, community and school sports.*

THE PODIUM INSTITUTE
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# VENUES

*Richard Doll Lecture Theatre*
*Conference Venue*

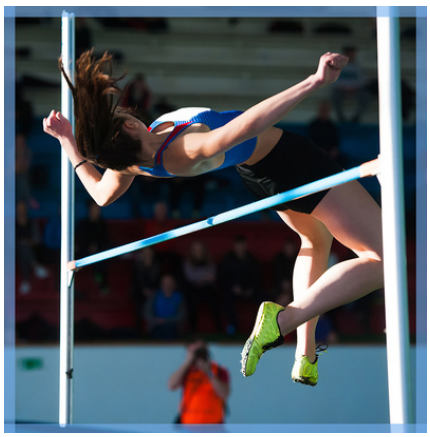
*Richard Doll Building*
*University of Oxford*
*Old Road Campus*
*Oxford*
*OX3 7LF*

*Link to Map*

*New College*
*Drink's Reception &*
*Gala Dinner*

*Holywell St,*
*Oxford*
*OX1 3BN*

*Link to Map*



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# KEYNOTE SPEAKERS

- ***Dr Mark Hart - Chair of the FEI Medical Committee and the Equestrian Safety Vest Working Group (ESVWG)*** *Challenges in Promoting Athlete Safety in International Sport Federations*
- ***Prof. Keith Stokes - Professor of Applied Physiology, University of Bath and Medical Research Lead at Rugby Football Union*** *Head Acceleration Events in Rugby Union Matches and Training: What have we discovered using Instrumented Mouthguards?*
- ***Dr Dario Cazzola - Senior Lecturer, Department for Health, University of Bath*** *Invisible Monitoring: How Computer Vision and physics-informed Machine Learning is Redefining Athlete Monitoring and Performance Optimisation*
- ***Prof. Johannes Weickenmeier - Associate Professor of Brain Health, The Podium Institute, University of Oxford*** *Multiphysics and Multiscale Modelling of Traumatic Brain Injury (M3TBI): Current Challenges and Opportunities*
- ***Rhys Hughes - Head of Medical Services, Gloucester Rugby*** *Practical Application & Screening for Posterior Lower Limb Injury in Elite Athletes*
- ***Dr Thomas Parker - NIHR Clinical Lecturer, Department of Brain Sciences, Imperial College London*** *Linking Sporting Head Impact Exposure to Brain Health*
- ***Dr Lee E Goldstein - Associate Professor, Boston University*** *Sports-Related Repetitive Head Impacts and Chronic Traumatic Encephalopathy: New Insights and Novel Biomarkers*

# CONFERENCE PROGRAMME

THE PODIUM INSTITUTE
FOR SPORTS MEDICINE & TECHNOLOGY

## DAY 1

*Thursday 25th September, 8:30-17:00*

*8:30-9:00* **REGISTRATION**

*9:00-9:20* **PROFESSOR CONSTANTIN COUSSIOS**
**DIRECTOR OF THE PODIUM INSTITUTE**
*Introduction*

## MENTAL HEALTH, SLEEP & COGNITION

*Thursday 25th September, 09:20-10:20*

ABSTRACTS - PAGES 13 TO 18

*9:20-9:30* **DENISE KOHLHEPP - UNIVERSITY OF OXFORD**
*Contributed Talk*

*9:30-9:40* **DR ANDREW ROBERTS - BRITISH ARMY**
*Contributed Talk*

*9:40-9:50* **ELYSE LEVENS - THE PODIUM INSTITUTE**
*Contributed Talk*

*9:50-10:00* **DR EMMA NEUPERT - UNIVERSITY OF PORTSMOUTH**
*Contributed Talk*

*10:00-10:10* **BEN SEYMOUR - UNIVERSITY OF OXFORD**
*Contributed Talk*

*10:10-10:20* **DANAE TAVLARIDIS - BRUNEL MEDICAL SCHOOL**
*Contributed Talk*

*10:20-10:50* **COFFEE BREAK**

# CONFERENCE PROGRAMME

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## PPE, WEARABLES & CARDIOVASCULAR

*Thursday 25th September, 10:50-12:40*

ABSTRACTS - PAGES 19 TO 28

| | |
|---|---|
| *10:50-11:10* | **MARK HART - CHAIRMAN OF THE HUMAN AND EQUINE SAFETY & WELFARE COMMITTEE**<br>*Keynote* |
| *11:10-11:20* | **AIDAN HEGARTY & DANIEL RILEY - UNIVERSITY OF LIVERPOOL**<br>*Contributed Talk* |
| *11:20-11:30* | **DR LISA GANNON - LEEDS TRINITY UNIVERSITY**<br>*Contributed Talk* |
| *11:30-11:40* | **YIXING LEI - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *11:40-11:50* | **DR RYMAN HASHEM - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *11:50-12:00* | **CARLA VERÓNICA FUENTESLÓPEZ- UNIVERSITY OF OXFORD**<br>*Contributed Talk* |
| *12:00-12:10* | **KYRA DELRAY - UNIVERSITY OF OXFORD**<br>*Contributed Talk* |
| *12:10-12:20* | **ERIK VANEGAS MÜLLER - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *12:20-12:30* | **DR GEORGIOS ZOUMPOURLIS - ORB INNOVATIONS LTD**<br>*Contributed Talk* |
| *12:30-12:40* | **DR CHENYING LIU - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *12:40-13:40* | **LUNCH** |

# CONFERENCE PROGRAMME

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## MUSCULOSKELETAL

*Thursday 25th September, 13:40-15:20*

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|---|---|
| *13:40-14:00* | **DARIO CAZZOLA - UNIVERSITY OF BATH**<br>*Keynote* |
| *14:00-14:10* | **LORENZA PROSPERO - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *14:10-14:20* | **LUKAS CHA - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *14:20-14:30* | **MELIS ATBINEK - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *14:30-14:40* | **DR QOTAIBA JAMAL - UNIVERSITY HOSPITALS BRISTOL & WESTON**<br>*Contributed Talk* |
| *14:40-14:50* | **DR MOHAMMAD RAHMAN - UNIVERSITY OF DUNDEE**<br>*Contributed Talk* |
| *14:50-15:00* | **DR RAPAHEL OLAIYA - UNIVERSITY COLLEGE LONDON**<br>*Contributed Talk* |
| *15:00-15:10* | **YIXUAN LENG - UNIVERSITY OF OXFORD**<br>*Contributed Talk* |
| *15:10-15:20* | **PHOEBE CHEUNG - UNIVERSITY OF OXFORD**<br>*Contributed Talk* |
| *15:20-15:50* | **COFFEE BREAK** |

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# CONFERENCE PROGRAMME

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## DEBATE OF THE DAY

*Thursday 25th September, 15:50-16:40*

| | |
|---|---|
| **DEBATE** | *"Sports governing bodies should be willing to accept simulation and video analysis data alone to impose limits on training loads, implement rule changes, or modify and endorse personal protective equipment"* |
| **FOR** | *Dr Mark Hart - Professor Johannes Weickenmeier - Dr Chenying Liu* |
| **AGAINST** | *Dr Dario Cazzola - Professor Liang He - Professor Nick Peirce MBE - Professor Amy Zavatsky* |

## GALA DINNER AT NEW COLLEGE

*Thursday 25th September, 18:45-22:00*

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|---|---|
| *18:45-19:30* | **DRINKS RECEPTION**<br>*North Undercroft and Bar - New College* |
| *19.30-22:00* | **DINNER**<br>*Medieval Dining Hall - New College* |

# CONFERENCE PROGRAMME

THE PODIUM INSTITUTE
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## DAY 2

*Friday 26th September, 8:30-16:40*

*8:30* **DOORS OPEN**

## MUSCULOSKELETAL

*Friday 26th September, 9:00-10:30*

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|---|---|
| *9:00-9:20* | **RHYS HUGHES - HEAD OF MEDICAL SERVICES GLOUCESTER RUGBY**<br>*Keynote* |
| *9:20-9:30* | **LUCY BUCHANAN - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *9:30-9:40* | **HARRY MANSHIP - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *9:40-9:50* | **AFREEN AZAD - ASTON MEDICAL SCHOOL**<br>*Contributed Talk* |
| *9:50-10:00* | **JESSSICA STAMFORD - ORB INNOVATIONS LTD.**<br>*Contributed Talk* |
| *10:00-10:10* | **SAMANTHA BAKER-JONES - UNIVERSITY OF OXOFRD**<br>*Contributed Talk* |
| *10:10-10:20* | **BISOLA LAWAL - KASI HEALTHCARE**<br>*Contributed Talk* |
| *10:20-10:30* | **JAVIER BATISTA - UNIVERSITY OF TEXAS**<br>*Contributed Talk* |
| *10:30-11:10* | **COFFEE BREAK** |
| | **MEET THE EDITOR - DEPUTY EDITOR AT WILEY, DR SNEHA RHODE GUPTA** |

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# CONFERENCE PROGRAMME

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## CONCUSSION

*Friday 26th September, 11:00-13:10*

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|---|---|
| *11:10-11:30* | **PROFESSOR KEITH STOKES - UNIVERSITY OF BATH**<br>*Keynote* |
| *N/A* | **DR HERSH PUNJANI - NHS - LONDON NORTH WEST**<br>*Contributed Talk* |
| *11:30-11:40* | **PHILIPPA HEATH - UNIVERSITY OF BRISTOL**<br>*Contributed Talk* |
| *11:40-11:50* | **KONSTANTIN DZAVARYAN - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *11:50-12:00* | **DR THEO VERSTEEGH - TOPSPIN TECHNOLOGIES LTD**<br>*Contributed Talk* |
| *12:00-12:20* | **DR THOMAS PARKER - IMPERIAL COLLEGE LONDON**<br>*Keynote* |
| *12:20-12:30* | **TOBIAS HARRITZ - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *12:30-12:40* | **MR SHEIKH MOMIN - UNIVERSITY OF BIRMINGHAM**<br>*Contributed Talk* |
| *12:40-12:50* | **IZABELLE LÖVGREN - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *12:50-13:10* | **PROFESSOR JOHANNES WEICKENMEIER - THE PODIUM INSTITUTE**<br>*Keynote* |
| *13:10-14:10* | **LUNCH**<br>*Group photo at 14:00* |

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# CONFERENCE PROGRAMME

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## CONCUSSION

*Friday 26th September, 14:10-15:10*

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|---|---|
| *14:10-14:30* | **DR LEE E. GOLDSTEIN - BOSTON UNIVERSITY**<br>*Keynote* |
| *14:30-14:40* | **DR ARNAV SINGH - UNIVERSITY OF BIRMINGHAM**<br>*Contributed Talk* |
| *14:40-14:50* | **PHOEBE HASTE - THE PODIUM INSTITUTE**<br>*Contributed Talk* |
| *14:50-15:00* | **DR DYLAN POWELL - UNIVERSITY OF STIRLING**<br>*Contributed Talk* |
| *15:00-15:10* | **DR THEO VERSTEEGH - TOPSPIN TECHNOLOGIES LTD**<br>*Contributed Talk* |
| *15:10-15:40* | **COFFEE BREAK** |

# CONFERENCE PROGRAMME

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## DEBATE OF THE DAY

*Friday 26th September, 15:40-16:30*

| | |
|---|---|
| **DEBATE** | *"Instrumented mouthguards and their associated thresholds as they stand today are robust enough to advance concussion safety in contact professional, community and youth sports"* |
| **FOR** | *Professor Simon Kemp - Dr Thomas Parker - Professor Mauro Villarroel* |
| **AGAINST** | *Professor Keith Stokes - Dr Lee Goldstein - Professor Antoine Jerusalem* |

## CLOSING REMARKS & WILEY PRIZES ANNOUNCEMENT

*16:30–16:50*

WILEY
ADVANCED

*We are excited to announce that, in collaboration with Wiley, the Podium Institute Annual Conference on Sports Medicine & Technology 2025 will award three £250 Tango Card prizes to three of our accepted speakers. The prizes are as follows:*

- ***Best student presentation*** *(must be a registered student at a higher education institution)*
- ***Best young researcher presentation*** *(within 10 years of PhD completion)*
- ***Best newcomer presentation*** *(first time presenting technology/medicine in a sports context)*

*Wiley will also organise a special collection related to the conference where authors are invited to submit a manuscript to Advanced Intelligent Systems. More information on the journal can be found on Advanced Intelligent Systems - Wiley Online Library.*

# ABSTRACTS

## MENTAL HEALTH, SLEEP & COGNITION

THE PODIUM INSTITUTE
FOR SPORTS MEDICINE & TECHNOLOGY

**TALK TITLE** *How Boys and Girls Differ: Accelerometer Insights into Distinct Developmental Pathways Linking Physical Activity, Cognition and Mental Health*

**SPEAKER** *Denise Kohlhepp - University of Oxford*

**AUTHORS** *Denise Kohlhepp, Prof Gaia Scerif, Prof Helen Dawes, Dr Karen Mansfield*

**ABSTRACT** *The ways in which physical activity influences cognition and mental health during childhood and adolescence remain poorly understood. Adolescence is a critical period of cognitive development, heightened vulnerability to psychopathology and declining physical activity, making this question especially important.*

*Using accelerometer-derived activity data from 14,099 participants in the UK Millennium Cohort Study, we examined sex-specific mediation pathways across development. Distinct patterns emerged: in girls, the impact of moderate-to-vigorous physical activity at age 7 on emotional symptoms at 14 was mediated via decision-making at 11, whereas in boys, the pathway ran in the opposite direction, with activity predicting decision-making via earlier emotional symptoms.*

*These findings suggest directional, sex-specific mechanisms and highlight opportunities for tailored early interventions to support long-term wellbeing.*

**TALK TITLE** *Extending Morning Wake-Times Impacts Sleep and Fitness in Adolescent Military Recruits*

**SPEAKER** *Andrew Roberts - British Army, Army Recruit Health & Performance Research*

**AUTHORS** *Andrew Roberts, Alex Rawcliffe, Ellie Lidell*

**ABSTRACT** *Introduction: Adolescent recruits in military training often experience chronic sleep restriction, which may impair recovery, adaptation, and health. This study evaluated the impact of extending morning wake-times on sleep, well-being, and physical performance during basic training.*

*Methods: A two-arm, clustered, parallel trial was conducted with 701 Junior Soldiers (age 16.5±0.5yrs). From weeks 11–40, the experimental group (EXP; n=337) received a 90-min later wake-time (07:00), while controls (CON; n=364) maintained standard wake-time (05:30). Lights out was 22:00 for both groups. Sleep was assessed via actigraphy (subsample) and self-report; surveys captured sleep quality, stress, and sleepiness. Role Fitness Tests (2-km run, mid-thigh pull [MTP], medicine ball throw [MBT]) were completed at baseline and week 40. Linear mixed models examined group differences and predictors of change in fitness.*

*Results: EXP achieved ~1h more nightly sleep (07:08±0:45h vs. 06:08±0:42h) and reported improved sleep quality (↓12% poor), reduced excessive sleepiness (↓22%), and lower stress (↓18%). Both groups improved aerobic fitness similarly, but EXP gained significantly more lower-body strength (+5kg MTP, p=0.004), while CON improved upper-body power more (+12cm MBT, p=0.002). Baseline fitness strongly predicted change across all tests.*

*Conclusion: Extending wake-times during training improved sleep duration, quality, and perceived well-being, and enhanced strength adaptation without compromising aerobic fitness. Sleep-focused strategies, supported by wearable technology, are feasible in military settings and may reduce health risks while supporting performance, though targeted training remains necessary for power and endurance gains.*

# ABSTRACTS

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**TALK TITLE** *Decoding Athletic Team Coordination with Machine Learning Techniques*

**SPEAKER** *Elyse Levens - The Podium Institute*

**AUTHORS** *Elyse Levens, Joseph Russell, Jeroen H.M. Bergmann, and Timothy Denison*

**ABSTRACT** *Coordination plays an essential role in contact team sports. Performance and instance of injury are affected by how well players are coordinated with each other. The quantification of whole-body coordination between people has not been explored before. Machine learning algorithms are designed to identify between classes, and they will be leveraged in this study to differentiate between coordinated and uncoordinated tasks. We will compare and contrast machine learning techniques to determine the accuracy of each model for identifying coordinated segments of movement between two participants.*

*A coordination game was developed, and 10 sets of two participants were given coordination tasks to complete. The classifiers involved included K-nearest neighbours, a support vector machine (SVM) kernel, neural networks, and a long-short-term memory (LSTM) time series analysis. The analysis was completed using leave-one out cross validation. The accuracy of these machine learning techniques varied considerably between methods. A Bayesian weighted voting system was implemented to combine predictions between sensing modalities over time, and this was found to improve classification accuracy. Further work should include investigation of additional features to improve the model.*

# ABSTRACTS

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**TALK TITLE** *Surveillance or Support? Reflections on the Ethics of Athlete Biometric Data Collection*

**SPEAKER** *Dr Emma Neupert - University of Portsmouth*

**AUTHORS** *Dr Emma Neupert, Dr Simon Kolstoe, University of Portsmouth, Dr Andrew Kirkland, University of Stirling*

**ABSTRACT** *Introduction: The Whyte Review and a discussion paper from the Australian Academy of Science have highlighted the misuse of athlete biometric data, and the urgent need for reform of athlete monitoring practices within elite sport. This is particularly pressing given the rapid technological advancements in biometric monitoring. Yet, despite the depth and breadth of athlete biometric data collection in sport, limited primary research explores how sports scientists and coaches perceive the ethical implications of its collection and use.*

*This study therefore investigated common themes and divergent perspectives on the ethics of monitoring athlete data. Methods: Participants worked with athletes across World Class to National Development Teams (Tier 3-5). Thirty coaches and coaching academics (27 men, 2 women, 1 non-binary; mean age = 38.0 ± 7.8 years) participated in a two hour facilitated World Café discussion. Two separate hour-long focus groups were also conducted: one with three male sports science practitioners (mean age = 32.0 ± 4.8 years), and another with two male coaches (mean age = 46.0 ± 5.7 years).*

*Key findings: Reflexive thematic analysis revealed four core themes: transparency builds trust; purposeful not performative data collection; closing the feedback loop; and, data collection for organisational surveillance or support? Participants acknowledged that they had not always considered the ethical implications of their biometric data collection, however as the discussions progressed, they recognised its importance. The findings highlight a clear need for a practical decision-making framework to support and guide ethical practices in athlete biometric monitoring.*

# ABSTRACTS

THE PODIUM INSTITUTE
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**TALK TITLE** *More Than Pain Avoidance: Exploring Intrinsic Reward in Physically Demanding Tasks*

**SPEAKER** *Ben Seymour - University of Oxford*

**AUTHORS** *Ruohan Yangyang Liu Luo, Ben Seymour, Sarah Schreiber, Pranav Mahajan, Danielle Hewitt*

**ABSTRACT** *Pain is commonly framed as an aversive signal evolved to deter physical harm. Yet in sport and endurance contexts, individuals often willingly endure—and even derive satisfaction from—painful exertion. This study investigates how physically induced discomfort interacts with intrinsic motivation, focusing on task difficulty and delayed-onset muscle soreness (DOMS), as well as other psychological traits. Participants completed a simulated cycling task across systematically varied resistance levels. Following each trial, they reported perceived pain and intrinsic reward (e.g., satisfaction, accomplishment). To explore how individual differences modulate this experience, we incorporated trait fear of pain (FPQ-III) scores and athletic background measures.*

*A subset of participants underwent a DOMS protocol 24–48 hours prior to testing to simulate real-world soreness. Higher task difficulty was consistently associated with greater reported intrinsic reward, indicating that challenge enhances perceived value despite increased discomfort. DOMS reliably elevated pain ratings but did not reduce reward — suggesting that soreness may amplify rather than diminish the satisfaction of task completion.*

*Notably, individuals with lower fear of pain and/or athletic backgrounds reported higher reward under painful conditions, highlighting trait-level modulators in pain-reward processing. These findings challenge the traditional view of pain as purely aversive, revealing that under certain motivational contexts, pain can enhance rather than inhibit reward. The intrinsic value of overcoming effortful challenges appears to be shaped both by physical factors (difficulty, soreness) and individual psychological profiles.*

# ABSTRACTS

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**TALK TITLE** *Heartbeats and Headspace: A Pilot Study on Wearable-Derived Biomarkers and Mental Health in University Student-Athletes*

**SPEAKER** *Danae Tavlaridis - Brunel Medical School*

**ABSTRACT** *Student-athletes face a high-risk intersection of physical training, academic stress, and psychosocial strain, making them especially vulnerable to mental health challenges. While awareness is increasing, research on real-time, physiological indicators of psychological well-being in this group remains scarce. Wearable devices capable of tracking heart rate variability (HRV), sleep quality, and resting heart rate offer a novel, passive method to assess stress and burnout risk in athletic settings.*

*This pilot study proposes to evaluate the feasibility of using wearable-derived biometric data to detect early markers of psychological distress in university student-athletes. A cohort of 20–30 student-athletes from Brunel University will be monitored over a four-week period using commercially available wearables. Collected physiological data will be correlated with weekly self-reported mental health outcomes via validated instruments: the Athlete Burnout Questionnaire (ABQ), Generalized Anxiety Disorder-7 (GAD-7), and Patient Health Questionnaire-9 (PHQ-9).*

*Primary outcomes will include adherence to wearable use, data integrity, and participant feedback on acceptability. Secondary analysis will explore potential associations between biometric trends and psychological metrics.*

*This study aims to establish proof-of-concept for scalable, non-invasive mental health monitoring in athletic populations. Findings will inform the design of future trials and the development of early intervention strategies across sports medicine, digital health, and education sectors.*

**TALK TITLE** *Challenges in promoting athlete safety in International Sport Federations*

**SPEAKER** *Mark Hart - Human & Equine Safety & Welfare Committee* **KEYNOTE**

**ABSTRACT**

*Each International Sport Federation (IF) has a mission to promote athlete safety which is also mandated by the International Olympic Committee. Due to the nature of the Sport, each IF has different safety responsibilities. Equestrian sports (FEI) are considered to be moderate to high risk for injuries due to the involvement of a 500kg equine partner in competitions at high speed and jumping over obstacles. While the goal is to reduce the frequency of human and horse falls, there is a simultaneous effort to reduce the severity of injury in the event of a fall. This involves the use of helmets and safety vests to help mitigate human athlete injuries.*

*There have been barriers to riders' adoption of personal protective equipment (PPE) based on such factors as sports traditions, cost, sense of reducing movement , lack of scientific date for effectiveness of some types of safety vests, and hesitation of organizations to adopt rules mandating PPE use. In addition, there are multiple international equipment standard bodies that are not always in alignment. Recently there is growing social pressure from the public for sports to become safer for athletes of all ages. I will discuss the journey of the FEI in advancing PPE safety data and improving standards.*

# ABSTRACTS

THE PODIUM INSTITUTE
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**TALK TITLE** *The Athlete Life Vest- A revolutionary wearable for team sports to predict and prevent cardiac events in real time*

**SPEAKER** *Aidan Hegarty & Daniel Riley - University of Liverpool*

**AUTHORS** *Aidan Hegarty & Daniel Riley- University of Liverpool*

**ABSTRACT** *Sudden cardiac arrest remains the leading cause of death in young athletes during training and competition. Despite its catastrophic consequences, current screening protocols rely heavily on infrequent resting ECGs and questionnaires, which often fail to detect underlying arrhythmic or structural cardiac conditions. There is a critical unmet need for continuous, real-time cardiac monitoring in athletic populations to enable early identification of lethal arrhythmias.*

*We present the Athlete Life Vest: a next-generation wearable ECG platform embedded within a sports vest. This device integrates textile based ECG electrodes, multiple health sensors, and inertial measurement units, connected to a weatherproof receiver module. This module captures high-fidelity ECG signals and physiological data including the vital signs and performance coaching data, with real-time wireless transmission to a pitch-side medic.*

*Our prototype is engineered for 12-hour continuous use, offering clinicians and coaches a live feed of cardiac rhythms and physiological performance. By leveraging embedded AI algorithms, the vest aims to detect early signs of arrhythmia and cardiac fatigue, potentially identifying at-risk individuals before collapse occurs on the pitch.*

*This innovation proposes a paradigm shift from reactive to proactive cardiac care in sport. The ALV is currently undergoing functional validation and athlete usability testing. Our vision is to make real-time, clinical-grade cardiac screening accessible on the field, empowering safer training environments and preventing avoidable deaths in sport.*

**TALK TITLE** *Innovating Athlete Support: Evaluating Wearable Technology for Load Quantification in Artistic Gymnastics*

**SPEAKER** *Dr Lisa Gannon - Leeds Trinity University*

**AUTHORS** *Dr Lisa Gannon, Dr Danielle Davis, Archie McKenzie - Masters student*

**ABSTRACT** *Background: Competitive artistic gymnastics demands intense physical conditioning and precise skill, achieved through extensive training (Mkaouer et al., 2018). While linked to enhanced peak bone mass in young males (Gannon & Hind, 2024), the risks of pathological overload remain underexplored. Given the training volume and limited coach education on load management (Whyte, 2022), this study examined wearable technology's role in monitoring gymnastics training loads.*

*Methodology: Eighteen elite male gymnasts (age 21 ± 3) participated, each wearing a Catapult Optimeye S7 device during training over two weeks. Data were collected via Openfield cloud, supplemented by training logs, video recordings, and qualitative feedback.*

*Results: A total of 128 training sessions were recorded (average duration 172.52 ± 73.85 minutes). The devices captured detailed metrics including Total Player Load (mean 362 ± 191), individual Player Load per session, per minute, and per apparatus. e.g. The highest session load occurred on Floor (95.49 ± 45.47). Work-to-rest ratios and impact were also measured across sessions and apparatus providing a baseline level of data for discussion. Some gymnasts reported minor discomfort wearing the devices, particularly on pommel horse.*

*Conclusions: Wearable technology proved effective in generating foundational data on training loads in elite gymnastics. This evidence base can inform coach-athlete discussions around performance and wellbeing. Future studies should explore longer-term monitoring, improved device comfort, and gymnastics-specific wear to support broader adoption.*

# ABSTRACTS



**TALK TITLE** *Comparing Sensory Feedback Designs for Motor Learning in Postural Control Tasks*

**SPEAKER** *Yixing Lei - The Podium Institute*

**ABSTRACT** *Background: Augmented feedback and assistive devices, such as virtual guidance and robotic manipulators, are commonly used in VR-based sports training to improve efficiency and safety. However, motor learning theories, including internal model formation and optimal Bayesian inference, suggest that sensorimotor coordination develops based on the sensory inputs available during training. If these inputs differ from those encountered in real-world performance, it may hinder the transfer of learning.*

*Methods: This study investigates how different designs of sensory information will affect this learning process and retention using a fine posture control motor skill. Participants are trained on a fingertip distance control task using five types of feedback. Visual feedback displays the desired distance in the virtual environment. Three types of haptic feedback—vibration, error-augmented proprioception, and mirrored proprioception—are delivered via a pneumatic glove. Numerical feedback is also provided.*

*Results: Preliminary results show that visual feedback and error-augmented haptic feedback both improve fingertip distance control. Although error-augmented feedback results in lower training accuracy, it leads to better retention when feedback is removed. We recruited ten healthy participants for this full comparison of the different feedback modalities.*

*Conclusion: This study investigates how different types of sensory feedback influence the training of postural control skills in VR and their transfer to real-world performance. The proposed framework could also be applied to other closed motor skills that require precise body alignment, such as shooting posture control and movement sequence learning in cricket bowling.*

# ABSTRACTS

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**TALK TITLE** *Smart Wearable Inflatable Airbag Systems for Real-Time Fall Mitigation in High-Risk Sports*

**SPEAKER** *Dr Ryman Hashem - The Podium Institute*

**ABSTRACT** *Injuries from falls remain a leading cause of trauma in high-risk sports such as equestrian riding, cycling, and skiing. Existing wearable airbag systems often rely on mechanical triggers and offer limited adaptability to the complexity of fall dynamics and human posture during impact. This research presents a new generation of wearable inflatable airbag protection systems that integrate inertial sensor data with AI driven fall detection and postural correction mechanisms.*

*The project investigates how sensor-based systems can not only detect fall events but also assess the orientation and trajectory of the body in real time, enabling targeted inflation patterns to stabilise the user and maximise protective coverage. The airbags are fabricated using TPU coated textile structures shaped for specific body zones, including spine, neck, and thorax. Finite element simulations and physical prototypes are used to evaluate interactions between the airbag and helmet systems, particularly during rotational impacts.*

*Ongoing work includes laboratory validation using a custom built pneumatic test rig replicating real-world fall scenarios, as well as collaboration with regulatory bodies to inform future standards. This research aims to establish the foundation for intelligent, posture-aware protective equipment capable of reducing sports injury severity across multiple disciplines.*

**TALK TITLE** *3D In Vitro Microvascular Model for Traumatic Injury Research*

**SPEAKER** *Carla Verónica Fuenteslópez - University of Oxford*

**AUTHORS** *Carla Verónica Fuenteslópez, Prof Mark S Thompson & Prof Hua Ye*

**ABSTRACT** *Microvascular injury critically influences the progression and severity of traumatic injuries, yet existing in vitro models often fail to replicate microvascular architecture and function accurately in 3D. This research presents the optimisation of a 3D hydrogel-based in vitro model that supports the formation and long-term stability of microvascular endothelial networks for trauma research.*

*Human dermal microvascular endothelial cells (MVECs) were embedded in fibrin-based hydrogels, and their performance was benchmarked against the widely used human umbilical vein endothelial cells (HUVECs). Systematic variations in hydrogel composition (fibrinogen source and concentration, crosslinking ratio, and medium) were examined to assess their effects on scaffold material properties and endothelial network formation, architecture, and longevity.*

*Network analysis showed that hydrogels formulated with high concentrations of human fibrinogen, a 200:10:1 fibrinogen:thrombin:CaCl2 crosslinking ratio, and either endothelial basal medium (EBM) or EBM supplemented with VEGF supported the most robust and durable microvascular networks, maintaining structural integrity for up to 14 days. In contrast, HUVEC-based models underwent rapid network degradation within 24 hours.Microrheometry revealed that increasing fibrinogen concentration significantly accelerated gelation kinetics, increased storage and loss moduli, and reduced creep compliance, thereby improving the constructs' mechanical stability.*

*To investigate trauma mechanisms, controlled non-penetrating injuries (contusion, compression, and strain) were applied to optimised 3D microvascular constructs. This approach enabled the characterisation of immediate and short-term microvascular responses, establishing crucial links between trauma parameters and the resulting injury.*

*The optimised model offers a physiologically relevant platform for studying traumatic injury and evaluating therapeutic strategies to improve vascular repair and recovery.*

**TALK TITLE** *Unveiling Hidden Rhythms: Continuous Cyclical Modeling of Mobile App Heart Rate Data Across the Menstrual Cycle*

**SPEAKER** *Kyra Delray - University of Oxford*

**AUTHORS** *Kyra Delray, Glyn Lewis - University College London, Division of Psychiatry and Clinical Epidemiology*

**ABSTRACT** *Background: Resting Heart Rate (RHR) and Heart Rate Variability (HRV) are well established markers of health and the body's readiness for physical activity. These have been assumed to be constant in a woman as they are for men. Analysis of variables of the menstrual cycle has previously been poorly interpretable and over simplified.*

*Methods: To investigate RHR and HRV over the menstrual cycle, we analysed data from the mobile period tracking app, "Flo" and heart rate data from consumer wearable devices such as an Apple Watch, using a general additive model and piecewise linear regression models.*

*Results: We found that RHR and HRV fluctuate in relation to the day of the menstrual cycle with a range of 2.8% and 8% respectively ($p<0.001$). We show that general additive models and piecewise linear regression are appropriate methods for analyse of menstrual cycle data.*

*Conclusion: Heart rate data should not be assumed constant for women in future research, menstrual cycle data should be collected when observing biomarker variables in women. A female's optimal time for performance is days 1 to 5 of the cycle. Adjustments can be made using the findings of this study or should be analysed using general additive modelling as a gold standard or linear regression, multilevel models.*

**TALK TITLE** *Deep Learning Optimisation for Sports Cardiology: Neural Architecture Search-Driven Arrhythmia Classification*

**SPEAKER** *Erik Vanegas Müller - The Podium Institute*

**ABSTRACT** *Background and Aims: Cardiac arrhythmias on the athletic field are mainly due to undetected cardiac morphological or electrophysiological defects. Discerning between sports-related cardiac adaptations and cardiac pathologies with the potential for life-threatening arrhythmias presents a fundamental clinical problem. We aim to leverage neural architecture search (NAS), an automated machine learning technique, to optimise deep learning architectures for classifying sports-related cardiac arrhythmias.*

*Methods: We propose a NAS-driven arrhythmia classification of a self-attention neural network. A NAS consists of a search space, a search strategy, and a performance estimation metric. The search space consisted of AutoFormer, a chain-structured search space which combines convolutional operations and self-attention blocks. The Differentiable ArchiTecture Search (DARTS) strategy was then applied on the chain structured AutoFormer search space, while the performance was evaluated with the estimation strategy encoded within DARTS. We used the PhysioNet Challenge 21 dataset (n = 88,253) for training and the PF12RED dataset (n = 163) for evaluation. We compared the model performances with and without the neural architecture search optimisation using the area under the receiver operating characteristic curve (AUROC).*

*Results: The NAS-optimised model demonstrated superior performance compared to the baseline self-attention neural network without architecture optimisation. The NAS showed a preference for converging towards smaller architectures. For overall arrhythmia classification, our NAS approach achieved an AUROC value of 0.90, representing a 13%improvement over the non-optimised baseline (0.80).*

*Conclusion: Our findings demonstrate that NAS can effectively optimise neural network architectures for sports cardiology applications, enhancing differentiation between physiological adaptation and pathology. The convergence towards smaller architectures suggests that transformer models can effectively encode the most relevant diagnostic information from reduced representations of electrocardiogram signals, indicating that substantial portions of the raw waveform may contain redundant information not critical for accurate classification of cardiac abnormalities.*

**TALK TITLE** *The Validity of Intraoral Photoplethysmography for Heart Rate Measurement During High Intensity Intermittent Exercise*

**SPEAKER** *Dr Georgios Zoumpourlis - Orb Innovations Ltd.*

**AUTHORS** *Dr Georgios Zoumpourlis, Jessica Stamford, St Mary's University London*

**ABSTRACT** *Background: Previous efforts to measure heart rate using intraoral photoplethysmography (PPG) within a mouthguard have not demonstrated validity during high intensity intermittent exercise (HIIE). Our objective was to assess the validity of an intraoral PPG sensor (ORB Sport) and the effects of heart rate algorithm optimisation during HIIE.*

*Methods: 27 volunteers performed 5 minutes rest, followed by progressive treadmill running to volitional fatigue followed by 5 minutes rest and 5 periods of running (1 minute, 90% of maximum speed) separated by 2 minutes recovery. Raw PPG was recorded from the ORB Sport, while reference heart rate was measured with a Polar H10 monitor. We conducted an offline analysis of the recorded data to optimise the hyperparameters of the heart rate algorithm integrated within the ORB Sport.*

*Results: The ORB Sport demonstrated a Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) of 10.5 bpm and 6.0% compared to the Polar H10. The optimised hyperparameters reduced RMSE by 9 bpm and MAPE by 4.4%. Intraclass correlation coefficient (ICC) increased by 0.18 (ICC = 0.62 to 0.80). Improvements were achieved in higher heart rate zones (MAPE 16.34% to 5.5% for 150 to 220 bpm) and the proportion of time steps where the algorithm could not infer a valid value decreased from 7% to 3%.*

*Discussion: HIIE provided a realistic basis for benchmarking and optimisation. In conclusion, we found intraoral PPG to provide valid measurements of heart rate and overall achieved agreement comparable with studies of wrist worn PPG devices.*

# ABSTRACTS



**TALK TITLE** *A High-Fidelity Finite Element Framework for Head-Helmet Impact Simulation and Brain Injury Evaluation*

**SPEAKER** *Dr Chenying Liu - The Podium Institute*

**AUTHORS** *Dr Chenying Liu, Zhong You, Huifeng Xi, Yanxuan Chen, Jianjun Zhang, Constantin Coussios, Liang He*

**ABSTRACT** *Background: Helmets are critical for reducing traumatic brain injuries (TBIs) in many sports. However, their effectiveness remains questionable, as current certification standards rely on tests that overlook key factors like rotational accelerations, neck dynamics, and individual variability. Additionally, real-world impacts are shaped by complex environmental (e.g., angle, velocity) and individual (e.g., age, neck strength) variables. Experimental studies to systematically evaluate these factors are time-consuming and expensive, especially given the variety of helmet designs.*

*Methods: To address this challenge, we have developed a finite element model in Abaqus to simulate realistic head-helmet impacts. The model includes simplified but representative head and helmet geometries and allows variation in parameters such as impact angle, velocity, head size, and neck stiffness. Both linear and rotational accelerations are recorded, and helmets with controlled rotational movement are simulated. Validation was performed using published experimental impact data.*

*Results: Simulations across over 100 scenarios revealed that excluding neck dynamics can underestimate peak rotational acceleration by up to 40%. Helmets with rotational slip systems reduced predicted brain strain by up to 30% compared to standard designs. Anthropometric variations, particularly in head size and neck strength, significantly influenced injury metrics, demonstrating the need for more inclusive testing approaches.*

*Conclusion: This modelling framework enables efficient, realistic evaluation of helmet performance and injury risk. By accounting for rotational dynamics and individual variability, it offers valuable insights that can inform future helmet design. The results also contribute to the evolution of certification standards that are aimed at reducing TBIs across diverse populations.*

**TALK TITLE** *Invisible Monitoring: How Computer Vision and physics-informed Machine Learning is Redefining Athlete Monitoring and Performance Optimisation*

**SPEAKER** *Dr Dario Cazzola - University of Bath* **KEYNOTE**

**ABSTRACT** *Recent technological advancements are transforming athlete monitoring and management, with a focus on biomechanics and injury risk profiling. This talk will examine what has changed in the technological landscape—from traditional lab-based testing and wearables to the rise of unobtrusive, video-based systems powered by physics-informed AI. He will demonstrate how it is now possible to measure lab-grade metrics and training responses, on the pitch, from standard video footage.*

*Dr. Cazzola will outline where the field is heading, highlighting the growing role of invisible monitoring—the collection of meaningful data without disrupting athletes' routines. Thanks to advancement in computer vision and machine learning, we are now able to generate automatic KPI, simulate training effects, and personalise intervention design in virtual environment.*

*He will also challenge common misconceptions around new technologies, including validity gaps, and data integration challenges. Throughout the talk, he will discuss how these technologies could be used in practice to inform decision making in RTP and performance enhancement.*

# ABSTRACTS

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**TALK TITLE** *Toward Robust 3D Human Pose Estimation in Uncalibrated Multi-View Sports Footage*

**SPEAKER** *Lorenza Prospero - The Podium Institute*

**AUTHORS** *Lorenza Prospero, Joao Henriques, Christian Rupprecht*

**ABSTRACT** *Accurate 3D human pose estimation from video is a critical enabling step for downstream applications such as injury detection, player performance analysis, and biomechanical understanding in sports. However, reconstructing 3D poses in dynamic, occlusion-heavy environments like rugby matches remains a significant challenge in computer vision. Current state-of-the-art 3D pose and shape estimators often fail in these settings due to rapid player motion, frequent inter-person occlusions, and the absence of a calibrated multi-view setup. In this project, we explore an alternative pipeline designed to operate on uncalibrated, multi-view rugby videos.*

*Rather than relying on direct 3D prediction, we begin by applying 2D pose estimation and person segmentation to each view and frame independently. Using these 2D keypoints, we employ multi-view geometry techniques and cross-frame optimization to triangulate and refine a set of pseudo ground-truth 3D poses. These pseudo-labels serve as a foundation for training a model capable of predicting 3D human pose in a single pass from one or multiple 2D images.*

*While still under development, this approach aims to overcome the limitations of existing methods in highly dynamic scenes with minimal manual supervision or calibration. By leveraging weak 3D supervision from our pseudo ground truth, we aim to train models that are robust to occlusion and viewpoint variation, enabling practical deployment in sports analytics and other real-world domains. This pipeline represents a promising direction for scalable 3D pose estimation and sets the stage for advanced downstream tasks in sports science and athlete monitoring.*

# ABSTRACTS

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**TALK TITLE** *Multimaterial 3D Printing of Garment-Integrated Strain-Sensor Arrays for Knee-Motion Monitoring*

**SPEAKER** *Lukas Cha - The Podium Institute*

**AUTHORS** *Lukas Cha, Prof Liang He*

**ABSTRACT** *Background: Anterior cruciate ligament (ACL)-injury prevention programmes rely mainly on muscle-strengthening exercises and periodic form checks. Whether an athlete continues to load the knee in high-risk valgus or rotational patterns during play is judged subjectively by coaches, as no field-compatible system provides objective, real-time kinematic feedback.*

*Methods: A dual-print-head direct-write process was designed to deposit silicone-elastomer and conductive piezoresistive ink onto a pre-tensioned nylon–spandex knee sleeve. Layer-by-layer deposition created stretchable, multilayer sensor arrays in a single build. Silicone elastomer serves as the base matrix material, while the conductive trace pattern produces capacitive strain gauges aligned circumferentially and longitudinally. Electrical routing and contact pads were printed in situ, eliminating sew-on leads and preserving garment breathability.*

*Results: The integrated strain sensors showed high linearity ($R^2$ = 0.99), gauge factor 0.95, and low hysteresis 1.36 %, enabling accurate tracking of knee adduction–abduction and internal–external rotation in addition to flexion–extension.*

*Conclusion: One-step co-printing of elastomeric matrix and conductive networks yields a soft, unobtrusive sleeve that captures multiaxial knee motion during field activity. Using such a knee sleeve sensor, future work aims to develop a framework that can provide objective, on-field detection of valgus and rotational loads implicated in ACL injury, and thus augment coach observations and inform real-time form correction.*

**TALK TITLE** *Quantifying Fatigue State from GPS Data using Self-supervised Learning*

**SPEAKER** *Melis Atbinek - The Podium Institute*

**ABSTRACT**

*Background*
*In elite football, most teams compete in two or more competitions at the same time. This busy schedule results in cumulative load throughout a season. The overloading and insufficient recovery over this period may lead to injuries. Monitoring training load becomes essential to minimise overuse injuries, which can cause significant financial and performance losses for the clubs. This project aims to track both external and internal load to detect abnormal patterns and predict excessive load and ultimately predict injuries.*
*Method*

*We acquired data from a men's football team competing in English Football League. Physical and tracking data were collected through multi-camera system from matches. Throughout the season, this was complemented by GPS tracking, balance assessments, and isometric force testing to monitor player load and physical condition over time. A sequence-to-sequence LSTM encoder model was developed to learn temporal dependencies within individual player profiles. The encoder compresses multi-modal load sequences into latent representations, which are then used to reconstruct expected patterns and flag deviations as potential anomalies. The association between flagged anomalies and subsequent non-contact injuries is being evaluated. Subsequently, the model is tested on the different seasons.*

*Conclusion*
*We suggest that multi-modal tracking and physical data can help us monitor athletes closer to detect signs of overloading. Athletes under risk of injury can be detected. This process involves close collaboration with the club's technical and medical staff to ensure data-driven insights translate into informed decisions around training, recovery, and injury prevention. Future work will integrate biological data to enhance individualised risk injury risk. Importantly, the outcomes of this project have the potential to be applied beyond elite men's football, supporting injury prevention strategies in youth and the women's football.*

# ABSTRACTS

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**TALK TITLE** *Ankle Sprain Injury in Sport, A Biomechanical Investigation of Landing After a Jump*

**SPEAKER** *Dr Qotaiba Jamal - University Hospitals Bristol and Weston*

**ABSTRACT** *Background: LAS are common injuries in volleyball, particularly in block jumps. Sprains pose a risk for chronic ankle instability (Gribble et al., 2016). Suspected methods of ankle injury are ankle inversion and possibly plantar flexion (Kobayashi and Gamada, 2014). There has been debate on the effectiveness of KT on the prophylaxis of ankle sprains. The contribution of fatigue is also considerable for investigation. The aim of the study is to investigate the muscle activity, GRF, and joint angles of the ankle during a volleyball block jump and whether fatigue and KT effect the result.*

*Methods: Four participants aged 16-46 with volleyball experience were recruited for the study. Four conditions were tested: No KT and no fatigue (NN), KT and no fatigue (YN), no KT with fatigue (NY), and KT with fatigue (YY). Joint angle data were recorded using a motion capture system and markers placed on the dominant leg. Sensor EMG electrodes recorded TA and PL muscle activity. Participants performed three jumps of each condition on force plates.*

*Results: There was no statistical significance in the difference in maximal vertical power across the four conditions. There was a statistically significant difference in peak plantar flexion and plantar flexion on landing, with condition NN having the highest degree of plantar flexion. Condition YY had the least. There was no statistically significant difference in peak inversion and inversion on landing. Fatigue demonstrated a reduced PL pre-landing activation time compared to no fatigue. There was no significant difference in maximal PL muscle activation.*

*Conclusion: The study was limited by the small sample size, affecting the significance of the data. Larger inversion angle may risk ankle sprains. KT has not shown any significant improvement in ankle sprain prophylaxis. Fatigue may affect PL function and is a possible contributor to ankle sprains worthy of further investigation.*

# ABSTRACTS

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**TALK TITLE** *The Effect of Wrist Wraps and Wrist Straps on Wrist Injury and Performance Enhancement in the Conventional Barbell Bench Press Using 3D Motion Analysis and Surface Electromyography*

**SPEAKER** *Dr Mohammad Rahman - University of Dundee*

**AUTHORS** *Dr Mohammad Rahman, Dr Tim Drew, Dr Graham Arnold, Mr Sadiq Nasir, Dr Weije Wang, Mr Ian Christie*

**ABSTRACT** *Background: Wrist wraps (WWs) are used by lifters to limit wrist range of motion (ROM) in the sagittal plane, while wrist straps (WSs) enhance grip strength to improve lifting performance.*

*Aim: This study compared the effects of WWs and WSs on wrist angles in the sagittal plane to determine wrist ROM, and on surface electromyography (sEMG) to assess activity of the pectoralis major (PM), anterior deltoid (AD), and triceps brachii (TB) during the bench press.*

*Materials and Methods: Thirteen male participants performed the bench press under barehand, WW, and WS conditions at 90% of one-repetition maximum (1RM). Wrist ROM was assessed via 3D motion analysis, and peak EMG data were recorded using sEMG. Wrist angle data were analysed using pairwise comparisons; EMG data were analysed using one-sample t-tests and Wilcoxon signed-rank tests.*

*Results: Both WWs and WSs significantly reduced wrist ROM during both the descent and ascent phases compared to barehand ($P<0.05$), with WWs being more effective. WSs significantly reduced activity of the right PM and increased activation of the right TB ($P<0.05$). No significant differences ($P>0.05$) were found for the left PM, left/right AD, or left TB.*

*Conclusion: WWs may help prevent wrist injury by reducing ROM, offering potential benefits for lifters handling heavy loads. However, the effects of WSs on muscle activity remain inconclusive, as peak EMG is not a reliable comparison method across tasks and participants. Future studies should use maximal voluntary isometric contraction (MVIC) to normalize EMG data.*

# ABSTRACTS

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**TALK TITLE** *Robotic Lower Limb Exoskeleton Motion Intent Prediction for Autonomous Reconfiguration Control Using Time Series Machine Learning Methodologies Generated from Motion Capture Data*

**SPEAKER** *Dr Raphael Olaiya - University College London*

**ABSTRACT** *Despite their potential to transform neuromuscular and spinal cord injury rehabilitation and address the physiotherapy workforce shortage, robotic exoskeletons (REs) remain a novelty in sports and rehabilitation medicine. While several RE models have entered the healthcare market in the past decade, the transformative potential of artificial intelligence in REs remains largely confined to research settings. Two key areas of emerging RE research are motion intent prediction (MIP) and device reconfigurability—robotics subfields that could significantly enhance RE ergonomics and adaptability for patients with neuromuscular disorders.*

*This study developed a novel MIP system using time-series machine learning, based on lower-limb kinematic data captured with passive optoelectronic motion capture system(Vicon). Predictive models—including Support Vector Machines, LSTM Recurrent Neural Networks, and Random Forests—were trained to rapidly infer user intent, enabling the RE to autonomously adjust its mechanical configuration in real time.*

*The study focused on improving prediction accuracy and responsiveness. Data were collected from two healthy participants performing four dynamic and static lower-limb exercises in a controlled lab setting. Results showed a trained Random Forest algorithm achieved 99% accuracy in identifying motion intent within 3.75 seconds.*

*This proof-of-concept highlights the promise of MIP for enhancing neuromuscular-injury rehabilitation exoskeletons and broader assistive robotics. However, further research is needed to improve prediction speed and validate the approach in real-world settings.*

# ABSTRACTS

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**TALK TITLE** *3D Electrode Bioelectronic Device for Haptic Sensing*

**SPEAKER** *Yixuan Leng - University of Oxford*

**ABSTRACT** *Cutaneous electric stimulation is widely employed in muscle rehabilitation. However, prolonged use often results in muscle fatigue due to imprecise stimulation. To address this limitation, we have developed 3D electrode wearable devices for electro-tactile stimulation. By integrating 3D electrodes into thin-film wearable devices, electrode-skin contact is enhanced. This enables precise muscle targeting and reduces unnecessary muscle activation, minimizing the risk of muscle fatigue.*

*Systematic evaluation of electrode geometry and material are presented. We show that optimized 3D geometries result in a significant reduction in the sensory threshold current (approximately 30% lower compared to traditional 2D electrodes), and significant improvements in tactile spatial resolution. Adhesion testing is presented as a screening tool for different electrode materials systems, identifying a Parylene C–Ti/Pt stack as a promising structure, showing robust adhesion and minimal delamination under dynamic movement conditions, imperative for sports applications.*

*These advancements highlight the potential of 3D electrodes in sports injury therapies, particularly benefiting precise muscle activation and post-injury sensory recovery.*

**TALK TITLE** *Characterising Body Motion in Walker Boots for Achilles Tendon Rupture Rehabilitation*

**SPEAKER** *Phoebe Cheung - University of Oxford*

**AUTHORS** *Phoebe Cheung, Julie Stebbins, David Keene, Amy Zavatsky*

**ABSTRACT** *The Achilles tendon is the body's largest and strongest tendon, allowing for transfer of calf muscle forces across the ankle to the foot. Upon tearing the Achilles tendon, a patient typically wears an immobilisation boot for several weeks, with ankle motion increased in stages to progressively load the healing tendon. To compensate for leg length asymmetry caused by the boot, a shoe balancer is occasionally worn on the uninjured side. Although studies have tried estimating tendon loads during rehabilitation, there is little research on how boots and shoe balancers affect body motion and foot loading within the boot.*

*This study's aim is to characterize how different rehabilitation boots and shoe balancers affect body motion and foot loading. Healthy adult participants will complete a series of standing movements and walking trials in three different boots, with and without a shoe balancer. They will perform the same tasks barefoot and in trainers for comparison. Marker-based motion capture (Valkyrie; Vicon, Oxford, UK) and IMUs (Blue Trident; Vicon, Oxford, UK) are used to capture body segment positions and lower leg and foot accelerations within the boot. Foot loading is characterised using plantar pressure sensor insoles (F-Scan64; TekScan, Boston, USA) and a floor-mounted pressure mat (emed-xl; novel, Munich, Germany).*

*Preliminary results show viability of the data collection protocol and confirm the expected asymmetric body movements caused by wearing the boot. Results of the full study will help physiotherapists and orthopaedic surgeons to make informed recommendations to patients about boot types, shoe balancers, and rehabilitation activities.*

# ABSTRACTS

## MUSCULOSKELETAL

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**TALK TITLE** *Practical Application & Screening for Posterior Lower Limb Injury in Elite Athletes*

**SPEAKER** *Rhys Hughes - Head of Medical Services at Gloucester Rugby* **KEYNOTE**

**ABSTRACT** *Objectives Lower limb posterior chain injury (PCI) is common among athletic populations, with multifactorial risk factors including age, previous injury, strength measurements, range of motion and training load. Biomechanics are commonly considered in the prevention and rehabilitation of PCI by performance staff.*

*However, there is no documented testing method to assess for associations between biomechanics and PCI. The aim of this study was to investigate whether there is an association between an easily applicable, novel biomechanical assessment tool and PCI.*

**TALK TITLE** *Experimental Characterisation of Wrist Biomechanics During Upper Limb Loading in Gymnastics*

**SPEAKER** *Lucy Buchanan - The Podium Institute*

**AUTHORS** *Lucy Buchanan, Professor Liang He, Professor Amy Zavatsky*

**ABSTRACT** *Background: Gymnastics places large physical demands on the body, and unlike in most sports, the wrist functions as a weight-bearing joint. Repetitive upper limb loading predisposes gymnasts to high risks of wrist injury. Gymnast's wrist is a stress injury to the distal radial physis common in adolescents who sustain high training volumes during periods of musculoskeletal immaturity, when the epiphyseal growth plates remain open and vulnerable to load-induced injury. The injury mechanism involves repetitive wrist loading in an extended position. Understanding wrist biomechanics during loading conditions is essential for developing monitoring techniques and injury prevention strategies. This study characterises wrist motion and loading during basic gymnastics activities.*

*Methods: Each participant performed three trials of handstand, cartwheel, handstand-walk, handstand-hop. Their motion was recorded by a sixteen-camera Vicon motion capture setup (Valkyrie 16), force plates (AMTI), and IMUs (Vicon Blue Trident). Marker trajectories, ground reaction forces and hand and forearm accelerations were collected for 10 adult volunteers (5M, 5F; height 1.72 m (SD 0.095); mass 65.3 kg (SD 9.2)). A one degree-of-freedom model was implemented to investigate wrist extension under load.*

*Results: Early results show the mean range of wrist extension utilised was 84.3° (SD 6.1°). Forces experienced were largest in the handstand-hop movement, with peak vertical ground reaction forces reaching up to three times bodyweight.*

*Conclusion: Results are consistent with the knowledge that gymnasts sustain forces multiple times their bodyweight at the wrist joint during upper limb weight-bearing activities. Future analysis will investigate the effect of different techniques on wrist moment.*

**TALK TITLE** *Modelling Cam-Type Femoroacetabular Impingement During the Rowing Stroke: Linking Joint Kinematics to Impingement Risk*

**SPEAKER** *Harry Manship - The Podium Institute*

**AUTHORS** *Harry Manship, Dr Stephen Mellon, Professor Amy Zavatsky, Professor Sion Glyn-Jones, Dr Alison Jones,*

**ABSTRACT**

*Cam-type femoroacetabular impingement (FAI) occurs when an abnormal bony prominence that forms during adolescence around the femoral head-neck junction makes premature contact with the acetabulum during motion. Repeated abutment of these structures leads to performance-limiting symptoms, such as, cartilage damage, labral tears, and can lead to osteoarthritis. FAI is common in young people who participate in high-level sport from an early age. Therefore, early detection methods are critical to improve outcomes for adolescent athletes.*

*This research focusses on validating an open-source computational model which aims to identify impingement using CT images and a motion capture system, and improving the model's functionality to assess impingement within a cohort of elite-level rowers.*

*A dataset containing motion capture data for five expert rowers was used to run the model. CT images of patients with cam morphology were used to build the hip anatomy to simulate individual impingement cases. Using the model, impingement incidence and severity could be identified for all motion cases and compared to impingement metrics from a previous 4D CT study to provide initial validation. Individual joint kinematics were isolated to understand their effect on impingement.*

*Preliminary results suggest that impingement is likely to occur at flexion angles over 56.8 ± 9.8° (mean ± SD, n = 5) during the drive phase of the rowing stroke and over 51.4 ± 10.7° during the recovery phase. Further validation of this model will assist in the formation of a robust understanding of how individual anatomy, biomechanics and sport contribute to FAI in athletes.*

**TALK TITLE** *Rehabilitation and Return-to-Sport After ACL Injury in a Female Athlete: A Case Reflection and Review of Sex-Specific Challenges*

**SPEAKER** *Afreen Azad - Aston Medical School*

**ABSTRACT** *This case report and literature review describes a 27-year-old female who sustained an Anterior cruciate ligament (ACL) injury following a sporting event. She described the injury as one of the most painful experiences of her life and faced significant physical and psychological challenges associated with it.*

*ACL injury is a common debilitating condition that affects the knee by compromising its stability. Female athletes are disproportionately affected due to inherent anatomical and hormonal differences, namely oestrogen. Due to lower bone mineral density, increased ligament laxity, and smaller bone size compared to males, they become more susceptible to such injuries.*

*The subject of my study, Mrs. S.B., was a former high school athlete. She sustained her injury following a traumatic fall, resulting in immense pain and emotional distress. S.B reported feelings of low self-worth, which was worsened by recent changes in her personal life. Support from her family, especially her in-laws, was an important factor in her rehabilitation journey. The injury markedly affected her daily living, including reliance on a wheelchair, and raised concerns about fulfilling her daily roles as a newlywed.*

*The multidisciplinary team (MDT) focused primarily on restoring functional capacity through physiotherapy alongside pharmacological management for pain control. Although her injury forced cessation of competitive sports, she was given counselling and therapy alongside advice on pursuing alternatives. The injury had affected her psychologically, including depressive episodes, highlighting the need for holistic care for such individuals.*

**TALK TITLE** *The Validity of a Smart Mouthguard to Estimate Steps & Distance during Walking & Running*

**SPEAKER** *Jessica Stamford - ORB Innovations Ltd.*

**AUTHORS** *Jessica Stamford, Thomas Watkinson, Daniel Silva, Karl Cooke, Stuart McErlain Naylor, Loughborough University*

**ABSTRACT** *Background: This study aimed to determine the performance of a smart mouthguard compared to the criterion measurement of selected gait parameters on a force plate instrumented treadmill.*

*Methods: 8 participants performed walking and running stages (30 seconds) from 1 to 6 m/s (no gradient), plus incline and decline running (3 m/s, + 2°; - 2°) on an instrumented treadmill (Treadmetrix LLC, Utah, US) while wearing a smart mouthguard (ORB Innovations Ltd, UK). Force plate signals (Fx, Fy, Fz; 1000Hz) were used to determine step count, step frequency, and the distance travelled for each stage and compared to the smart mouthguard.*

*Results: For all stages the smart mouthguard mean absolute error (MAE) and mean absolute percentage error (MAPE) for step count was 5.0 ± 5.3 steps and 7.0 ± 9.8 %. Mouthguard step count MAE was lower for running and incline stages (3.4 ± 2.1 steps) but greater for walking and decline (14.0 ± 8.0 steps). Mouthguard step frequency (steps/min) also demonstrated low errors for running and incline stages (MAE = 7.8 ± 5.4 steps/min and MAPE = 4.6 ± 2.2%). Distance (meters) from the smart mouthguard showed the lowest errors occurring between 1.5 and 4.5 m/s (MAE = 13.6 ± 6.5 (m) and MAPE = 14.4 ± 3.8%).*

*Discussion: The smart mouthguard was found to be valid with low errors for step count, frequency and distance during the running and incline stages, but not so during walking and decline stages.*

**TALK TITLE** *Sub-Zero Multi-Material Additive Manufacturing of Biomimetic Scaffolds for ACL Injury Repair*

**SPEAKER** *Samantha Baker-Jones - University of Oxford*

**AUTHORS** *Samantha Baker-Jones, Professor Malavika Nair, Professor Patrick Grant*

**ABSTRACT** *ACL injuries are one of the most prevalent soft tissue injuries seen in athletes across a range of sports. The current solution for high-grade tears is reconstructive surgery, which requires substantial recovery time (> 9 months) and poses a high risk of re-injury with poor rates of return to pre-injury levels of performance. Therefore, alternative, less-invasive strategies are being explored through tissue engineering to address the ligaments' limited and slow self-healing ability. There is a demand for novel manufacturing methods that offer a route to create hybrid structures that mimic soft-to-rigid musculoskeletal interfaces, to meet the structural and biomechanical demands needed for effective stress transfer. Multi-material additive manufacturing (MMAM) techniques allow control over local spatial variations of material composition in a single construct, addressing the key challenge of fabricating with both polymeric and ceramic biomaterials at once.*

*In this study, a MMAM system was combined with a sub-zero deposition surface to create a manufacturing platform for low-viscosity biomaterials. Highly porous collagen and hydroxyapatite-based constructs, representing the ligament-bone interface, have been produced through controlled ice-crystal growth. Using X-ray Computed Tomography (XCT), architectures were assessed for their pore size and interconnectivity, exploring the effects of processing parameters on internal structural attributes, and understanding their impact on cell migration and infiltration. Crucially, the individual constructs possessed an interface-free gradation in structural and mechanical properties. These results offer cryo-MMAM as a method with significant potential to improve the biointegration and biomimicry of manufactured scaffold structures and therefore improve musculoskeletal injury recovery.*

# ABSTRACTS

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**TALK TITLE** *Sports Injury Epidemiology on Youth Athletes at the 2025 Nike EB Summer Classic, Nigeria*

**SPEAKER** *Dr Bisola Lawal - Kasi Healthcare*

**AUTHORS** *Dr Bisola Lawal, Dr Dayo Osholowu, Mr Odesola Victor (Paramedic) KASI Healthcare*

**ABSTRACT** *Youth basketball is a strenuous sport with a high risk of musculoskeletal injuries, especially in underserved regions where sports medicine is poorly utilized. The study aimed to evaluate the incidence, pattern, and distribution of injuries among youth athletes participating in the Nike EB Summer tournament which held on the 28th - 29th of june, 2025.*

*A prospective study was conducted whichinvolved 60 male athletes in the age range of 16 - 24 years from six teams. Data on injury type, anatomical location, and severity were collected onsite using standardized injury surveillance protocols. Descriptive statistics and graphical representations were used to present findings.*

*Thirty-nine injuries were recorded, yielding an injury incidence of 65%. The most common injuries were ankle sprains (n=10, 25.6%), knee sprains (n=8, 20.5%), thigh sprains (n=4), cuts (n=4), and eye injuries (n=3). Overall, 72% of injuries involved the lower limb, 14% affected the head/face and 14% the upper body. The majority of injuries were acute and related to sudden movement, collision, or poor landing mechanics.*

*This study emphasizes a significant incidence of avoidable lower limb injuries among youth basketball players in Nigeria. It highlights the need for a multidisciplinary sports medicine approach, targeted neuromuscular training, and data-directed injury prevention techniques in youth tournaments.The findings also promote the use of mouth guards, ankle braces as well as proper stretching and warm-ups to reduce injury risks in under-resourced athletic populations. This study would be used as a guide for planning future youth basketball tournament in Nigeria.*

**TALK TITLE** *Smart Insole Foot Pressure Analysis for Injury Risk: A Framework for Sport-Specific and Gender-Informed Wearable Diagnostics*

**SPEAKER** *Javier Batista - University of Texas at Austin*

**AUTHORS** *Javier Batista, Dr. Nick Fey*

**ABSTRACT** *In the pursuit of injury prevention and performance optimization in sport, foot pressure analysis offers untapped potential for proactive diagnostics—providing indicators of asymmetry, overload, and instability, all of which are risk factors in fractures and other musculoskeletal injuries. However, high-dimensional data presents a challenge for real-time analysis and interpretation.*

*This work introduces a Principal Component Analysis (PCA) framework to identify the most biomechanically relevant plantar foot regions and their dependence on movement tasks. Using smart insoles pressure data, we analyzed 10 different activities, including daily movements (e.g., walking, stair ascent) and sport-specific actions (e.g., soccer kicking, baseball pitching, golf swinging). While PCA has been applied to study walking, running, or calf raising, to our knowledge it has never been used to analyze a broader variety of functional and sport-specific tasks.*

*After applied, PCA consistently reduced the dataset to 3–4 components explaining over 85% of the variance. In some components the variance was explained by less than 20 sensors (from 341), this finding enables the most informative sensors regions to be isolated. Notably, the dominant pressure regions varied significantly across tasks, emphasizing the need for responsive, task-aware analysis.*

*These outcomes are twofold: first, this method enhances data processing efficiency by filtering noise and focusing on variance-rich regions. Second, it provides a blueprint for developing sport-specific wearable devices (e.g., footwear) targeting injury-prone zones. Next, we will use PCA to identify gender-based differences, offering insight into how women's footwear and protective equipment can be engineered to reflect their distinctive biomechanical demands.*

**TALK TITLE** *Head Acceleration Events in Rugby Union Matches and Training: What Have we Discovered Using Instrumented Mouthguards?*

**AUTHOR** *Professor Keith Stokes - University of Bath* **KEYNOTE**

**ABSTRACT** *Our aim is to apply world-leading research and development to understand and manage risks to player health and safety in rugby union. In recent years the development of instrumented mouthguards has provided opportunities for the measurement of head accelerations experienced by players. When combined with video data, instrumented mouthguard data offers new insights that has the potential to shape policy and practice.*

*Head accelerations occur at a much higher rate in matches compared with training, with the tackle event (both tackling and carrying the ball into the tackle) being most likely to result in head accelerations. However, training is an environment that is more controllable than matches, and approaches to mitigate head accelerations in training, such as reducing the speed of players going into contact or using pads, do reduce the head accelerations experienced by players. It has also become clear that there is substantial inter-individual variation in head acceleration exposures during matches and training, with further exploration required to determine the factors that influence this variation.*

*Integration with other data sets, including video, GPS data, and clinical data will provide further insight in the future.*

**TALK TITLE** *From Impact to Insight: What Instrumented Mouthguard Data Tells Us About Concussions*

**AUTHOR** *Dr Hersh Punjani - NHS-London North west*

**AUTHOR** *Dr Hersh Punjani, Dr Ali Abdelaal MBChB, Dr Bilaal Mirza BDS, Dr Nikhil Patel BDS*

**ABSTRACT** *Background: The rising prevalence of chronic traumatic encephalopathy (CTE) in sports highlights the urgent need for reliable concussion detection methods. This systematic review analyses the types of accuracy and kinematic data captured by instrumented mouthguards to improve understanding of concussion biomechanics and enhance detection.*

*Method: Following PRISMA guidelines, a PubMed search identified 436 articles, with 26 studies (2013–2024) meeting inclusion criteria. Most research focused on American football (46%), rugby (31%), and boxing (23%). The Stanford MiG-C was the most studied device, with 38.5% of studies addressing kinematic data and 34.6% examining accuracy metrics.*

*Findings: Instrumented mouthguards differ in accuracy and detection reliability. The Stanford MiG-C and Prevent Biometrics' PRE-C show low relative error percentages (REPM) between 4.9% and 6.7%, indicating precise impact measurement in football and rugby. Detection accuracy, assessed by positive predictive value (PPV), is high in rugby (98.4% with HitIQ Nexus A9) but lower in MMA (89.1%) due to more complex impact patterns.*

*Kinematic data reveal American football has the highest average peak linear acceleration (PLA) at 26g, followed by rugby at 21.5g. Peak rotational acceleration (PRA) is also highest in football (~1,900rad/s²), slightly above MMA and soccer. Maximum principal strain (MPS), reflecting brain tissue stress, peaks highest in rugby (up to 0.280), with football close behind (0.262).*

*Conclusion: Together, these accuracy and biomechanical data deepen our understanding of the nature and forces involved in head injuries, providing crucial insights that can inform better concussion protocols and athlete safety measures across sports.*

**TALK TITLE** *Exploring Gait as a Candidate Marker for Sports Related Concussion Compared to Reference Standard*

**SPEAKER** *Dr Dylan Powell - University of Stirling*

**ABSTRACT**

*Background: Sports-related concussion (SRC) is a form of mild traumatic brain injury (mTBI) that can cause a range of neurological impairments. These may be subtle or delayed in presentation but can worsen over time without warning. A commonly used tool to support SRC diagnosis and monitoring is the Sports Concussion Assessment Tool (SCAT5). However, the subjective and paper-based nature of the SCAT5 means that clinical judgement, particularly of self-reported symptoms, plays a significant role in rehabilitation and return-to-play (RTP) decisions. Physical impairments, especially in balance and gait, are highly prevalent in mTBI: up to 80% report acute balance issues, and up to 30% experience persistent gait impairment. Despite this, there are currently no validated, holistic protocols that integrate remote, free-living gait and balance assessment into SRC baseline testing in rugby union.*

*Objective: To (1) explore gait and dynamic balance outcomes in university athletes with and without a history of SRC; and (2) test and refine baseline multimodal protocols that may support or augment SCAT5.*

*Methods: Fifty university rugby athletes underwent a multimodal assessment comparing SCAT5 with supervised (3m tandem walk) and remote (7-day wearable) gait analysis. Gait quality was measured via a lumbar-worn inertial sensor (MoveMonitor, McRoberts).*

*Results: No statistically significant differences were found in SCAT5 outcomes ($p > 0.05$). However, significant differences were observed in tandem walk times and free-living step velocity. ROC analysis demonstrated discriminatory potential of digital gait measures.*

*Conclusion: Traditional SRC assessments may overlook subtle motor impairments. This study supports the use of remote gait assessment as a potential candidate marker to enhance objectivity in SRC return to play and monitoring.*

**TALK TITLE** *Modelling Head/Neck system-activated Bracing in Finite Element (FE) Simulation With A Proportional-Integral-Derivative Controller*

**AUTHOR** *Konstantin Dzavaryan - The Podium Institute*

**AUTHOR** *Konstantin Dzavaryan, Antoine Jerusalem, Liang He*

**ABSTRACT** *Anticipation of impact and neuromuscular reflexes, such as bracing, reduce head accelerations associated with traumatic brain injuries (TBI) in sports, either with intentional collisions, e.g., American Football, or accidental, e.g., Football.*

*However, reflexes and active response (anticipation) of the cervical spine are typically overlooked in Finite Element (FE) simulations of head collisions in sports. Therefore, this study implements physiologically inspired feedback-control mechanisms of muscle and nervous system to imitate human ability to resist against head perturbations. The active neck is then integrated with an existing FE head model to study athlete responses prior and during head impacts.*

*Here, we propose to use a Proportional-Integral-Derivative (PID) controller to imitate muscle bracing by minimising deviation from neutral posture. It is able to responsively adapt muscle activation patterns to oppose muscle strain during simulated sports impacts. The PID-based neuromuscular control is then integrated into a head–neck FE model with to simulate reflexive bracing on impact. This work provides a foundation for future model-based studies on neuromechanical injury mechanisms and the design of anticipatory interventions to mitigate TBI risk.*

**TALK TITLE** *Dynamic Multi-Planar Neuromuscular Neck Training (TopSpin360) Reduces Headache and Neck Pain Associated with Post-Concussion Syndrome: A Feasibility Randomized Controlled Trial*

**SPEAKER** *Dr Theo Versteegh - TopSpin Technologies Ltd*

**AUTHORS** *Dr Theo Versteegh, Michael Robinson, PhD, Doug Fraser, MD PhD, Lisa Fischer MD*

**ABSTRACT**

*Purpose/Hypothesis: Post-concussion syndrome (PCS) occurs in 11–82% of mild traumatic brain injury (mTBI) cases, with headaches and neck pain among the most common symptoms. This study investigates whether dynamic multi-planar neuromuscular neck training (TopSpin360) reduces PCS-related symptoms.*

*Materials and Methods: In this feasibility randomized controlled trial, 58 participants with PCS >4 weeks post-injury (mean = 72 days) were randomized to either standard care (CON; n=29, 21 female) or standard care plus TopSpin360 (INT; n=29, 21 female). The INT group performed 3 sets of 30 revolutions twice weekly for 8 weeks (~2 minutes per session). Outcome measures included the Headache Disability Index (HDI), Neck Disability Index (NDI), and SCAT5 total symptom score, assessed pre- and post-intervention. Independent t-tests compared group change scores with Bonferroni correction; effect sizes were calculated using Cohen's d.*

*Results: No adverse events were reported. INT participants completed 94.6% of prescribed sessions. The INT group showed statistically significant improvements with large effect sizes for SCAT5 (71.2% reduction vs 10.4% increase in CON; d=1.08, p=0.0129) and HDI (35.8% reduction vs 10.3% increase; d=1.01, p=0.0098), and a medium effect size for NDI (40.5% reduction vs 4.9% increase; d=0.65, p=0.0161).*

*Conclusions: TopSpin360 significantly reduced headaches and neck pain in PCS with high adherence and no adverse events, supporting its feasibility and potential for broader clinical use.*

*Clinical Relevance: This novel intervention may address a critical treatment gap for PCS rehabilitation through efficient, multi-planar neck training.*

**TALK TITLE** *Linking Sporting Head Impact Exposure to Brain Health*

**AUTHOR** *Dr Thomas Parker - Imperial College* **KEYNOTE**

**ABSTRACT** *The Advanced Brain Health Clinic (ABHC) study provides a detailed clinical, cognitive, and biomarker characterisation of former elite rugby and football players presenting with brain health concerns. Using structured interviews, validated symptom questionnaires, formal neuropsychological testing, advanced MRI and blood-based biomarkers, the study captures a comprehensive profile of this cohort, alongside detailed histories of playing career, concussion exposure, and other relevant health factors.*

*The Traumatic Brain Injury Thresholds Study (TBI-TS) will build on these insights through a large-scale investigation of head impacts in elite men's and women's rugby union and rugby league at the point of exposure. Over two seasons, the study will combine instrumented mouthguard technology, advanced finite element modelling of brain biomechanics, and blood-based biomarker analysis to quantify the relationship between in-game head impact kinematics, brain tissue strain, and objective markers of injury.*

*Standardised clinical head injury assessments and longitudinal follow-up will enable the derivation of sex-specific and impact-specific biomechanical thresholds for brain injury. Together, these complementary programmes integrate clinical phenotyping with mechanistic modelling to inform improved detection, monitoring, and prevention strategies for traumatic brain injury in sport.*

**TALK TITLE** *A Multimodal Protocol for Objective Assessment of Acute Sport-Related Concussion*

**SPEAKER** *Tobias Harritz - The Podium Institute*

**AUTHOR** *Tobias Harritz, Professor Constantin Coussios, Professor Peter Jezzard*

**ABSTRACT** *Concussions are common in sports, and accurate identification is crucial for managing recovery and return-to-play decisions. However, current assessments rely on self-reported symptoms and subjective clinical evaluations, which may not reliably reflect underlying brain dysfunction. There is a need for objective, sensitive tools to assess whether a head impact has resulted in structural or functional brain changes. Ideally, such tools should be scalable and allow for rapid, pitch-side assessment, having been referenced to less scalable but more interpretable imaging markers.*

*Advanced magnetic resonance imaging (MRI) is sensitive to subtle changes in brain structure and function and may provide a reference objective measure of brain impairment after concussion. Field-deployable technologies, such as pupillometry, electroencephalography (EEG), and balance testing, offer promise as rapid, scalable tools for assessing acute brain dysfunction.*

*We present a multimodal protocol for acute concussion assessment, to be implemented in elite rugby players. Approximately 60 athletes (30 male, 30 female) will undergo comprehensive baseline testing during pre-season, including assessments with a mobile 3T MRI scanner, pupillometry, low-density EEG, blood and saliva sampling, and balance testing. The same multimodal protocol will be repeated shortly after any injury. The mobile MRI scanner will be stationed at match venues on match days, enabling neuroimaging and portable assessments to be performed within hours of a suspected concussion.*

*This approach aims to identify acute neuroimaging markers of concussion and to evaluate how well portable, scalable technologies reflect these markers, with the goal of informing future tools for objective concussion assessment.*

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**TALK TITLE** *Deep Learning-based Quantification of White Matter Hyperintensities in Sports Concussion: an Integrated Clinical-Imaging Study*

**SPEAKER** *Mr Sheikh Momin - University of Birmingham / The Podium Institute*

**AUTHORS** *Mr Sheikh Momin, Andrew Stevens, Yidian Gao, Alan George, Ivan Abbott, Rajan Chand, Arnav Singh, Katherine Hill, Antonio Belli, Vijay Sawlani, Davinia Fernandez-Espejo,*

**ABSTRACT**

*Introduction: White matter hyperintensities (WMH) on T2-weighted imaging in the sports-related concussion (SRC) context may reflect cumulative brain injury or altered white matter integrity, even in young, otherwise healthy athletes. While long-term neurological sequelae of repetitive head impacts are increasingly recognised, the role of WMHs as an imaging biomarker in sports concussion remains underexplored. Previous work from our group has estimated WMH burden through radiology report text analysis; however, volumetric quantification using raw imaging may offer greater precision.*

*Methods: Athletes attending the Birmingham Sports Concussion Clinic (BSCC) between 2017 and 2024 who underwent 3T MRI with T2-FLAIR sequences were included. The Lesion Segmentation Tool-AI (LST-AI) was used to automatically segment and quantify WMH volume. Standardised pre-processing included bias field correction and spatial normalisation to MNI space, with periventricular artefacts unrelated to SRC also excluded. Clinical and demographic data were extracted from the electronic health record (EHR). Descriptive statistics are used to summarise findings.*

*Results: 95 athletes had MRIs suitable for LST-AI processing. Clinical data were available for 46 athletes (38 male, mean age 25), with a median 3 prior concussions. Rugby was the most common sport (65%), with 61% playing professionally and 59% injured during competition. Return to play occurred in 76%. The LST-AI detected a median 4.5 WMHs, with a median volume of 54mm3 (range 0.54-3667mm3), primarily in subcortical regions.*

*Conclusion: We demonstrate a scalable automated method for WMH quantification paried with clinical data in SRC. Future work will evaluate associations with symptom trajectories and long-term outcomes.*

**TALK TITLE** *Utilising Outlier Detection Methods to Identify Abnormalities on Advanced MRI Following Head Trauma: A Proof-of-Concept Study*

**SPEAKER** *Izabelle Lövgren - The Podium Institute*

**AUTHORS** *Izabelle Lövgren, Michiel Cottaar, Natalie Voets, Tim Lawrence*

**ABSTRACT** *Traumatic brain injury (TBI) is a leading cause of morbidity and mortality worldwide. Given that 20-40% of mild TBI patients endure persisting symptoms, current methods of injury severity stratification do not appear to reliably identify those at risk of incomplete recovery. Furthermore, with studies reporting neurodegenerative features and chronic traumatic encephalopathy in athletes exposed to repeated head impacts, a better understanding of the effects of head injuries on the brain is vital.*

*Several studies to date have highlighted the utility of advanced magnetic resonance imaging (MRI) in investigating various pathophysiological features of TBI, such as traumatic axonal injury and altered functional connectivity. Nevertheless, there is substantial variability between studies with respect to whether MRI-derived injury markers are detected, particularly in cohorts with mild TBI or concussion. This may partly be due to the tendency to evaluate injury features on a group-level (i.e., compare directly to a control group). Such approaches rely on injury patterns to be consistent between patients in order for group-level effects to emerge. However, as head injuries can be sustained through a range of different mechanisms, spatial overlap of injury features may be limited. Hence, analysis methods that firstly capture abnormalities on a subject-level are needed.*

*In a small cohort of adults with TBI, we provide a proof-of-concept analysis using a multivariate outlier detection method to quantify the magnitude of subject-level abnormalities on advanced MRI. The abnormality metrics are then correlated with outcome, to evaluate their clinical relevance.*

**TALK TITLE** *Multiphysics and Multiscale Modeling of Traumatic Brain Injury (M3TBI): Current Challenges and Opportunities*

**SPEAKER** *Professor Johannes Weickenmeier - The Podium Institute* **KEYNOTE**

**ABSTRACT** *Traumatic brain injury (TBI) is a multifaceted condition that spans spatial and temporal scales—from the external mechanics of head impact to long-term neurological decline. This talk presents a comprehensive overview of current multiphysics and multiscale modeling approaches to TBI, highlighting recent advances and persistent challenges. We will explore state-of-the-art models addressing the biomechanics of head impact, structural and cellular tissue damage, recovery dynamics, blood-brain barrier (BBB) dysfunction, and fluid-structure interactions including cerebrospinal fluid and vasculature. The talk will also review how these models have informed our understanding of brain injury mechanisms, support clinical decision-making, and reveal critical gaps—particularly in predicting individual injury recovery and long-term comorbidities such as dementia.*

*Scientific insights derived from these models include estimates of strain localization, axonal injury thresholds, edema formation, and the influence of repeated sub-concussive events. However, limitations persist in bridging scales, modeling patient-specific responses, and integrating biophysical processes such as inflammation and neurodegeneration. Opportunities lie in coupling these models with longitudinal data and biomarkers to improve predictive accuracy and simulate long-term brain health trajectories. We will discuss how computational frameworks can help elucidate the link between acute biomechanical injury and chronic neurodegeneration, providing a platform to assess the compounded risk of dementia following TBI.*

*By synthesizing knowledge across disciplines, M3TBI modeling holds the potential to transform our mechanistic understanding of TBI and drive the development of personalized diagnostic and therapeutic strategies.*

**TALK TITLE** *Sports-Related Repetitive Head Impacts and Chronic Traumatic Encephalopathy: New Insights and Novel Biomarkers*

**SPEAKER** *Dr Lee E. Goldstein - Boston University* **KEYNOTE**

**ABSTRACT** *Repetitive head impacts (RHI) resulting from sports-related play and practice are associated with acute traumatic brain injury (TBI), cognitive deficits, and latent sequelae, including chronic traumatic encephalopathy (CTE), a progressive and ultimately fatal tau protein neurodegenerative disease. This talk will provide an overview of sports-related head injuries and relationship to CTE with a focus on recent research showing early neuronal loss and neuroinflammation in young athletes. This talk will also review novel biomarkers to detect physiological and functional deficits associated with RHI and the earliest stages of CTE.*

**TALK TITLE** *Management of Concussion in Para-athletes: a Single-Centre Case Series*

**SPEAKER** *Dr Arnav Singh - University of Birmingham, Medical School*

**ABSTRACT** *Background: Individuals with physical disabilities face unique complexities in sustaining and recovering from concussion. In 2021, the Concussion in Para Sport (CIPS) group published guidance on concussion assessment in para-athletes, including adaptations to the Sports Concussion Assessment Tool (SCAT), return-to-sport protocols, and prevention strategies. Clinical practice following introduction of this guidance is not widely reported. This study aimed to evaluate current clinical practice in relation to CIPS recommendations, identify diagnostic and management challenges, and suggest ways clinicians can optimise concussion care for people with physical disabilities.*

*Methods: Retrospective case series of para-athletes who sustained concussions between January 2022 and October 2023 and were assessed at the Birmingham Concussion Clinic.*

*Results: Seven athletes (four female), median age 30 years (range: 20–40), were included. Four were in full-time or part-time education or employment alongside elite sport. Impairments included limb deficiency (unilateral/bilateral), spinal cord injury, cerebral palsy (spastic hemiplegia/diplegia), connective tissue disorder, and spina bifida. Six concussions were sport-related (five in competition, one in training); one occurred outside of sport. Assessments requiring full limb use, such as the modified Balance Error Scoring System (mBESS), Unterberger, and gait-based tests, often needed to be adapted or omitted. All followed a Graduated Return to Play (GRTP) protocol, and two experienced repeat concussions. By 12-month follow-up, 3/7 athletes had fully recovered or reported minimal ongoing symptoms.*

*Conclusion: Clinical practice at the concussion clinic aligns well with CIPS guidance. High-quality concussion care for individuals with physical disabilities requires routine baseline testing and adapted assessment tools.*

**TALK TITLE** *A Mechanics-Informed Machine Learning Framework for Subject-Specific Injury Risk Prediction*

**SPEAKER** *Phoebe Haste - The Podium Institute*

**AUTHORS** *Phoebe Haste, Eryn Kwon, Vickie Shim, Antoine Jerusalem*

**ABSTRACT** *Sports-related concussion (SRC) is a traumatic brain injury induced by biomechanical forces [1]. Risk functions for SRC have been developed using both in vivo accelerations of the athletes head and the results of mechanical head impact simulations [2].*

*These mechanics-based risk functions neglect patient-specific factors such as age, prior injuries and sex, despite females having a higher SRC prevalence, higher symptom burdens, and worse outcomes [3]. To this end, we propose a flexible framework that predicts the risk of concussion in real-time, whilst accounting for influential factors such as sex, age and concussion history.*

*A surrogate model is trained to predict the results of mechanical simulations of head impacts, removing the need to run long and computationally expensive simulations for each collision. The predicted simulation results can be combined with longitudinal multi-modal datasets examining sports-related head injuries to estimate injury risk. Preliminary results will be shown.*

*[1]https://bjsm.bmj.com/content/51/11/877*
*[2]https://www.tandfonline.com/doi/full/10.1080/14763141.2021.2016929#d1e141*
*[3] https://pubmed.ncbi.nlm.nih.gov/30618335/*

**TALK TITLE** *Gender-Informed Concussion Recovery: Co-Designing Safer Sporting Environments Through the Concussion Toolkit*

**SPEAKER** *Philippa Heath - University of Bristol*

**AUTHORS** *Philippa Heath, Millie Puddephatt, Concussion Toolkit*

**ABSTRACT** *Introduction and Purpose: Despite women's increased susceptibility to sport-related concussion, distinct symptomology, and longer recovery, concussion protocols remain predominantly androcentric. 80% of research is based on male populations (D'Lauro et al., 2022), leaving women underserved and authorities under scrutiny for ignoring gender-based differences. University students are particularly vulnerable due to their maturing brains, heightening the risk of second impact syndrome. This study challenges medical reductionism and gender bias in concussion research through co-design of a gender-informed, student-centred Concussion Toolkit.*

*Methods: A mixed-methods approach, grounded in feminist theory, prioritises qualitative data to centre lived experiences and critique androcentric norms in concussion research (Dean and Wiley, 2022). We conducted a qualitative review of 52 peer-reviewed studies and cluster analysis to map barriers to recovery.*

*Primary data was collected from a mixed-methods survey of student-athletes (n=106; 76% women), expert interviews (n=9), participant observation at 14 university sports matches, stakeholder workshops with student-athletes (n=18), a focus group with professional female athletes (n=3), and two co-design sessions.*

*Results: Four key insights emerged: student-athletes lack recovery knowledge; guidance fails to reflect students' needs; personalised, holistic care is essential; and androcentric research excludes gender-informed advice. Participants described the Toolkit as the first-time concussion care feels "relevant" to them.*

*Conclusion: The Toolkit reframes recovery as both a social and biological process, offering an inclusive, scalable model to improve outcomes across universities and grassroots sport. Concussion guidance must be gender-informed, user-centred, and holistic to ensure safety, equity, and impact.*

**TALK TITLE** *Concussion Risk and Severity Associated with a Pre-Season Multi-Modal Neurologic Training Program among Elite Male Ice Hockey Players*

**SPEAKER** *Dr Theo Versteegh - TopSpin Technologies Ltd*

**AUTHORS** *Theo Versteegh, Maryam Butt, Sean Dukelow, Jalena Bertagnolli, Debbie Luk, Jonathan Charest, John Ralston, Brad Layzell, Brian Benson*

**ABSTRACT** *Objective: To determine whether concussion risk and severity differ in male ice hockey players who complete a pre-season neurologic training program.*

*Materials and Methods: This prospective cohort study (2022–2024) included 12 elite male players (mean age: 15.2) in the intervention group (IG) and 142 age- and sex-matched controls (CG). The IG completed a two-month pre-season multi-modal training program comprising of: dynamic vision, multi-planar neck training, neuromuscular and cardiovascular training, custom performance mouthwear, psychological counseling (if indicated), and sleep performance tools. This was alongside standard training. CG followed usual pre-season routines. Athlete participation exposure was tracked across games and practices. Poisson regression assessed concussion incidence rate ratios (IRRs), adjusting for age, competition level (AA vs AAA), and prior concussion. Linear regression analyzed time loss from concussion.*

*Results: Twenty-four concussions were reported (IG: 1, CG: 23). IG athletes had a significantly lower risk of concussion (IRR=0.029, 95% CI: 0.001–0.661, p=0.026). Prior concussion significantly increased the risk of future concussion (IRR=2.04, 95% CI: 1.47–2.83). Time loss due to concussion did not differ between groups (IG: 12.0 days, CG: 11.7 days), but older age (β=2.99 days, 95% CI: 0.31–5.66) and higher competition level (β=4.48 days, 95% CI: 0.82–8.15) predicted greater time loss (p<0.05).*

*Conclusions: A two-month multi-modal pre-season neurologic training program significantly reduced concussion risk among elite male hockey players by 97%. While time loss per concussion was similar across groups, age and competition level were significant predictors of recovery duration.*

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