

FITNESS- WISSEN- SCHAFTS- KONGRESS



11 – 12 September 2026, Düsseldorf, Germany

eBook of Abstracts

5th Fitness Science Congress

(Fitnesswissenschaftskongress)

Hosted by

IST University of Applied Sciences

Edited by

Wiewelhove, T., Dissemond, J., Gavanda, S., Havers, T., Isenmann, E., Kreutz, T.,
Matzka, M., Held, S., Brinkmann, C., Schrey, S., Meuffels, F. & Geisler, S.

DOI: <https://doi.org/10.17605/OSF.IO/E4Y98>



© Copyright by IST University of Applied Sciences



HOCHSCHULE
für Management
University of Applied Sciences



Table of Contents

2

Sports Nutrition	5
Carbohydrates for post-exercise recovery: replenishing liver and muscle glycogen – Fuchs, C.	5
Exogenous Ketone Bodies: Exercise Performance and Adaptation – Areta, J.	6
Dietary Collagen Protein – Really Needed? It Depends! – Aussieker, T.	7
NSCA	8
Muscular Fine Tuning and Injury Prevention in Sport – a Practical Exercise Approach – Schlumberger, A.	9
Gamespeed – Rethinking Speed Development for the Team Sport Athlete – Jeffreys, I.	10
Molecular Mechanistic Adaptation	11
Chipping Away at the Resistance Training Responder Question: What's Known and What's Unexplored – Roberts, M.	12
Orchestrating Skeletal Muscle Fiber Adaptation to Resistance Exercise: Damage, Synthesis, and Degradation During Short Periods of Repeated and Interrupted Training – Gehlert, S.	13
Young Investigators	14
The Influence of Menstrual Cycle Phases on Strength Performance in Experienced Female Strength Athletes Under Varying Training Frequency: An Exploratory Investigation of Cycle-Based Training Adaptation – Hammer, F.	14
Acute Inflammatory Responses to Blood Flow Restriction Training: A Systematic Review – Barawi, S.	15
Markerless AI-Based Motion Capture in Professional Sport: Tracking Intra- and Inter-Individual Biomechanical Variances in the High-Velocity Tennis Serve – Stamm, K.	16
Effects of Additional Electronically Guided Resistance Training on Motivation and Physical Performance in Rehabilitation Sports – A Quantitative Comparative Study – Feldmann, P.	17
Acute Effects of Ketone Monoester and 1,3-Butanediol on Energy Metabolism and Endurance Performance in Recreational Cyclists – Reitz, A.	18
Beyond Passive Treatment: The Self-Reported Impact of Physical Activity on Pain Perception and Empowerment in Women with Endometriosis – Schmiedinger, T.	19
Effects of Aronia Juice Supplementation on Performance During and Recovery After High-Intensity Functional Training: a Randomized Double-Blind Placebo-Controlled Crossover Trial – Starke, L.	20
Training-Induced Strength and Hypertrophy in Prepubertal and Pubertal Youth: A Randomized Controlled Trial – Komm, Y.	21



Table of Contents

3

Healthy Aging	22
Anti-obesity Effects of Muscle Hypertrophy – Wackerhage, H.	22
Exercise is Medicine for Cardiovascular Ageing: Integrating Physiological and Molecular Mechanisms – Donath, L.	24
Wearables and AI	25
Velocity-Based Training: From Theory to App – Held, S.	25
Wearables and AI: Do Smartwatches, ChatGPT, and More Make Us “Fitter”? – Düking, P.	26
Continuous Glucose and Ketone Monitoring – Applications and Potential in Sport and Exercise – Brinkmann, C.	27
Endurance Performance Today & Tomorrow: Testing, Intensity, and Application	28
Beyond Thresholds and the Laboratory: Field Testing as a Window into Durability and Fatigue – Meixner, B.	28
Understanding the Role of Low-Intensity Exercise in Endurance Training – Lenk, M.	29
HYROX® Decoded: Endurance Meets Strength – Schaffarczyk, M.	30
Stretching and Muscle Adaptation	31
Stop stretching like it's 1990: Practical takeaways from the new SPHERE guidelines – Wilke, J.	31
Is stretching necessary? “Can I?” versus “Do I Have To?” - A practical perspective on stretching alternatives – Warneke, K.	32
Mechanisms Underlying Flexibility Increases With Acute and Chronic Stretching – Behm, D.	33
Clinical Setting	34
Exercise is Medicine – Update Oncology – Zimmer, P.	34
BFR-Training Between Rehabilitation and Performance – Behringer, M.	35
Muscle Physiology	37
Reversing Age-Related Muscle Loss: High-Intensity Resistance Training for the Prevention and Treatment of Sarcopenia – Giessing, J.	37
Block vs. Traditional Periodization in High-Intensity Functional Training – Micke, F.	38
What Do We Know About HIIT Today? An Overview of Evidence and Application – Sperlich, B.	39



Table of Contents

4

Adaptations in Females	40
Pregnancy and Training in Elite Sports – From Preconception to Postpartum – Legerlotz, K.	40
Influence of the Menstrual Cycle on Performance and Trainability – Zinner, C.	41
Female Biomechanics and its Relevance to Injury Prevention – Zech, A.	42
Fitness Across the Lifespan – Presented by the German Society of Sport Science	43
The Relevance of Biological Maturation in Youth Sport: Insights From Female and Male Football – Ruf, L.	43
Beliefs and Myths Versus Science in Exercise Training – Rappelt, L.	44
The Menopausal Transition and Skeletal Muscle: Interactions Between Estrogen Status and Physical Training – Hansen, M.	45



Carbohydrates for post-exercise recovery: replenishing liver and muscle glycogen

Fuchs, C.

Department of Human Biology, NUTRIM Institute of Nutrition and Translational Research in Metabolism, Maastricht University, Maastricht, the Netherlands

Both liver and muscle glycogen contribute substantially to energy requirements during prolonged moderate- to high-intensity exercise, and their contribution increases with exercise intensity. After prolonged and exhaustive exercise both stores can become substantially depleted, and athletes who must perform again within 24 h, such as cyclists in multi-stage races, depend on rapid repletion. Therefore, in such situations, it is important to focus on the right amount, timing and type of carbohydrate during recovery to optimise glycogen repletion. This presentation discusses recent data on the impact of post-exercise carbohydrate ingestion on liver and muscle glycogen repletion, together with practical examples from professional cycling.

Using ¹³C magnetic resonance spectroscopy we have quantified post-exercise liver and muscle glycogen repletion in vivo in trained endurance athletes. During the first 5 h of post-exercise recovery, the type of carbohydrate matters for the liver, but not for muscle: sucrose ingestion at 1.5 g/kg/h accelerates liver glycogen repletion compared with glucose alone, whereas muscle glycogen repletion does not differ between the two. Accordingly, when sufficient amounts of sucrose are ingested during early recovery, liver glycogen can be fully replenished well within 6 h, whereas muscle glycogen is not fully replenished within a 12-h recovery period, despite ample carbohydrate intake (10 g/kg). Complete muscle glycogen repletion may require up to 24 h.

Liver glycogen can be restored well within 6 h when both the amount and the type of carbohydrate are taken into account, whereas muscle glycogen repletion can be a rate-limiting step in early recovery and may take up to 24 h after exhaustive cycling exercise. In professional cycling, where turnaround times are short, carbohydrates are therefore provided directly after each stage, glucose + fructose sources are used, and a high daily carbohydrate intake is targeted to maximise glycogen repletion.



Exogenous Ketone Bodies: Exercise Performance and Adaptation

Areta, J.

Research Institute for Sport and Exercise Sciences (RISES), Liverpool John Moores University, Liverpool, UK

Exogenous ketone esters (KE) are a novel nutritional intervention with the potential to influence metabolism, physiology, and exercise adaptation. KE rapidly increase circulating concentrations of β -hydroxybutyrate and acetoacetate, inducing a state of nutritional ketosis within approximately 30 minutes without the need for fasting or adherence to a ketogenic diet. Initially developed for potential military applications, exogenous ketones subsequently attracted considerable interest as a potential ergogenic aid for endurance athletes.

Early hypotheses proposed that KE could alter substrate utilisation during exercise, provide an alternative fuel source, and thereby enhance endurance performance. However, subsequent research indicates that KE supplementation during exercise is unlikely to meaningfully improve endurance performance. Furthermore, the oxidation of exogenous ketones during exercise appears relatively limited, calling into question their importance as a substantial energy substrate for working muscle.

More recent research has shifted attention towards the potential role of KE during recovery and training adaptation. Emerging evidence suggests that KE may influence endocrine responses, including erythropoietin, and modulate molecular and physiological processes involved in skeletal muscle adaptation. However, the consistency, practical significance, and underlying mechanisms of these effects remain unclear.

This presentation will provide an overview of ketone metabolism and critically evaluate the current evidence regarding the metabolic, endocrine, and physiological effects of exogenous KE. Particular emphasis will be placed on distinguishing their potential role as an acute ergogenic aid from their possible effects on recovery and longer-term adaptation to exercise training.



Dietary Collagen Protein – Really Needed? It Depends!

Aussieker, T.

Faculty of Agriculture, Food, and Health, OWL University of Applied Sciences and Arts, Lemgo, Germany

Collagen is generally considered a low-quality dietary protein because it has an incomplete essential amino acid profile and a low leucine content, making it less effective than high-quality proteins for stimulating myofibrillar protein synthesis. However, protein quality may be tissue- and outcome-specific. Collagen provides large amounts of glycine, proline and hydroxyproline, which are abundant in the extracellular matrix of tendons and provide a rationale for targeted supplementation.

This presentation critically evaluates collagen supplementation for two distinct aims: increasing muscle mass and supporting tendon adaptation. Acute studies indicate that collagen does not meaningfully increase myofibrillar protein synthesis at rest or following exercise and consistently underperforms whey protein. Although some longer-term resistance-training studies report greater gains in fat-free mass with collagen than with placebo, fat-free mass is not equivalent to skeletal muscle mass, and direct comparisons with high-quality proteins are lacking. For tendon, mechanical loading remains the principal adaptive stimulus. Collagen ingestion before exercise increases circulating collagen-derived amino acids and may enhance biomarkers of collagen synthesis in a dose-dependent manner. Emerging training studies further suggest that collagen supplementation can augment increases in tendon cross-sectional area, stiffness or both. Nevertheless, the evidence base remains relatively small, optimal dosing and timing are not fully established, and direct evidence for a reduction in tendon injuries is currently lacking.

Collagen is neither necessary nor the preferred supplement for muscle growth when sufficient high-quality protein is consumed. It may, however, offer a modest, tissue-specific benefit for individuals seeking to support tendon adaptation alongside appropriate loading. Its value therefore depends on the target tissue, intended outcome and quality of the alternative protein sources available. Collagen protein should not replace the intake of high-quality protein.

5th Fitness Science Congress

2026 | Düsseldorf

FITNESS-
WISSEN-
SCHAFTS-
KONGRESS



NSCA

Friday, 11 September 2026 | 14:00

8



HOCHSCHULE
für Management
University of Applied Sciences



Muscular Fine Tuning and Injury Prevention in Sport – a Practical Exercise Approach

Schlumberger, A.

BSP Business & Law School, Berlin, Germany

Since neuromuscular factors play a crucial role in the development of injuries, one important aspect of injury prevention in sport is to have a flexible and well-coordinated neuromuscular system. In this context, it seems reasonable to constantly optimise intra- and intermuscular coordination based on an adequate individual load distribution within the kinetic chain as an important basis of efficient posture and movement. When planning related exercise programmes, important aspects to consider are “use”- or “disuse”-related hypo- or hyperactivities of single muscles, synergistic dominance within a group of synergists as well as changes in length-tension relationships.

The approach to muscular fine-tuning programmes is to identify “deviations” from an assumed muscle reference status by assessing muscle function in different test procedures, like gait analyses, range-of-motion assessment, manual muscle tests, but also injury history and typical “key focus areas” (i.e. relatively high local muscle tension after fatiguing training, back pain, especially unilaterally).

Based on the assessment, individualised hypotheses are created as to which aspects of function need to have priority. Typical areas with functional potential are the hip flexor complex, the neutral pelvic-spine position as well as the lumbar spine-pelvis-hip-lower extremity complex. Within the muscular fine-tuning approach, typical sessions address assessment-derived target areas based on an exercise classification scheme which also integrates motor learning principles (from local to complex, from horizontal to vertical, from non-weight-bearing to weight-bearing etc.). Single sessions are performed with the ultimate goal to induce short-term improvements in intra- and intermuscular coordination (the basis of pain- and overtension-free complex quality movement). This optimisation of individual training sessions, in turn, forms the important basis for long-term successful training programmes.



Gamespeed – Rethinking Speed Development for the Team Sport Athlete

Jeffreys, I.

All-Pro Performance, NSCA President, Department of Sport Science, Reykjavik University, Reykjavík, Island

So many of the highlight reel moments of sport involve the application of speed and agility. Yet it remains questionable as to how well our current approaches to speed and agility development are actually helping athletes perform the specific tasks of their sport.

Scientific research has been a mainstay of strength and conditioning and this is based on accurate definition and measurement. Yet ironically, it could be that the very desire to define and measure speed and agility is actually sending us in the wrong direction when it comes to our understanding of these capacities. Whenever we frame and define we naturally “exclude” and this presents a great danger to our understanding of speed and agility. We must always remember that in relation to sports performance, speed and agility should not be seen as generic capacities, but instead viewed as being an integral part of the game and contributing to overall performance. As a result, speed and agility can only be fully understood in context and consequently, our current understanding of these capacities is incomplete and we are missing multiple opportunities for enhancing these qualities.

To rectify this situation, we need different concepts and this presentation looks at how a Gamespeed approach, where the focus is on the goal of speed and agility application, can help shed light on the best way forward. It will outline the key constraints to Gamespeed, its underpinning components along with pathways to developing this elusive capacity.

5th Fitness Science Congress

2026 | Düsseldorf

FITNESS-
WISSEN-
SCHAFTS-
KONGRESS



Molecular Mechanistic Adaptation

Friday, 11 September 2026 | 16:00

11



HOCHSCHULE
für Management
University of Applied Sciences



Chipping Away at the Resistance Training Responder Question: What's Known and What's Unexplored

Roberts, M.

School of Kinesiology, Auburn University, Auburn, Alabama, United States

Individual variability in muscle hypertrophy following resistance training (RT) remains a persistent challenge in exercise science, yet the mechanisms driving „responder“ heterogeneity are still only partially understood. This talk addresses this question through a series of targeted inquiries drawn from recent literature and original data from the Roberts laboratory. Lower and higher responders are most reliably classified using imaging-based hypertrophy measures (e.g., DXA, pQCT, ultrasound), which have low technical noise. At the molecular level, higher responders tend to show greater expansion of the muscle stem cell pool and increased ribosome content with training, though the full picture is likely more complex than these two markers alone. Whether nutritional interventions (e.g., whey protein, leucine, soy protein, or creatine) can convert lower responders into higher ones remains largely untested and unclear. Genetic testing to predict RT responsiveness is not currently supported by evidence. Finally, novel compiled data from college-aged males suggest that starting resistance training earlier in adolescence (ages ~10–14) is associated with substantially greater adult muscle mass and strength, with no evidence of compromised growth. These latter data raise the possibility that early-life training initiation may itself be a lever for generating more „higher responders“ later in life.



Orchestrating Skeletal Muscle Fiber Adaptation to Resistance Exercise: Damage, Synthesis, and Degradation During Short Periods of Repeated and Interrupted Training

Gehlert, S.

Department for Biosciences of Sports, Institute for Sports Sciences, University of Hildesheim, Hildesheim, Germany

Resistance exercise (RE) is an essential component of fitness, health, and elite sports. While RE promotes muscle mass and strength, mechanical strain continuously challenges the structural integrity of the sarcomere. Efficient damage control, repair, and cytoskeletal adaptation are therefore fundamental to acute and long-term adaptation. In human skeletal muscle, we investigated the time course, fibre-type specificity, and spatial localisation of damage, repair, and sarcomeric adaptations.

RE induces a rapid anabolic response, characterised by increased phosphorylation of ribosomal protein S6 (rpS6) in both type I and type II fibres. Concurrently, molecular chaperones such as HSPB5, which protect unfolded sarcomeric proteins, become phosphorylated, enhancing their activity. Both responses depend on fibre type, exercise volume, and intensity. With repeated RE, phosphorylation of HSPB5 and rpS6 is attenuated, indicating an adaptive response. Repeated RE also promotes rapid cytoskeletal remodelling, reflected by increased sarcomeric desmin content after only seven sessions. This adaptation is strongly reduced after 10 days of detraining. RE-induced myofibrillar damage is characterised by XIRP1-positive lesions. Acute, unaccustomed RE results in lesions affecting between 4.7–42.6% of all myofibres, demonstrating pronounced interindividual variability. Fibre-type-specific damage also differed between individuals. Six weeks of repeated RE significantly reduced XIRP1-positive lesions, whereas three weeks of training cessation restored lesion abundance. Within 4 h after RE, HSPB5 and autophagy-related proteins accumulated at sites of sarcomeric damage but largely disappeared within 24 h. Those proteins coordinate the selective removal of damaged sarcomeric components, while anabolic signalling is temporarily suppressed at damaged sites.

Human RE elicits highly variable damage responses, tightly coupled to damage recognition, selective degradation, and repair, enabling rapid restoration and structural adaptation to repeated mechanical stress. The pronounced interindividual variability suggests that proteostatic mechanisms activated by mechanical damage may also contribute to individual differences in adaptation to resistance training and muscle hypertrophy.



The Influence of Menstrual Cycle Phases on Strength Performance in Experienced Female Strength Athletes Under Varying Training Frequency: An Exploratory Investigation of Cycle-Based Training Adaptation

Hammer, F.

Department of Molecular and Cellular Sports Medicine, Institute for Cardiovascular Research and Sports Medicine, German Sports University Cologne, Cologne, Germany

Evidence on cycle-based resistance training in experienced female athletes remains limited and inconsistent. This study investigated whether higher training volume in the follicular versus luteal phase leads to different adaptations in strength performance and body composition.

In this 12-week randomised intervention, 24 eumenorrheic, resistance-trained women were enrolled, of whom 12 completed the study. Participants were assigned to either a follicular high-volume group (FHV, $n = 6$) or a luteal high-volume group (FLV, $n = 6$). Both groups performed the same exercises at the same relative intensity, differing only in the menstrual-phase distribution of training frequency. Outcomes were assessed at four time points (T0–T3) and included body mass, fat mass, fat-free mass, muscle mass, circumferences, and 1RM squat and bench press. Menstrual cycle phases were determined using cycle diaries, LH ovulation tests, and salivary hormone measures. Data were analysed using linear mixed-effects models.

Body mass increased over time in both groups (FHV: 61.0 ± 7.7 to 62.9 ± 7.6 kg; FLV: 69.0 ± 5.2 to 72.2 ± 5.6 kg; $p_{\text{time}} = 0.001$), accompanied by gains in fat-free mass and muscle mass. 1RM performance in squat and bench press improved by approximately 12–18 % in both groups. However, no significant time $\times$ group interactions were observed for body composition or strength outcomes, indicating comparable adaptations between groups.

Concentrating higher training volume in either the follicular or luteal phase resulted in similar improvements in strength and body composition in experienced female strength athletes. These findings suggest that total training volume, progressive overload, and individual load tolerance may be more important than the specific timing of higher volume within the menstrual cycle.



Acute Inflammatory Responses to Blood Flow Restriction Training: A Systematic Review

Barawi, S.

**Department of Sports Medicine and Exercise Physiology, Institute of Sports Sciences, Goethe University
Frankfurt, Frankfurt am Main, Germany**

The effects of Blood Flow Restriction (BFR) training are well-established, but its impact on the inflammatory response remains unclear. This systematic review evaluates whether BFR training induces acute inflammation by analysing changes in inflammatory parameters.

This review was conducted according to PRISMA guidelines. The literature search was performed across PubMed, Web of Science, BISP-Surf and Google Scholar up to July 2025. Studies were included if they reported acute changes in inflammatory markers within 72 hours after BFR training, as well as macrophage presence up to 14 days. Only trials involving healthy adults with inflammatory parameters assessed via peripheral blood or muscle biopsy were considered. Risk of bias was assessed using RoB 2 and ROBINS-I. Standardised mean differences (SMDs) were calculated to quantify within-study changes. In addition, relative percentage changes were calculated to enable a comparison of the magnitude of inflammatory responses across studies. An effect direction plot was created to summarise the direction of inflammatory marker changes.

Nine studies involving 189 healthy adults were included in the systematic review. Transient increases in total leukocytes (18–33 %) and lymphocytes (37–43 %) were consistently observed in peripheral blood following exercise. Significant increases in total tissue macrophages (200 %) were also reported. Findings on neutrophils (up to +40%), cytokines (up to +340 %), and lymphocyte subpopulations (TCD4⁺: +25 %, TCD8⁺: +39 %) varied across studies.

The findings suggest that BFR training induces acute inflammation, characterized by transient leukocytosis, lymphocytosis, and increased macrophage activity. However, the variability in neutrophil and cytokine responses, as well as in lymphocyte subsets, may be attributed to variations in training parameters and methodological approaches. Overall, these responses appear comparable to those observed following high-load resistance training (HL-RT). Further research is needed to clarify the underlying mechanisms and their potential contribution to muscle adaptation.



Markerless AI-Based Motion Capture in Professional Sport: Tracking Intra- and Inter-Individual Biomechanical Variances in the High-Velocity Tennis Serve

Stamm, K.

Faculty of Sport Sciences, DHGS Deutsche Hochschule für Gesundheit und Sport, Berlin, Germany

High-performance biomechanical monitoring in elite tennis is frequently limited by the high logistical and laboratory barriers of marker-based tracking systems. Advanced multimodal AI systems present an innovative avenue for valid, field-based movement analysis. This study investigated the feasibility and diagnostic validity of markerless AI video tracking to identify performance degradation and kinematic errors in professional tennis players.

A 2D video dataset comprising 40 first serves from four professional ATP Challenger Tour players (10 maximal serves each, 120 fps, outdoor clay courts) was analysed. A multimodal AI system (Google Gemini 1.5 Pro) was trained to extract kinematic parameters using the athlete's anatomy and tennis racquet as reference scales to calculate pixel distances. AI-generated parameters included joint angles, angular velocities, and spatial displacements (centre of mass [CoM] vertical drive, racquet drop depth, and landing distance), validated against manual kinographic analysis.

The markerless AI system demonstrated high internal consistency, yielding a low velocity measurement deviation of < 1.5 km/h and spatial precision within ± 3 cm. Biomechanically, a significant fatigue-induced drop in ball velocity was observed across the consecutive serve series for all players. This velocity drop strongly correlated with a reduced vertical CoM displacement from Phase 3 to Phase 4 and an incomplete racquet drop. The resulting restriction of the stretch-shortening cycle (SSC) within the anterior muscle chain directly caused a reduction in internal shoulder rotation velocity by up to 14 %.

This study confirms the practical validity and diagnostic utility of markerless AI motion capture in elite training environments. It enables coaches to identify critical sub-visual kinetic chain errors—such as premature collapse of the upper torso axis—outside of a laboratory setting. To mitigate fatigue-induced mechanical errors, athletic programming must incorporate specific loading protocols targeting rate of force development (RFD) and tendon stiffness within the Anterior Oblique Sling.



Effects of Additional Electronically Guided Resistance Training on Motivation and Physical Performance in Rehabilitation Sports – A Quantitative Comparative Study

Feldmann, P.

Department of Fitness and Health, IST University of Applied Sciences, Düsseldorf, Germany

Orthopaedic rehabilitation sports primarily focus on mobility, coordination, and general physical activity, while structured resistance training is often limited. However, strength training has been shown to improve physical performance and reduce musculoskeletal complaints. The aim of this study was to investigate whether additional electronically guided resistance training improves motivation and training-related outcomes in rehabilitation sports participants.

A prospective quasi-experimental longitudinal intervention study was conducted over a three-month period. Thirty-one participants prescribed orthopaedic rehabilitation sports were included (control group: $n = 11$; intervention group: $n = 20$; mean age: 55.74 ± 14.05 years). The intervention group additionally completed electronically guided resistance training using a standardised “milon” circuit system. Assessments were performed at baseline (T0) and after the intervention period (T1). Outcome measures included subjective health complaints (health questionnaire), maximal strength (1-RM), muscle mass (BIA), phase angle (BIA), attendance, and dropout rate. Data were analysed using independent-samples t-tests based on change scores ($\Delta = T1 - T0$). Effect sizes were calculated using Cohen's d .

The intervention group demonstrated stronger improvements across major outcome parameters. Most notably, overall subjective complaints were significantly reduced in the intervention group with a large effect size, decreasing by 20.0% compared to 8.0 % in the control group.

These findings suggest that supplementary electronically guided resistance training may provide substantial additional benefits for participants' perceived physical well-being. Particularly pronounced reductions were observed for back, hip, and knee complaints. In addition, the intervention group showed greater improvements in maximal strength, increasing by 24.59 % compared to 18.33 % in the control group. Descriptive analyses further indicated reduced pain localisation and higher training adherence in participants performing the additional electronically guided training.

Supplementary electronically guided resistance training appears to provide additional physiological and motivational benefits for orthopaedic rehabilitation sports participants. Structured and feedback-oriented training systems may therefore represent a valuable extension of conventional rehabilitation sports by promoting measurable training success, self-efficacy, and long-term exercise adherence. These findings highlight the potential of integrating electronically guided resistance training into rehabilitative practice.



Acute Effects of Ketone Monoester and 1,3-Butanediol on Energy Metabolism and Endurance Performance in Recreational Cyclists

Reitz, A.

Department of Fitness and Health, IST University of Applied Sciences, Düsseldorf, Germany

Exogenous ketone supplements are marketed to shift substrate utilisation and enhance endurance performance, yet the evidence remains inconsistent. Ketone monoesters (KME) rapidly elevate β -hydroxybutyrate (β -HB), whereas the precursor 1,3-butanediol (BD) requires hepatic conversion. A direct comparison of both formulations on energy metabolism and cardiorespiratory performance in recreational cyclists is lacking.

In a double-blind, randomised, placebo-controlled, three-arm exploratory crossover trial, 14 recreationally trained cyclists (1 female, 13 males; 41.0 ± 10.4 y; 84.8 ± 12.0 kg) completed three standardised incremental cycling tests (initial load 100 W men / 80 W women; +25 W every 3 min until volitional exhaustion). Thirty minutes pre-exercise, participants ingested $0.5 \text{ g} \cdot \text{kg}^{-1}$ KME, $0.5 \text{ g} \cdot \text{kg}^{-1}$ BD, or a taste-matched placebo (PLA). Energy-metabolism variables (β -HB, glucose, lactate, respiratory exchange ratio, carbohydrate and fat oxidation) and performance variables (power output, VO_2 , VCO_2 , heart rate) were assessed at the first (VT1) and second (VT2) ventilatory thresholds and at peak exercise. Data were analysed using linear and robust mixed-effects models, GAMM, and Tukey-adjusted contrasts in R 4.5.2.

Both supplements induced sustained hyperketonaemia, with a greater rise under KME ($\Delta = +3.07 \text{ mmol} \cdot \text{L}^{-1}$) than BD ($\Delta = +1.24 \text{ mmol} \cdot \text{L}^{-1}$; both $p < 0.001$). At VT1, KME reduced RER (0.92 vs. 0.94; $p = 0.030$) and carbohydrate oxidation (152.6 vs. $182.5 \text{ g} \cdot \text{h}^{-1}$; $p = 0.011$), and increased fat oxidation (19.1 vs. $12.1 \text{ g} \cdot \text{h}^{-1}$; $p = 0.029$); lactate kinetics were flatter under KME ($\beta = -0.675$; $p = 0.001$). Performance variables were largely unaffected. Relative peak power, $\text{VO}_{2\text{peak}}$, HR_{max} and heart-rate recovery did not differ between conditions, while VO_2 and VCO_2 at VT1 were reduced under both ketogenic conditions.

Acute KME ingestion induces an intensity-specific shift in respiratory substrate utilisation confined to the moderate exercise domain (VT1), without altering key endurance-performance variables, whereas BD elevates β -HB without producing a comparable metabolic signature. These exploratory findings suggest that elevated circulating β -HB does not translate into ergogenic benefits during incremental cycling in recreational cyclists.



Beyond Passive Treatment: The Self-Reported Impact of Physical Activity on Pain Perception and Empowerment in Women with Endometriosis

Schmiedinger, T.

Integrative and Experimental Exercise Science and Training, Institute of Sport Science, Julius-Maximilians-Universität Würzburg, Würzburg, Germany

Endometriosis is a complex chronic pain condition often managed through surgery or hormone therapy. Reflecting a shift toward comprehensive care, the new clinical guideline emphasises the importance of multidisciplinary and complementary approaches. Patients frequently perceive these clinical treatments as passive and externally controlled, leading to a growing need for active self-management. This qualitative study explores how physical activity – as one of these central multidisciplinary components – influences pain perception, quality of life, and self-image, aiming to understand exercise as a tool for regaining autonomy and self-efficacy.

Semi-structured, guideline-based interviews were conducted with eleven women (age 21–55). Data were analysed using qualitative structured content analysis and MAXQDA software to systematically identify perception patterns and individual coping strategies.

Findings demonstrate that regular physical activity serves as a vital pillar for stabilisation and symptom relief. Specifically, building core stability helps prevent protective posturing and facilitates activities of daily living. While low-to-moderate activities (e.g., yoga) promote relaxation and reduce acute symptoms, high-intensity exercise functions as a psychological compensation strategy to shift focus away from pain. Crucially, the impact of exercise is highly individual; effectiveness depends on lesion localisation and symptom manifestation. The ability to independently choose and adapt exercise modalities reduces kinesiophobia and fosters a transition from physical powerlessness to self-determined empowerment and restored bodily autonomy.

Physical activity is a central, individualised strategy for managing endometriosis that holds potential to transform patients from passive recipients into active health managers. In alignment with current multidisciplinary guidelines, this study highlights the necessity of integrating multimodal care, including exercise. To move beyond “trial and error”, there is an urgent need for evidence-based, cycle-oriented exercise programmes and specialised instructors. Integrating these multimodal, individual approaches is essential for a sustainable recovery of physical autonomy.



Effects of Aronia Juice Supplementation on Performance During and Recovery After High-Intensity Functional Training: a Randomized Double-Blind Placebo-Controlled Crossover Trial

Starke, L.

Department of Molecular and Cellular Sports Medicine, Institute for Cardiovascular Research and Sports Medicine, German Sports University Cologne, Cologne, Germany

Nutritional strategies aimed at improving recovery are of increasing interest in competitive and recreational sport. Polyphenol-rich foods, including aronia juice, have received attention due to their high content of anthocyanins and procyanidins, which may exert antioxidant and anti-inflammatory effects. These properties suggest a potential role in attenuating exercise-induced muscle damage and inflammatory responses. However, evidence regarding their effectiveness in high-intensity functional training contexts remains limited. Therefore, this study investigated whether short-term aronia juice supplementation improves functional and biochemical recovery following a standardised high-intensity functional strength training session in trained participants.

In a placebo-controlled, two-arm crossover trial, 17 healthy trained participants received either aronia juice or placebo for two days before exercise and acutely after the training session. Before and after the intervention, functional performance was assessed using one-repetition maximum squat performance and countermovement jump height. Blood markers of exercise-induced stress and muscle damage, including creatine kinase, myoglobin, lactate and interleukin-6, were measured at multiple time points. Data were analysed using linear mixed-effects models in RStudio.

The training protocol induced significant time-dependent increases in myoglobin, creatine kinase, interleukin-6 and lactate ($p < 0.05$), confirming a relevant physiological stress response. However, no significant differences between aronia juice and placebo were observed for any biochemical marker. Squat performance and countermovement jump responses did not indicate superior recovery following aronia supplementation.

Short-term aronia juice supplementation did not enhance biochemical or functional recovery after high-intensity functional training in trained athletes. These findings do not support a general recommendation for aronia juice as an acute recovery strategy in this context. Future studies should examine different dosing strategies, longer supplementation periods and sport-specific populations to clarify whether aronia juice may exert context-dependent effects on recovery.



Training-Induced Strength and Hypertrophy in Prepubertal and Pubertal Youth: A Randomized Controlled Trial

Komm, Y.

Institute for Sport Science, University of Augsburg, Augsburg, Germany

Resistance training is a safe and effective modality for improving physical performance and health in youth. While strength increases are largely attributed to neural adaptations, the extent to which resistance training induces morphological adaptations before puberty remains unclear. This study compared training effects on muscle hypertrophy and maximal strength between prepubertal and pubertal adolescents.

Sixty-eight male participants were classified as prepubertal ($n = 39$, 11.58 ± 1.04 years) or pubertal ($n = 29$, 14.28 ± 0.88 years) using maturity offset estimates and were randomised to a training or active control group. The 9-week intervention consisted of two weekly sessions of lower-body resistance training. Strength was assessed using the isometric mid-thigh pull and hypertrophy determined via changes in muscle thickness. Data were analysed using linear mixed-effects models with fixed effects for time, maturity, intervention and their interactions. Reliability of peak force and muscle thickness measurements was assessed using intraclass correlation coefficients, coefficient of variation and 95 % confidence intervals. Statistical significance was set at $p < 0.05$.

No significant Time $\times$ Intervention interactions were observed for rectus femoris and vastus intermedius ($p = 0.295$) and for vastus lateralis ($p = 0.711$). However, a significant Time $\times$ Intervention interaction ($p = 0.042$) was found for peak force, indicating superior strength improvements in the training group compared with the control group. Notably, no significant Time $\times$ Maturity $\times$ Intervention interactions were detected for absolute strength ($p = 0.289$), relative strength ($p = 0.656$), rectus femoris and vastus intermedius thickness ($p = 0.451$), or vastus lateralis thickness ($p = 0.731$).

Therefore, twice-weekly resistance training enhanced maximal strength in youth, with maturation having no significant influence on training adaptations. Consequently, strength training is essential to maintain or even improve relative force production and balance natural maturation during growth.



Anti-obesity Effects of Muscle Hypertrophy

Wackerhage, H.

Exercise Biology Group, Faculty of Sport and Health Sciences, Technical University of Munich, Munich, Germany

The stimulation of muscle hypertrophy in obesity causes substantial fat loss, approaching that achieved with GLP-1 receptor agonists such as semaglutide/Wegovy. However, whereas GLP-1 receptor agonists reduce lean and muscle mass, hypertrophy-inducing interventions increase muscle mass. Fat loss occurs with diverse hypertrophic stimuli, including testosterone, myostatin-modulating drugs such as bimagrumab, mTORC1 activation via Akt1, and β 2-agonists. Akt1 and myostatin mouse models further suggest that muscle hypertrophy itself is sufficient to drive secondary fat loss.

Two hypotheses may explain this effect. The Sushi bar hypothesis proposes that hypertrophying muscle acts like a hungry customer taking metabolites from the circulating “conveyor belt”, leaving less available for storage in white adipose tissue. Alternatively, the myokine hypothesis proposes that growing muscle releases signals that promote fat loss.

The DFG-funded Research Unit FOR5795 HyperMet aims to determine how increasing muscle mass alters whole-body metabolism and identify mechanisms linking muscle hypertrophy to fat loss. Future clinical trials should explore whether resistance training combined with pharmacological muscle hypertrophy stimulation could provide a sustainable, sarcopenia-preventing treatment for patients with obesity.

5th Fitness Science Congress

2026 | Düsseldorf

FITNESS-
WISSEN-
SCHAFTS-
KONGRESS



Healthy Aging

Saturday, 12 September 2026 | 9:30

23



HOCHSCHULE
für Management
University of Applied Sciences



Exercise is Medicine for Cardiovascular Ageing: Integrating Physiological and Molecular Mechanisms

Donath, L.

Department of Applied Exercise Science, Institute of Exercise Training and Sport Informatics, German Sport University Cologne, Cologne, Germany

Cardiovascular ageing is characterised by progressive structural, functional, and molecular changes that increase the risk of cardiovascular disease, frailty, disability, and premature mortality. Growing evidence indicates that many of these age-related alterations are not solely consequences of chronological ageing but are substantially influenced by physical inactivity and may be attenuated through regular physical activity and structured exercise.

This lecture provides an evidence-based overview of the role of exercise in promoting healthy cardiovascular ageing by integrating classical physiological concepts with recent advances in molecular and cellular biology. The presentation begins by summarising the principal cardiac and vascular adaptations associated with ageing, including left ventricular remodelling, impaired diastolic function, arterial stiffening, endothelial dysfunction, and the progressive decline in cardiorespiratory fitness. It then examines epidemiological and clinical evidence demonstrating that regular physical activity and exercise training are associated with lower cardiovascular morbidity and mortality, improved functional capacity, and greater longevity and healthspan.

Recent research in the biology of ageing has substantially expanded our understanding of how exercise exerts cardioprotective effects. The lecture highlights the influence of exercise on key hallmarks of cardiovascular ageing, including mitochondrial dysfunction, impaired proteostasis, cellular senescence, chronic inflammation, oxidative stress, genomic instability, and dysregulated neurohormonal signalling. These adaptations provide a mechanistic explanation for the broad preventive and therapeutic benefits of exercise across the lifespan.

Finally, practical implications for exercise prescription in older adults will be discussed, emphasising individualised programmes that combine aerobic, resistance, and balance training according to functional capacity and health status. Overall, the lecture illustrates why exercise should be regarded as a cornerstone intervention for preserving cardiovascular function, extending healthspan, and reducing the burden of age-related cardiovascular disease.



Velocity-Based Training: From Theory to App

Held, S.

Department of Sport and Management, IST University of Applied Sciences, Düsseldorf, Germany

Velocity-based training (VBT) uses movement velocity during the concentric phase of resistance exercises to inform load prescription and set termination. Unlike fixed percentages of the one-repetition maximum (1RM), velocity provides immediate information about the load-velocity relationship and the decline in performance within a set. This may help account for day-to-day variation, individualise training stimuli and manage neuromuscular fatigue. However, velocity-based diagnostics are task-specific and reflect both neuromuscular capacity and its application within a particular movement.

We introduce the theoretical basis of VBT and translate it into practical training and assessment decisions. Using sprint profiling as a case example, we illustrate why horizontal sprint mechanics and vertical neuromuscular tests provide complementary, but not interchangeable, information. We show how load-velocity profiles, real-time feedback and predefined velocity-loss thresholds can support strength assessment, exercise prescription and training monitoring. We compare conventional 1RM testing and linear position transducers with inertial measurement units (IMUs) and app-based solutions. Evidence indicates that velocity-loss approaches can support strength and explosive performance while reducing acute performance decrements associated with failure-based training. Validated IMUs can estimate mean concentric barbell velocity with acceptable accuracy and reliability in specific exercises. Smartphone applications may further reduce cost and complexity by using video analysis or communicating with external sensors. However, an app interface alone does not establish measurement validity, and findings from one device, exercise or movement condition cannot automatically be transferred to another.

VBT links performance assessment directly with day-to-day training decisions. App-based measurements may complement dedicated laboratory and field sensors and, where appropriately validated, provide an accessible alternative. Practitioners should select systems according to the intended metric, exercise and required precision, apply standardised testing procedures, and interpret longitudinal changes in light of device-specific measurement error. Velocity data should therefore always be interpreted in relation to the specific task and intended training decision.



Wearables and AI: Do Smartwatches, ChatGPT, and More Make Us “Fitter”?

Düking, P.

Department of Sports Science and Movement Pedagogy, Technische Universität Braunschweig, Braunschweig, Germany

Wearable technologies and artificial intelligence (AI) are increasingly embedded in fitness and training practice, accompanied by strong claims that they can improve performance, health, and training outcomes. However, the availability and adoption of technology are advancing faster than the scientific evidence supporting many of these claims.

This presentation critically examines whether wearables and AI can genuinely make us fitter, using selected applications across the training process. Examples include large language models for generating training plans, infrared thermography for assessing muscular load, and heart rate variability-guided endurance training.

The available evidence suggests that these technologies can provide useful information and, in some contexts, support training decisions. At the same time, important limitations remain. AI-generated recommendations are not consistently complete or optimal and may require substantial domain knowledge to interpret safely. Thermography shows potential for monitoring muscular load, but physiological mechanisms, influencing factors, and evidence-based decision thresholds remain insufficiently established. HRV-guided training may support individualised endurance training, although the available evidence is still limited, particularly in highly trained athletes and long-term settings.

Wearables and AI should currently be viewed primarily as decision-support tools rather than autonomous decision-makers. As the level of automation increases, the underlying scientific evidence often becomes weaker. Technology selection should therefore start with the training problem rather than with the technology itself. Practitioners should critically evaluate both technological and non-technological solutions, understand the limitations of algorithms and measurements, and retain human expertise in the decision-making process.



Continuous Glucose and Ketone Monitoring – Applications and Potential in Sport and Exercise

Brinkmann, C.

Department of Fitness and Health, IST University of Applied Sciences, Düsseldorf, Germany

Continuous glucose and ketone monitoring provides the opportunity to capture individual metabolic responses to exercise and physical activity.

In people with diabetes mellitus, continuous glucose monitoring (CGM) is already well established. In the context of sport and exercise, CGM can help people with insulin-treated diabetes mellitus monitor glucose dynamics, adjust insulin administration and carbohydrate intake, and keep glucose levels within their individually targeted range during and after exercise. Through biofeedback and repeated experience of how exercise and physical activity can reduce postprandial glucose excursions, people with type 2 diabetes mellitus or prediabetes, particularly those who frequently experience hyperglycaemia, may be motivated to change their physical activity behaviour and become more active. The possibility of continuously monitoring ketones could potentially improve safety for people with type 1 diabetes mellitus, who are at increased risk of developing ketoacidosis, a dangerous metabolic complication.

Applications of continuous glucose and ketone monitoring in sport and exercise beyond diabetes mellitus are also being explored and critically discussed (e.g. for the optimisation of fuelling strategies or for gaining insights into changes in substrate metabolism). In general, it must be considered that physiological fluctuations in glucose and ketone body concentrations should not be overinterpreted, as this may cause unnecessary stress.

Further research is needed to gain a more comprehensive understanding of the relationships between interstitial glucose availability, ketone body concentrations, performance, and recovery, particularly in healthy individuals and athletes.



Beyond Thresholds and the Laboratory: Field Testing as a Window into Durability and Fatigue

Meixner, B.

Institute of Sport Science, University of the Bundeswehr Munich, Neubiberg, Germany

Laboratory testing remains the gold standard of endurance diagnostics: standardised, calibrated, and comparable. Two developments limit what it provides. Access remains restricted, whereas recreational athletes increasingly own power meters, heart-rate monitors, and wearable sensors and perform home-based testing irrespective of scientific endorsement. More fundamentally, conventional protocols characterise the rested athlete, quantifying maximal oxygen uptake, thresholds, and efficiency, but neglecting how these – and ultimately performance – are affected as fatigue accumulates.

The proposed fourth dimension concerns how the classical determinants, and the performance they support, change under prior work. Maximal oxygen uptake may decline, thresholds shift, and efficiency deteriorate, so rested-state rankings may no longer persist. Physiological deterioration does not necessarily translate proportionally into performance loss, as compensatory responses may temporarily preserve external performance despite a rising internal cost. Prior work is thus part of the measurement, not variability to be standardised away. Field and home diagnostics suit this problem because heart rate, pace, mechanical power, and perceived exertion can be tracked continuously, complemented where available by blood lactate, near-infrared spectroscopy, core temperature, and environmental exposure. The approach is sport-specific: cycling allows responses to be anchored to directly measured accumulated work; in running, external power is modelled and changes in physiological cost relative to speed may be more informative; in intermittent and multi-event competition, the question becomes how well performance is reproduced despite accumulated strain.

Field testing is therefore not merely a less controlled substitute for the laboratory. It can quantify both the deterioration of physiological capacities and the extent to which performance is maintained despite it. The presentation illustrates practical examples using commonly available field-based measures. Such values are interpretable only when the preceding work, its intensity distribution, nutritional intake, environmental conditions, and test duration are specified; otherwise, they characterise the protocol as much as the athlete.



Understanding the Role of Low-Intensity Exercise in Endurance Training

Lenk, M.

Integrative and Experimental Exercise Science and Training, Institute of Sport Science, University of Würzburg, Würzburg, Germany

Zone 2 training has gained considerable attention in endurance sports and the wider fitness community, with proposed benefits ranging from improved fat oxidation to enhanced mitochondrial adaptations. However, “Zone 2” does not refer to a universally defined exercise intensity. Different zone models and methods of intensity prescription can assign the same label to substantially different physiological intensities, making both scientific interpretation and practical application challenging.

This presentation examines what Zone 2 training actually represents and what role low-intensity exercise plays in endurance training. First, different approaches to defining Zone 2 are compared, highlighting the limitations of fixed intensity prescriptions and the importance of individual physiological responses. Second, the evidence for adaptations commonly attributed to Zone 2 training is evaluated. Low-intensity endurance training can improve aerobic fitness and induce mitochondrial and capillary adaptations, but current evidence does not suggest that a narrowly defined Zone 2 provides unique or consistently superior adaptations. Finally, the extensive use of low-intensity training by successful endurance athletes is considered within the context of overall training-intensity distribution rather than as evidence for an isolated optimal training zone.

Zone 2 should therefore be understood as a practical training tool rather than a uniquely effective physiological “sweet spot”. Effective training prescription requires a clear definition of intensity, consideration of individual responses, and integration of low-intensity exercise into the overall training programme.



HYROX® Decoded: Endurance Meets Strength

Schaffarczyk, M.

Integrative and Experimental Exercise Science and Training, Institute of Sport Science, Julius-Maximilians-Universität Würzburg, Würzburg, Germany

HYROX® combines repeated 1-km running bouts with functional exercise stations requiring strength, power and local muscular endurance. This combination creates substantial and repeatedly alternating metabolic and mechanical demands and raises the question of how endurance and strength capacities interact in determining performance. From the perspective of the classical interference hypothesis, simultaneously developing these capacities may appear inherently conflicting.

This presentation synthesises current evidence on the physiological and performance determinants of HYROX® and translates these findings into practical training implications. Available evidence indicates that HYROX® is predominantly supported by oxidative energy metabolism, while high-intensity exercise stations impose substantial anaerobic demands. Aerobic capacity therefore appears to provide an important physiological foundation for sustaining performance across the prolonged competition. Running accounts for approximately half of total race time and is strongly associated with overall performance, while strength and local muscular endurance remain relevant for limiting time losses during demanding functional stations. The repeated transitions from functional exercise to running may additionally challenge the ability to maintain efficient running under accumulated fatigue, and the concept of „durability“ – the progressive decline of physiological characteristics such as VO₂max or running economy over sustained exercise – may offer a promising framework for understanding this phenomenon in HYROX®. Current evidence on concurrent training challenges the notion that endurance and strength development are inherently incompatible and instead suggests that potential interference depends largely on how training volume, intensity, modality and sequencing are organised.

Effective HYROX® preparation should prioritise running performance while concurrently developing sufficient strength, power and muscular endurance to meet the demands of the functional stations. Training should combine aerobic endurance, high-intensity intervals and strength training with competition-specific run–station–run sessions. Rather than avoiding concurrent training, practitioners should strategically manage training volume, intensity, sequencing and specificity according to individual performance limitations.



Stop stretching like it's 1990: Practical takeaways from the new SPHERE guidelines

Wilke, J.

Department of Neuromotorics and Movement, University of Bayreuth, Bayreuth, Germany

Stretching is among the most popular forms of exercise and is applied for multiple purposes. Whereas compelling evidence is available regarding its actual efficacy, surveys still demonstrate a high prevalence of myths and misconceptions among coaches and practitioners.

Following a multi-round Delphi consensus process, a panel of the most active international stretching researchers (n=20) has issued the SPHERE guidelines. These guidelines provide specific recommendations on the optimal methods (e.g., static, dynamic, or PNF stretching) and training variables (e.g., weekly volume, number of sets, or set duration), tailored to various fields of application. While SPHERE encourages stretching to enhance range of motion, reduce stiffness (if this is desirable), and improve vascular health, it advocates against its use for injury prevention, post-exercise recovery, or postural imbalance. A further caution relates to stretching during warm-up, as this may compromise strength performance.

Contrary to common belief, stretching often fails to achieve the expected outcomes. Although it has proven efficacious in some specific contexts, it no longer represents the only viable method or may even be an inadequate exercise choice in others. The SPHERE guidelines provide a clear framework and nuanced guidance for practitioners seeking to apply stretching on an evidence-led basis.



Is stretching necessary? “Can I?” versus “Do I Have To?” - A practical perspective on stretching alternatives

Warneke, K.

Institute for Exercise, Sport and Health, Leuphana University, Lüneburg, Germany

Stretching is one frequently employed training routine to improve flexibility with a long-standing tradition reaching back to the ancient Greeks. For thousands of years, different types of stretching were used to prepare for subsequent movement/performance or to chronically enhance range of motion (ROM). Today, in sports and rehabilitation practice, the effects of stretching on injury prevention, within therapeutic applications, and on performance enhancement remain controversial.

The most recent expert consensus on stretching applications in healthy adults sought clarification regarding benefits and drawbacks when implementing stretching exercises. Although supporting evidence on stretch-induced advantages is missing in several settings, the expert panel made explicit suggestions for stretching dosages for ROM increases, passive stiffness decreases, or stretch-mediated hypertrophy and strength increases, as research indicated positive effects in acute and/or chronic studies. Accordingly, those athletes and coaches who seek to use stretching in their training routines are provided with helpful advice on how to compose their exercise routine. Because the stretching consensus is narrowly focused on stretch effects only, stretching's relative effectiveness remains uncertain.

To provide more context, the proposed underlying mechanisms of acute and chronic stretching effects in several settings will be revisited to discuss potentially more time-efficient alternatives where stretching was recommended as effective. Numerous more active alternatives can also improve acute ROM and have shown similar effectiveness without the potential harms of a stretch-induced force deficit. Chronic ROM, strength, and muscle size can be enhanced to a comparable or even higher extent by performing full ROM resistance training, long-length partials or eccentric overload, which seems to provide additional benefits, e.g., in injury prevention.

Although numerous psychological and neurovascular stretching effects as well as connective tissue property adaptations remain widely unexplored, it seems that stretching might be a possible, but not a required intervention for many goals.



Mechanisms Underlying Flexibility Increases With Acute and Chronic Stretching

Behm, D.

**School of Human Kinetics and Recreation Memorial University of Newfoundland St. John's,
Newfoundland and Labrador, Canada**

Stretching has been used for millennia to increase range of motion (ROM), enhance performance, improve movement efficiency, and reduce injuries. The mechanisms underlying stretching-induced increases in ROM are diverse and not always well understood. While the focus is typically on the responses of muscles and tendons, other tissues such as ligaments and fascia are also placed under tension affecting the extent of flexibility.

Since ligaments provide joint stability, the stretching goal is typically not to substantially decrease their stiffness, although stretch-induced tension up-regulates ligament fibroblast markers strengthening the ligament matrix making it more resistant to injury. Since tendon elongation exceeds muscle, stress-induced muscle strain surpasses tendon strain about four-fold. Since fascia fibronectins are in contact with integrin molecules on the muscle membrane, tension from stretching is transduced to the nucleus increasing protein synthesis and may aid injury prevention (↑ strength at longer muscle lengths). Myofibrils can stretch double their resting length mainly due to Titin, which acts as a spring in response to high tension. Whether relatively brief bouts of stretching can increase sarcomere number has yet to be determined in humans. Fascicle rotation may be more important for flexibility than fascicle lengthening. Connective tissue stiffness can be altered through realignment of collagen fibres. Increases in muscle fluid pressure will increase the resistance (passive stiffness) to muscle lengthening.

Acute increases in ROM with stretching can be attributed to thixotropic factors (decreased visco-elasticity), disfacilitation of spindle reflexes, cutaneous receptor reductions in sympathetic drive (decrease muscle tone) and increased stretch (pain) tolerance. Recommendations for increasing ROM include stretching 3–6 days per week, starting with a dynamic aerobic warm-up. When stretching there is no need to go to the maximum point of discomfort. For static and PNF stretching, hold the position for 30–60 s with 3–4 repetitions with 15–30 seconds of recovery for each muscle group.



Exercise is Medicine – Update Oncology

Zimmer, P.

Institute for Sport and Sport Science, TU Dortmund University, Dortmund, Germany

Physical activity and exercise training/therapy have risen to become cornerstones of both cancer prevention and cancer treatment. With regard to the latter, epidemiological studies have shown robust associations between physical activity and overall as well as cancer-specific mortality. Just recently, the first large-scale randomised controlled trial has delivered level Ia evidence for the effectiveness of exercise therapy to reduce mortality in persons suffering from colon cancer. An increasing number of translational studies suggest that at least some of those beneficial effects of exercise are driven by its anti-inflammatory and immunomodulating properties. Besides its impact on hard disease outcomes (e.g. mortality), a vast body of literature proves exercise as one of the most effective treatments to counteract disease- and treatment-specific effects, such as fatigue, lymphoedema, loss of bone density, depression, chemotherapy-induced polyneuropathies, and incontinence. Overall, these effects result in an increased quality of life throughout the course of the disease from curative to palliative settings.



BFR-Training Between Rehabilitation and Performance

Behringer, M.

Department of Sports Medicine and Exercise Physiology, Institute of Sport Sciences, Goethe University Frankfurt, Frankfurt am Main, Germany

Blood flow restriction (BFR) training combines partial restriction of arterial inflow and marked limitation of venous outflow with low-load resistance or aerobic exercise. It has moved from a rehabilitation technique to a method for enhancing athletic performance. This presentation critically examines where BFR provides meaningful benefit and where conventional training remains preferable.

Current syntheses indicate that low-load BFR produces greater strength and hypertrophy gains than equivalent low-load exercise without BFR. Hypertrophic adaptations may approach those achieved with high-load resistance training, whereas maximal strength gains generally remain smaller. The principal clinical value of BFR therefore lies in eliciting a substantial muscular stimulus while limiting external load. This is particularly relevant after orthopaedic surgery, during pain-limited rehabilitation, in older adults and when temporary reductions in mechanical loading are required. Evidence following anterior cruciate ligament reconstruction suggests possible improvements in quadriceps strength and selected patient-reported outcomes, although findings for muscle size, pain, function and long-term return to sport remain heterogeneous. In healthy athletes, BFR can provide supplementary hypertrophy or strength-endurance stimuli, support maintenance of muscle mass during injury or deloading, and add training volume with comparatively low mechanical stress. Effects on maximal strength, speed and sport-specific performance are less consistent, and BFR should not be considered a replacement for high-force, high-velocity or task-specific training. Aerobic BFR may improve aerobic capacity and peripheral muscular adaptations, but transfer to competitive performance remains uncertain. Safe application requires appropriate screening, suitable equipment, conservative pressure selection and monitoring of discomfort, neurological symptoms and haemodynamic responses.

BFR is best understood as a load-management strategy rather than a universally superior training method. Its value is greatest when mechanical load is the limiting factor. As tissue capacity and performance demands increase, BFR should progressively shift from a primary rehabilitation stimulus to a targeted adjunct within conventional strength and conditioning.

5th Fitness Science Congress

2026 | Düsseldorf

FITNESS-
WISSEN-
SCHAFTS-
KONGRESS



Clinical Setting

Saturday, 12 September 2026 | 15:00

36



HOCHSCHULE
für Management
University of Applied Sciences



Reversing Age-Related Muscle Loss: High-Intensity Resistance Training for the Prevention and Treatment of Sarcopenia

Giessing, J.

Institute of Sport Science, University Kaiserslautern-Landau (RPTU), Landau, Germany

Age-related loss of skeletal muscle mass begins as early as the fourth decade of life and may progress to clinically significant levels in later life. Sarcopenia is associated with an increased risk of metabolic and musculoskeletal disorders, including type 2 diabetes, hypertension and osteoporosis. It is particularly concerning that age-related muscle loss is associated with the progressive loss of entire motor units, comprising the motor neuron, its axon and the muscle fibres it innervates. This loss contributes substantially to the decline in neuromuscular function observed with advancing age.

Performed on a regular basis, resistance training is a key component of strategies aimed at preventing and managing sarcopenia. A substantial body of evidence indicates that high-intensity resistance training can increase muscle strength and mass in older adults and can counteract, and in some cases reverse, established sarcopenic changes.

Emerging evidence suggests that resistance training may also contribute to the maintenance of cognitive function and may reduce the risk of cognitive decline and neurodegenerative disease. Regular resistance training has been shown to induce muscle hypertrophy or, at a minimum, preserve muscle mass and strength in the elderly, provided that the training stimulus is appropriately intense and progressively adapted. Higher-intensity resistance training appears to be particularly effective because it provides a strong stimulus for the recruitment and maintenance of type II muscle fibres which are particularly vulnerable to age-related atrophy.

High-intensity training represents an effective approach to preventing and managing sarcopenia. By promoting the preservation and restoration of muscle mass, strength and neuromuscular function, resistance training has the potential not only to delay age-related functional decline but also to partially reverse established sarcopenic changes.



Block vs. Traditional Periodization in High-Intensity Functional Training

Micke, F.

Department of Sport and Management, IST University of Applied Sciences, Düsseldorf, Germany

High-intensity functional training (HIFT) aims to develop strength and metabolic conditioning concurrently, but its high cumulative demands make the organisation of training intensity and recovery particularly important. This study investigated whether concentrating high-intensity training into specific loading weeks produces greater adaptations than distributing the same training more evenly across time.

Twenty experienced HIFT athletes (11 women, 9 men; age 34.5 ± 9.8 years; training experience 5.8 ± 3.2 years) completed two six-week, load-matched interventions (block periodisation (BP) vs. traditional periodisation (TP)) in a randomised crossover design. Both conditions comprised five sessions per week and the same overall pool of metabolic conditioning and running sessions. TP distributed three high-intensity and two low-intensity sessions evenly each week. BP used two three-week cycles, each beginning with five high-intensity sessions, followed by two weeks with two high-intensity and three low-intensity sessions. Outcome measures included maximal strength, HIFT-specific workouts, countermovement-jump performance, body composition, blood pressure and blood glucose.

Compared with traditional periodisation, block periodisation produced greater improvements in isometric mid-thigh pull peak force ($p = 0.038$, $d = 0.82$), deadlift one-repetition maximum ($p = 0.018$, $d = 0.85$) and CrossFit® Total ($p = 0.027$, $d = 0.78$). Furthermore, waist circumference was significantly decreased following BP ($p = 0.019$, $d = -0.79$). Countermovement-jump performance was acutely reduced during the concentrated loading week of BP ($p < 0.001$, $d = -1.41$), indicating substantial temporary fatigue. No between-condition differences were observed for metabolic conditioning, resting blood pressure or blood glucose.

For experienced HIFT athletes, strategically concentrating high-intensity sessions may be a feasible way to prioritise strength development without compromising metabolic conditioning. However, concentrated loading weeks generate acute fatigue and should therefore be paired with planned recovery and appropriate monitoring.



What Do We Know About HIIT Today? An Overview of Evidence and Application

Sperlich, B.

Integrative and Experimental Exercise Science & Training, Department of Sport Science, Julius-Maximilians-Universität Würzburg, Würzburg, Germany

High-intensity interval training (HIIT) is an established endurance-training strategy for improving cardiorespiratory fitness and selected cardiometabolic outcomes. Contemporary research has shifted from determining whether HIIT is effective toward identifying the conditions under which it provides meaningful, sustainable, and sport-relevant adaptations. Three areas are particularly relevant: optimization of the training stimulus, minimal effective dosing, and integration of HIIT within recovery and nutritional constraints.

Acute indices such as time accumulated near maximal oxygen uptake may characterize cardiorespiratory strain but should not be interpreted as validated surrogates of chronic adaptation. Prescription relative to Critical Power or Critical Speed may improve individualization by accounting for exercise-intensity domains and the finite work capacity available above the critical threshold. Low-volume HIIT, reduced-exertion HIIT, and exercise snacks can improve cardiorespiratory fitness, particularly in inactive or time-constrained population

ns. However, their equivalence to comprehensive endurance-training programmes remains uncertain, especially regarding long-term progression, peripheral adaptations, performance specificity, and adherence.

The adaptive value of HIIT is further determined by recovery status, sleep, preceding training load, carbohydrate availability, and the capacity to maintain the prescribed external workload. Consequently, readiness assessment should integrate subjective, physiological, and performance-based indicators rather than rely on isolated metrics.

Although meta-analyses and umbrella reviews consistently support the efficacy of HIIT, interpretation is limited by overlapping primary studies, heterogeneous protocols, short intervention periods, intensive supervision, and insufficient reporting of achieved training dose. Statistical significance should therefore be distinguished from practical relevance. Future research should prioritize longer pragmatic trials, standardized intervention reporting, individual-response distributions, adherence, adverse events, and sport-specific performance outcomes. The principal question is no longer whether HIIT works, but for whom, at what dose, under which conditions, and with what long-term benefit.



Pregnancy and Training in Elite Sports – From Preconception to Postpartum

Legerlotz, K.

Department of Movement and Training Sciences, Institute of Sport Science, University of Wuppertal, Wuppertal, Germany

The health benefits of exercise during pregnancy are widely acknowledged and guidelines advise pregnant individuals to engage in regular moderate-intensity exercise. However, general guidelines are designed for the general population and do not account for unique challenges resulting from the high training load and other possible risks associated with training in elite sport, highlighting a critical gap this review aims to address.

A systematic search was conducted in accordance with the PRISMA-ScR guidelines. Studies were eligible for inclusion if they involved highly trained female athletes (tiers 3–5) during the pre-pregnancy, pregnancy, or postpartum phases. Data extraction included information on study design, athlete classification, training, health, performance, and psychological outcomes.

Of 5236 records examined, 101 were included, indicating a significant mismatch between reviews/overviews/books ($n = 55$) and original studies ($n = 46$). Elite athletes often plan their pregnancies very carefully. The available evidence does not demonstrate negative effects of high training loads on pregnancy outcomes. However, the limited, often outdated, and predominantly endurance-focused data do not allow firm conclusions. Evidence shows that elite athletes typically continue to train throughout pregnancy, adjusting the load, and resume training early after childbirth. Although highly individualised, performance recovery is feasible. Moderate-intensity exercise appears to be safe, but thresholds above 90% of maximum heart rate may affect foetal responses. Psychological stress, identity conflicts, and a lack of tailored guidelines are common challenges. Most birth outcomes match or exceed those of the general population.

Despite the increasing recognition of the advantages of continuing to train during pregnancy, elite athletes are still not receiving the evidence-based, sport group-specific guidelines they need to address their unique requirements and performance objectives. While no consistent evidence of adverse pregnancy outcomes from high training loads has been reported, the existing studies are too limited and heterogeneous to allow firm conclusions.



Influence of the Menstrual Cycle on Performance and Trainability

Zinner, C.

Institute of Sport Science, University of the Bundeswehr Munich, Neubiberg, Germany

It has been proposed that cyclical fluctuations in ovarian hormones across the menstrual cycle (MC) influence acute physical performance and adaptations to exercise in women. The steadily growing number of studies about acute performance changes across the MC as well as MC-based training periodisation raises the question of whether the current evidence is sufficient to give specific recommendations for training.

Fluctuations in ovarian hormones, particularly oestradiol and progesterone, have been suggested to affect neuromuscular performance and substrate metabolism. Furthermore, higher performance together with a potentially increased favourable hormonal milieu especially in the follicular phase of the MC has sometimes been proposed. Accordingly, adapting training frequency, intensity, or volume across the MC has been suggested as a strategy to optimise training adaptations.

However, the available evidence supporting MC-based training periodisation remains limited and inconsistent. In a recent study, we compared two periodisation models in resistance-trained women. One group had a greater proportion of the training volume during the follicular phase, the other group during the luteal phase. Both groups showed comparable improvements in body composition and strength, with no meaningful differences between groups. These findings indicate that the overall training stimulus and progressive overload may be more relevant determinants of adaptation than the distribution of training volume across specific MC phases.

Although the number of studies on the MC and exercise is increasing, substantial knowledge gaps remain. Current evidence does not show consistent or practically meaningful effects of MC phase on physical performance or for MC-based training periodisation at the group level. The individual responses and cycle-related symptoms vary considerably. Therefore, women may benefit from monitoring their individual cycle and associated symptoms and adjusting training when meaningful individual patterns are observed.



Female Biomechanics and its Relevance to Injury Prevention

Zech, A.

**Department of Human Movement and Exercise Science, Institute of Human Movement Science,
University of Hamburg, Hamburg, Germany**

Although male and female athletes differ regarding their physiology, anatomy, biomechanics, injury risk and performance, research studies in exercise and sports medicine pay little attention to sex-specific analyses. This often includes a lack of a well-balanced ratio of women and men in mixed-sex studies or the neglect of female athletes. Recent evidence suggests that sex-specific differences in biomechanics explain differences in the risk of lower extremity injuries such as anterior cruciate ligament or hamstring injuries between female and male athletes. Future research and sports practice should clearly differentiate between both sexes when it comes to the identification of injury risk factors as well as the development and implementation of effective prevention and rehabilitation measures.



The Relevance of Biological Maturation in Youth Sport: Insights From Female and Male Football

Ruf, L.

TSG ResearchLab gGmbH, Zuzenhausen, Germany & TSG 1899 Hoffenheim, Zuzenhausen, Germany

Youth academies continuously aim to identify, select and develop the most promising talents within each age group. In this context, biological maturation, referring to the process of progressing towards the adult state, plays a crucial role, as differences in maturity status within a single age group can span up to six years during adolescence. This presentation highlights the relevance of biological maturation in male and female youth football by providing findings from applied research and the translation of these insights into practice.

A first focus is placed on maturity-associated selection biases. In male youth football, there is a consistent trend towards advanced maturity emerging around the adolescent growth spurt. However, increasing awareness of this phenomenon among key stakeholders has prompted new research questioning whether these selection patterns have changed over recent years. In female youth football, evidence on maturity-associated selection biases remains comparatively scarce, and emerging findings offer new insights into whether similar patterns exist.

A second focus addresses the relationship between biological maturation and physical performance. In male youth football, it is well established that advanced maturity confers an advantage in physical performance qualities such as strength, speed and power. In female youth football, however, this relationship remains considerably less understood. First findings are presented, enabling a more developmentally informed evaluation of the impact of maturation upon physical performance in female youth football.

The translation of research findings into practice is highlighted by showing how physical performance data can be contextualised in relation to both chronological age and maturity. In addition, initiatives such as bio-banding in the female academy are demonstrated together with perceptions of players, coaches and parents. Collectively, these findings underscore the importance of integrating biological maturation into talent development processes and demonstrate how research and practice can work hand in hand.



Beliefs and Myths Versus Science in Exercise Training

Rappelt, L.

Institute of Exercise Science and Sport Informatics, Department of Applied Exercise Science, German Sport University Cologne, Cologne, Germany

Misinformation, beliefs and myths are widespread in the fitness industry. Most persistent myths, however, do not originate in false physiology, but in correct findings that have been separated from the conditions under which they were obtained. In this context, the resulting statement remains plausible, travels easily, and becomes difficult to correct precisely because its core is sound.

The presentation examines several myths, among them that fat oxidation begins only after thirty minutes of exercise, that a cyclist climbing a hill emits more CO₂ than a car, that a strong back is a back without pain, and that sitting is the new smoking and cannot be offset by activity. Each is read against a published account of how false beliefs spread, which distinguishes the ways a belief travels between people from the ways the available evidence is shaped before it travels. All myths are traced back to their respective origins, checked against the available literature and corrected where necessary. Moreover, expert corrections are shown to be subject to the same process as the claims they address. Drawing on a documented case of scientific consultancy for a national news magazine, four outcomes are distinguished: adoption, weakening until the qualifying clause has gone, omission, and reversal of the submitted statement.

Corrections appear to inherit the same failure mode as the myths they replace: a conditional finding is transmitted unconditionally, merely with the opposite sign. Thus, it seems reasonable to assume that the boundary condition, rather than the conclusion, is the part worth transmitting. The presentation closes with a short set of questions intended for use before a finding is passed on, concerning the endpoint, the size of the effect, the conditions under which a result applies, the provenance of the statement, and the cost of the advice should it prove wrong. Thus, for practitioners and communicators alike, evidence-based practice may be less a matter of knowing the current answer than of knowing the conditions under which it holds.



The Menopausal Transition and Skeletal Muscle: Interactions Between Estrogen Status and Physical Training

Hansen, M.

Department of Public Health, Aarhus University, Aarhus, Denmark

The menopausal transition is accompanied by a marked decline in circulating oestrogen, which is associated with a reduction in skeletal muscle mass, strength and function. These changes may impair physical capacity and increase the risk of sarcopenia, functional limitations and loss of independence later in life. Identifying effective strategies to preserve skeletal muscle health during and after the menopausal transition is therefore increasingly important.

Resistance exercise and adequate dietary protein intake are key strategies for maintaining skeletal muscle mass and function with advancing age. Nevertheless, emerging evidence suggests that the decline in oestrogen may influence muscle protein turnover, satellite cell activity, muscle quality and the adaptive response to exercise. Human studies indicate that postmenopausal women may exhibit a reduced anabolic response to resistance exercise compared with younger women, although findings are not entirely consistent. Oestrogen-based menopausal hormone therapy may support skeletal muscle maintenance and enhance selected adaptations to exercise, but its effects appear to depend on factors including treatment type, timing, training status and the specific outcome assessed. Importantly, regular physical training remains effective in improving muscle strength and function after menopause, even when gains in muscle mass are modest.

The menopausal transition represents an important period for the implementation of strategies to preserve skeletal muscle health. Resistance training should be considered a cornerstone of these strategies, while the potential modifying role of oestrogen status and menopausal hormone therapy requires further investigation. This presentation will integrate evidence primarily from human in vivo studies and discuss how hormonal status may interact with exercise-induced skeletal muscle adaptations.