

SP-01-01

STUDY PROTOCOL

NR. 105

Wagner S, Haigis D, Bile M, Beiner E, Nieß AM, Fallgatter AJ, Eschweiler GW, Cramer H, Krauß I

Effektivität und Sicherheit von hochintensivem Intervalltraining, Yoga und intermittierender Hypoxie-Hyperoxie Exposition auf die kognitive Leistungsfähigkeit und Gesundheit bei Personen mit leichter kognitiver Beeinträchtigung

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Hintergrund:** Personen mit leichter kognitiver Beeinträchtigung (MCI) haben ein erhöhtes Risiko, an Demenz zu erkranken. Da momentan keine kurativen medikamentösen Therapien für MCI zur Verfügung stehen, stellen nicht-pharmakologische und bewegungsbezogene Verfahren einen vielversprechenden Ansatz dar. Ziel dieser Studie ist die Untersuchung der Auswirkungen nicht-pharmakologischer Interventionen auf die kognitive Leistungsfähigkeit von Personen mit MCI.
- **Methoden:** Die Studie wird als prospektive, randomisierte, Schein-kontrollierte, monozentrische Überlegenheitsstudie mit Parallelgruppen-Design durchgeführt (DRKS00038438). Insgesamt werden 100 Patienten im Alter von ≥ 60 Jahren mit MCI randomisiert und einer der drei Interventionsgruppen bzw. der Kontrollgruppe zugeteilt. Die drei Interventionsgruppen umfassen aerobes hochintensives Intervalltraining (HIIT), Yoga und intermittierende Hypoxie-Hyperoxie-Exposition (IHHE). Die Probanden der Kontrollgruppe erhalten eine Scheinbehandlung von IHHE (IHHE-S). Den primären Endpunkt stellt die kognitive Funktion nach dreimonatiger Interventionsphase dar, welche mittels Montreal Cognitive Assessment (MoCA) erfasst wird. Zu den sekundären Endpunkten und der Bewertung modifizierbarer Risikofaktoren für Demenz gehören u.a. Lebensqualität, Laborparameter, körperliche Aktivität, anthropometrische Daten und kardiorespiratorische Fitness.
- **Diskussion:** Diese Studie untersucht die Effektivität und Sicherheit von HIIT, Yoga und IHHE bei der Verbesserung der kognitiven Funktionen im Vergleich zu einer Scheinkontrolle mit IHHE-S. Die Ergebnisse könnten mit dem Ziel der Demenzprävention zur Entwicklung künftiger Therapieoptionen für Patienten mit MCI beitragen.

SP-01-03

STUDY PROTOCOL

NR. 142

Lauscher L, Ganahl A, Rosch M, Hecksteden A, Mazzolari R

Die Bedeutung muskulärer Beanspruchung für die Verträglichkeit von präventivem Training unter Statintherapie

MEDIZINISCHE UNIVERSITÄT INNSBRUCK, Austria

- Eine bekannte Nebenwirkung der cholesterinsenkenden Medikamentengruppe der Statine sind Statin-assoziierte Muskelsymptome (SAMS). Diese umfassen Muskelbeschwerden wie Myalgien und Schwäche und sind mit erhöhten Kreatinkinase-Serumkonzentrationen (CK) assoziiert. Obgleich die zugrunde liegenden Mechanismen nicht abschließend geklärt sind, legen molekularbiologische Befunde nahe, dass Belastungsformen mit hoher muskulärer Beanspruchung das Auftreten von SAMS begünstigen, während moderat-intensive Ausdauerbelastungen mit geringer muskulärer Beanspruchung die Statintoleranz möglicherweise sogar erhöhen könnten. Bestätigen sich diese Hypothesen, würde dies eine gezielte Anpassung von Trainingsempfehlungen für Patienten unter Statin-Medikation ermöglichen.
- Vor diesem Hintergrund soll der Effekt von leitliniengerechten Trainingseinheiten mit unterschiedlicher muskulärer Beanspruchung auf Marker von SAMS in Statin-Anwender:innen und Statin-naiven Personen verglichen werden. Die Zielpunkte umfassen Veränderungen von CK, der Druckschmerzschwelle und der Schmerzempfindung auf der visuellen Analogskala. Wir erwarten zunehmende Unterschiede zwischen Statin-Anwender:innen und Kontrollpersonen mit ansteigender muskulärer Beanspruchung.
- Durchgeführt wird eine prospektive Fall-Kontroll-Studie mit Dosisescalation der muskulären Beanspruchung innerhalb der Vorgaben aktueller Leitlinien. Eingeschlossen werden jeweils 20 körperlich inaktive Statin-einnehmende bzw. Statin-naive Erwachsene (30-65 Jahre) ohne relevante Vorerkrankungen. Matching erfolgt nach Geschlecht, Alter und BMI. Nach einer Familiarisierung durchlaufen die Teilnehmer:innen vier konsequente Blöcke mit jeweils zwei identischen Belastungseinheiten. Während der erste Block 40-minütige Ausdauertrainingseinheiten auf einem Fahrradergometer bei 60% Herzfrequenzreserve umfasst, sind die Blöcke zwei, drei bzw. vier aus maschinenbasiertem Krafttraining bei 40, 60 bzw. 80% des geschätzten 1RM mit 20, 12 bzw. 8 Wiederholungen zusammengesetzt. Die Trainingseinheiten werden in einem Abstand von 5-21 Tagen durchgeführt. Die Messung der Zielpunkte erfolgt unmittelbar vor bzw. 24 Stunden nach den individuellen Trainingseinheiten. Jedem Block folgt eine 10RM-Testung zur Ermittlung der geschätzten Maximalkraft. Zusätzlich füllen die Teilnehmer:innen täglich einen Fragebogen zu Muskelsymptomen sowie subjektiven Erholungsbedürfnissen aus.
- Die statistische Auswertung erfolgt mittels eines gemischten linearen Modells, um die hierarchische Datenstruktur zu berücksichtigen. Analysiert werden die Effekte von Gruppe, Trainingsintensität sowie deren Interaktion.

SP-01-02

STUDY PROTOCOL

NR. 114

Burkhardt M, Kubosch EJ, Mrachacz-Kersting N

Corticomuscular Coherence as a Predictor for long-term Mobility after Transtibial Amputation

UNIVERSITÄTSKLINIKUM FREIBURG, Germany

- **Background:** Regaining mobility with a prosthesis has been shown to be most significant rehabilitation goal for an amputee's quality of life. To enable accurate long-term mobility prediction and improve care procedures, valid and reliable prediction models and information on influential factors are needed. Current models using disease history and socio-economic data only partially explain the variance in rehabilitation outcomes. Corticomuscular coherence (CMC) depicts neuromuscular function, which is essential for completing motion tasks. This parameter may therefore prove a valid and reliable parameter for functional changes and a predictor for long-term mobility after amputation.
- **Methods:** In a longitudinal design, CMC will be measured in transtibial amputees during isometric strength tasks in four sessions within a period of 12 months after surgery. CMC will be calculated using surface EMG data from multiple leg muscles and EEG data from the motor cortex. Balance and mobility will be tested 6 and 12 months post-surgery and correlated with early CMC values using a mixed-effects model with random intercept and slope, and respecting potential covariates such as age, indication for amputation and psychological status. CMC will also be tested for longitudinal change using a linear mixed model, and compared to values from a matched, non-amputated control group using a two-tailed t-test.
- **Results:** Expected results are longitudinal changes in CMC and a positive correlation with long-term mobility and balance, potentially influenced by age, clinical indication and psychological status.
- **Conclusion:** In the case of significant correlations between CMC and mobility, appropriate diagnostics should be integrated into the care process after amputation and should then be tested for other amputations such as upper leg or upper limbs. Should significant longitudinal changes in CMC be found, potential intervention methods addressing these during rehabilitation should be developed to improve the correlated mobility outcome.

SP-01-04

STUDY PROTOCOL

NR. 200

Müller P, Tiedemann S

Hämodynamische Reaktionen auf akutes Krafttraining – Valsalva-Manöver, isometrische und dynamische Übungen im Vergleich: ein Studienprotokoll

UNIVERSITÄTSKLINIKUM MAGDEBURG A.Ö.R., Germany

- **Hintergrund:** Krafttraining erzeugt ausgeprägte akute hämodynamische Reaktionen, deren Charakteristik je nach Übungstyp und Atemmuster erheblich variiert. Während isometrische Übungen durch kontinuierlichen Muskeldruck auf die Gefäße wirken, erzeugen dynamische Übungen phasische Drucksitzen. Das Valsalva-Manöver (VM) als häufige Atemstrategie bei schwerer Last kann zusätzlich eigenständige kardiovaskuläre Reaktionen auslösen. Systematische Daten, die alle drei Komponenten unter einem standardisierten Protokoll und über verschiedene kardiovaskuläre Risikoprofile hinweg vergleichen, fehlen bislang.
- **Methoden:** Die HEART-Study (Hemodynamic Effects of Acute Resistance Training) ist eine prospektive, monozentrische Pilotstudie (Universitätsklinikum Magdeburg) mit ca. 40 Probanden, stratifiziert in vier Gruppen: gesunde junge Erwachsene, Personen mit arterieller Hypertonie, ältere Erwachsene (≥ 60 Jahre inkl. postmenopausaler Frauen) sowie Kraftsportler. Das Protokoll umfasst zwei Messtermine: Messtermin 1 beinhaltet ein isoliertes Valsalva-Manöver in drei Intensitätsstufen ($\sim 30/50/100\%$ EPmax) als hämodynamisches Referenzprofil sowie isometrische Kraftübungen (Handgrip, Wall Sit, Plank, isometrische Beinpresse bei zwei Gelenkwinkeln). Messtermin 2 umfasst dynamische Übungen (Goblet Squat, Kreuzheben, Overhead Press, Bizeps Curl) bei 60/80/90% des Einer-Wiederholungsmaximums, jeweils unter zwei Atemvarianten: kontrollierter Expiration und Valsalva-Manöver. Der Blutdruck wird über beide Termine kontinuierlich beat-to-beat nichtinvasiv mittels CNAP erfasst. Ergänzend werden Herzfrequenz, Schlagvolumen, totaler peripherer Widerstand, Pulswellengeschwindigkeit sowie Kraft-Zeit-Verläufe (Tindeq 500) gemessen. Die statistische Auswertung erfolgt explorativ: deskriptiv nach Gruppen, Gruppenvergleiche via ANOVA bzw. nichtparametrischen Verfahren sowie multivariable lineare Regressionsmodelle.
- **Ergebnisse:** Da es sich um ein Studienprotokoll handelt, liegen zum Zeitpunkt der Einreichung noch keine Ergebnisse vor. Primäre Outcomes sind maximaler systolischer und diastolischer Blutdruck sowie Blutdruckerholungszeit nach Belastungsende. Sekundäre Outcomes umfassen Herzfrequenzverlauf, Belastungswahrnehmung (Borg-Skala), unerwünschte Ereignisse sowie Feasibility-Parameter.
- **Schlussfolgerung:** Die HEART-Study erfasst erstmals systematisch und risikostratifiziert die hämodynamischen Reaktionen auf Valsalva-Manöver, isometrische und dynamische Kraftübungen in einem einheitlichen Protokoll. Der direkte Vergleich aller drei Belastungsformen ermöglicht eine differenzierte Bewertung übungstyp- und atemstrategiespezifischer Blutdrucksitzen, die als Grundlage für eine sichere Dosierung von Krafttraining in bevölkerungsnahen Präventionsprogrammen dienen soll.

SP-01-05

STUDY PROTOCOL

NR. 226

Schwarz E, Jerg A, Hartveg P, Beck M, Buckert D, Mühling B, Schulz S, Kirsten J

Implementation and Feasibility of an Ambulatory Prehabilitation Program in Patients with Non-Small Cell Lung Cancer (NSCLC)

UNIVERSITÄTSKLINIKUM ULM, Germany

- **Hintergrund:** Patients with non-small cell lung cancer (NSCLC) frequently present with reduced functional capacity and relevant comorbidities, increasing the risk of treatment-related complications. Prehabilitation has emerged as a promising strategy to improve physical performance, treatment tolerance, and quality of life. However, implementation in routine clinical care especially beyond surgical settings remains insufficiently studied.
- **Methods:** This monocentric prospective observational study investigates the feasibility and implementation of an ambulatory multimodal prehabilitation program at the University Hospital Ulm. Up to 200 patients with newly diagnosed NSCLC will be included. The intervention consists of supervised high-intensity interval training (HIIT), resistance training (HIRT), respiratory therapy, and mobility exercises, performed three times per week.
- **Assessments** are conducted at baseline (T0), post-intervention (T1), and follow-up (T2), including functional performance (Steep Ramp Test, 6-minute walk test, handgrip strength), pulmonary function (FEV₁, FVC), body composition, and patient-reported outcomes (SF-36, HADS, SGRQ).
- **Endpoints:** Primary endpoints include changes in physical performance and feasibility parameters (recruitment rate, adherence, dropout rate). Secondary outcomes comprise quality of life, psychological status, and additional functional measures.
- **Conclusion:** This study evaluates the real-world feasibility of integrating structured prehabilitation into oncological care pathways and aims to provide evidence for its clinical implementation in NSCLC patients.

SP-01-06

STUDY PROTOCOL

NR. 258

Nies S, Dieter V, Braun N, Greule C, Whittaker JL, Pohl M, Zieser K, Ahrend MD, Krauß I

Digital-gestützte Bewegungs- und Verhaltensintervention (KOALA) zur Prävention einer posttraumatischen Kniearthrose: Studienprotokoll für eine einarmige Pilotstudie

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Hintergrund:** Die Verletzung des vorderen Kreuzbandes (VKB) zählt zu den häufigsten Verletzungen des Kniegelenks und erhöht das Risiko einer posttraumatischen Arthrose (PT-OA). Die postoperative Rehabilitation fokussiert primär die Wiederherstellung der Gelenkfunktion, während die Aufklärung über langfristige Folgen (z.B. Entwicklung PTOA) sowie entsprechende Strategien zum Risikomanagement bislang unzureichend berücksichtigt werden. Sekundärpräventive Interventionen wie gezieltes körperliches Training, regelmäßige Bewegung, eine ausgewogene Ernährung und effektives Gewichtsmanagement gelten als vielversprechende Präventionsansätze. Deren spezifische Wirksamkeit auf die Reduzierung von Verzögerung oder Verhinderung von Folgen nach einer VKB-Rekonstruktion benötigt weitere Untersuchungen.
- Ziel des übergeordneten Projekts ist die Reduktion des PT-OA-Risikos durch ein Programm zur Kniegesundheit, das sekundärpräventiv gesundheitsförderliche Verhaltensweisen adressiert und die langfristige Gelenkgesundheit fördert. Die vorliegende nicht-kontrollierte Pilotstudie prüft die Machbarkeit hinsichtlich (1) Adhärenz zur KOALA-Intervention (1st Zielmessgröße), (2) Rekrutierung, (3) KOALA-Intervention und (4) Zielgrößenerhebung sowie Abschätzung der zu erwartenden Effektmaße. Aussagen zur PT-OA-Inzidenz sind nicht intendiert.
- **Methode:** Erwachsene bis 35 Jahre mit akuter VKB-Ruptur wurden für die telemedizinische patientenzentrierte KOALA-Intervention rekrutiert, welche vorläufig bei Aufnahme und endgültig nach Prüfung intra-operativer Kriterien eingeschlossen wurden. Die Fallzahl (n=40) wurde anhand der Machbarkeit der KOALA-Intervention (mindestens 70%) mittels exakten Binomialtest (Fleming Design) berechnet ($\alpha = 0,05$). Sechs Monate nach der OP startet die 12-wöchige KOALA-Intensiv-Phase mit Patientenedukation, individuellen SMART-Zielen und regelmäßigen Beratungsgesprächen. Gefolgt von 12 Wochen KOALA-Booster-Phase mit reduzierter Supervision und Fokus auf Selbstmanagement. Ergänzend wird ein wöchentliches Online-Gruppentraining angeboten. Die Daten werden mittels Excel und SPSS deskriptiv, über Effektgrößen (Cohen's d) und Regressionsanalysen ausgewertet.
- **Ergebnisse:** Erste Ergebnisse werden im April 2027 erwartet.
- **Diskussion:** Diese Pilotstudie wird durch das interne Programm „Applied Clinical Research (AKF)“ der Medizinischen Fakultät der Eberhard Karls Universität Tübingen gefördert (AKF-Förderantrag Nr. 1016-0-0) und leistet einen wichtigen Beitrag zur Erweiterung der Erkenntnisse über das Potenzial lebensstilbasierter Verhaltensstrategien in der Sekundärprävention nach VKB-Verletzungen. Bei nachgewiesener Machbarkeit ist die Durchführung einer randomisiert kontrollierten Studie zur Evaluation der Wirksamkeit geplant.

SP-01-07

STUDY PROTOCOL

NR. 271

Schulz J, van den Bongard F, Reinsberger C

EpiExCITE – Epilepsy and Exercise: Cardiorespiratory fitness and Intensity triggered Effects – Studienprotokoll

PADERBORN UNIVERSITY, Institute of Sports Medicine, Germany

- **Hintergrund:** Die Angst vor sportassoziierten Anfällen stellt eine bedeutende Barriere für die sportliche Aktivität bei vielen Epilepsiepatienten dar. Die zugrunde liegende Pathophysiologie sowie die Einflüsse der Ausdauerleistungsfähigkeit und der Belastungsintensität auf die sportassoziierten Anfälle bei etwa 10 % der Epilepsiepatienten sind bislang unzureichend erforscht. Studienergebnisse weisen auf eine negative Korrelation zwischen der maximalen Sauerstoffaufnahme (VO₂max) und sportassoziierten Anfällen hin. Außerdem deuten einzelne Berichte daraufhin, dass eine höhere Belastungsintensität mit einer höheren Anfallsinzidenz korreliert. Diskutierte pathophysiologische Mechanismen bei reduzierter Ausdauerleistungsfähigkeit umfassen eine geringere Effektivität des respiratorischen Kontrollsystems, eine Dysfunktion des autonomen Nervensystems sowie eine verstärkte Variabilität des Blutglukosespiegels.
- **Forschungsfrage:** Unterscheiden sich Epilepsiepatienten mit hoher und niedriger Ausdauerleistungsfähigkeit (VO₂max) während einer maximalen im Vergleich zu einer submaximalen Belastung hinsichtlich des Blut-pH-Wertes, des Blutglukosespiegels und autonomer Parameter (Root Mean Square of Successive Differences (RMSSD), elektrodermale Aktivität (EDA)), die als potenzielle Einflussfaktoren auf die Anfallswahrscheinlichkeit angesehen werden?
- **Methode:** Das Studiendesign umfasst eine Querschnittsuntersuchung von 30 Epilepsiepatienten (alle Syndrome) und 30 gesunden gematchten Kontrollpersonen (18-60 Jahre), die jeweils 2 Termine absolvieren: Spiroergometrie bis zur Ausbelastung (Termin 1) sowie Ergometrie bis 70% der HFmax (Termin 2). Vor und nach den beiden Belastungen erfolgt jeweils eine Ruhemessung (EEG [epilepsietypische Potentiale], EKG [HF, RMSSD], elektrodermale Aktivität [meanEDA], Blutabnahme [Serumkonzentration Antikonvulsiva, pH-Wert und Glukose]). Während der Belastungen werden EKG [HF, RMSSD], elektrodermale Aktivität [meanEDA] und Laktat gemessen und bei der Ausbelastung erfolgt zusätzlich eine Spirometrie (VO₂max).
- **Ausblick:** Die Studie untersucht den Einfluss von Ausdauerleistungsfähigkeit und Belastungsintensität auf die während körperlicher Aktivität ablaufenden physiologischen Mechanismen und deren potenzielle Bedeutung für die Anfallswahrscheinlichkeit bei Epilepsiepatienten. Ein besseres Verständnis der zugrunde liegenden Mechanismen kann entscheidend dazu beitragen, Barrieren für die sportliche Teilhabe von Epilepsiepatienten abzubauen und praxisrelevante Aktivitätsempfehlungen weiterzuentwickeln.

SP-01-08

STUDY PROTOCOL

NR. 282

Führmeister S-S, Kalski L, Wolfarth B

Evaluation des multimodalen Therapie- und Nachsorgekonzepts „AdiFit“ zur Behandlung von Adipositas

CHARITÉ – UNIVERSITÄTSMEDIZIN BERLIN/ HUMBOLDT-UNIVERSITÄT ZU BERLIN, Germany

- **Hintergrund:** Adipositas ist eine multifaktorielle Erkrankung mit hoher gesundheitlicher und gesellschaftlicher Relevanz, die mit einem erhöhten Risiko für somatische und psychische Komorbiditäten sowie mit Einschränkungen der Erwerbsfähigkeit einhergeht. Vor diesem Hintergrund gewinnt die Adipositas-Therapie in der medizinischen Rehabilitation zunehmend an Bedeutung. Zur nachhaltigen Verbesserung von Gesundheit, Teilhabe und beruflicher Leistungsfähigkeit hat die Rehabilitationsklinik Hohenelse der DRV Berlin-Brandenburg (DRV-BB) ein strukturiertes, multimodales und interdisziplinäres Rehabilitationskonzept entwickelt. Die Evidenz zur Wirksamkeit solcher Maßnahmen ist bislang jedoch begrenzt. Ziel der vorliegenden Studie ist es daher, die Effektivität und Nachhaltigkeit des Rehabilitationsprogramms „AdiFit“ zu evaluieren sowie relevante Erfolgsfaktoren und potenzielle Umsetzungshürden zu identifizieren.
- **Methodik:** Das Forschungsprojekt ist als prospektive Evaluationsstudie im Mixed-Methods-Design konzipiert. Eingeschlossen werden n = 100 Rehabilitand:innen mit der Zuweisungsdiagnose Adipositas, die am stationären Rehabilitationsprogramm „AdiFit“ der Rehabilitationsklinik Hohenelse teilnehmen. Die Datenerhebung erfolgt zu insgesamt sechs Messzeitpunkten. Medizinisch-diagnostische Daten werden standardisiert im Rahmen ärztlicher Untersuchungen zu Beginn und am Ende des Rehabilitationsaufenthalts erhoben. Psychosoziale, berufsbezogene und verhaltensbezogene Parameter werden fragebogenbasiert sowohl während des stationären Aufenthalts als auch im Rahmen einer zwölfmonatigen Nachbeobachtungsphase in dreimonatigen Intervallen erfasst. Ergänzend werden Aktivitätstracker eingesetzt, die über den gesamten Beobachtungszeitraum hinweg objektive Aktivitäts- und Gesundheitsdaten aufzeichnen. Zur Identifikation von Erfolgsfaktoren und Umsetzungshürden werden qualitative Daten mittels leitfadengestützter Interviews und Fokusgruppen erhoben und inhaltsanalytisch ausgewertet. Die Programmnutzung wird begleitend systematisch dokumentiert.
- **Ergebnisse:** Ergebnisse werden im Jahr 2028 erwartet. Es lassen sich Erkenntnisse zur Wirksamkeit des Rehabilitationsprogramms in Bezug auf medizinische, psychosoziale und funktionale Zielgrößen sowie zur Nachhaltigkeit der Effekte über einen Zeitraum von 12 Monaten gewinnen. Darüber hinaus werden zentrale Gelingenbedingungen und potenzielle Umsetzungshürden identifiziert.
- **Zusammenfassung:** Die Studie leistet einen Beitrag zur Verbesserung der Evidenzlage adipositas-spezifischer Rehabilitationsmaßnahmen. Die gewonnenen Erkenntnisse können zur wissenschaftlich fundierten Weiterentwicklung entsprechender Programme beitragen und praxisnahe Handlungsempfehlungen für Rehabilitationseinrichtungen, gesundheitspolitische Akteur:innen und die Forschung ableiten.

SP-01-09 STUDY PROTOCOL NR. 285

Schlüter P, Kalski L, Karathanos A, Hafermann L, Hofmann MA, Wolfarth B

Der Einfluss der Ü45-Check Studie auf die Inanspruchnahme von Präventions- und Rehabilitationsleistungen – Eine Follow-up-Studie

HUMBOLDT-UNIVERSITÄT ZU BERLIN, Germany

- **Hintergrund:** Die frühzeitige Identifikation gesundheitlicher Risikofaktoren ist zentral für den Erhalt der Erwerbsfähigkeit. Die Ü45-Check-Studie (2021–2024) untersuchte den Gesundheitszustand von Versicherten der DRV Berlin-Brandenburg (DRV-BB) im Alter von 45–59 Jahren. Dabei wurden fragebogenbasierte und klinisch erhobene Befunde getrennt in den Risikoindex Erwerbsminderungsrente (RI-EMR) überführt, um die Übereinstimmung beider Verfahren in der Identifikation von Präventions- und Rehabilitationsbedarfen zu vergleichen. Es zeigte sich eine geringe Übereinstimmung (29 %) sowie eine deutliche Unterschätzung des Rehabilitationsbedarfs durch den Fragebogen. Es stellt sich die Frage, inwieweit die identifizierten Bedarfe mit der tatsächlichen Inanspruchnahme von Maßnahmen und der Erwerbsentwicklung zusammenhängen. Aufbauend auf diesen Ergebnissen zielt die vorliegende Follow-up-Studie darauf ab, den Zusammenhang von Präventions- und Rehabilitationsmaßnahmen auf die Gesundheit, Erwerbsbiografie und -teilhabe zu untersuchen sowie klinisch relevante Parameter zu identifizieren, um so den Ü45-Check zu optimieren.
- **Methodik:** Die Follow-up-Studie wird als Längsschnittstudie konzipiert. Die Interventionsgruppe umfasst die 1.040 Teilnehmenden der ursprünglichen Ü45-Check-Studie, die erneut kontaktiert und zu einer klinischen Nachuntersuchung sowie einer Fragebogenerhebung eingeladen werden. Ergänzend wird eine Kontrollgruppe aus zufällig gezogenen Versicherten der DRV-BB einbezogen, die nicht an der Erststudie teilgenommen haben und mittels Fragebogen zur Inanspruchnahme von DRV-Leistungen sowie ihrer Erwerbsbiografie und -teilhabe befragt werden. Die Analysen untersuchen den Zusammenhang der Teilnahme am Ü45-Check auf die Inanspruchnahme von DRV-Leistungen und die Erwerbsbiografie im Vergleich zwischen Interventions- und Kontrollgruppe unter Einbezug von Routinedaten der DRV-BB.
- **Erwartete Ergebnisse und Schlussfolgerung:** Es wird erwartet, dass die Teilnahme am Ü45-Check mit einer erhöhten Inanspruchnahme von DRV-Leistungen sowie günstigeren Erwerbsverläufen (z.B. Krankheitsstage, Erwerbsstatus) assoziiert ist. Darüber soll untersucht werden, welche klinischen Parameter eine hohe prädiktive Relevanz für die Erwerbsteilhabe aufweisen und ob diese den fragebogenbasierten Items überlegen sind. Die gewonnenen Erkenntnisse liefern eine evidenzbasierte Grundlage zur Weiterentwicklung und Implementierung des Ü45-Checks im Kontext präventiver und rehabilitativer Strategien der DRV-BB.

SP-02-11 STUDY PROTOCOL NR. 119

Diktanaite D, Paziener A, Geurts E, Infanger D, Schmidt-Trucksäss A

Exercise-induced pulmonary edema in endurance athletes: a multimodal diagnostic approach using lung ultrasound and diffusion capacity during exercise

UNIVERSITY OF BASEL, Switzerland

- **Background:** Exercise-induced pulmonary edema (EIPE) is an underrecognized condition in endurance athletes, ranging from subclinical interstitial fluid accumulation to severe respiratory compromise. Despite its potential impact on performance and safety, its incidence, underlying mechanisms, and diagnostic criteria remain poorly defined. We present the PULMEX project, which is designed to address key gaps in current literature by investigating the incidence and physiological mechanisms of EIPE under controlled laboratory conditions.
- **Methods:** This monocentric cross-sectional cohort study includes 120 well-trained endurance athletes equally divided into three groups: young asymptomatic athletes (18–35 years), young athletes with exertional dyspnea not explained by exercise-induced bronchoconstriction or laryngeal obstruction, and master athletes (≥60 years) with a professional endurance background. Following baseline diagnostics (cardiopulmonary exercise testing, body composition, transthoracic echocardiography, spirometry), participants perform a standardized cycling protocol consisting of 60 minutes of steady-state exercise at 15% above the first ventilatory threshold, followed by a maximal effort phase (10-kilometer time trial). EIPE is defined as the new occurrence of ≥3 B-lines per hemithorax on lung ultrasound. Continuous measurements include heart rate, breathing frequency, muscle oxygenation (NIRS), and peripheral oxygen saturation. Lung ultrasound, lactate, and capillary blood gas analyses are performed every 10 minutes. Diffusing capacity for carbon monoxide (DLCO) is assessed at baseline, during exercise, and during recovery.
- **Statistics:** The planned statistical analysis includes comparison of EIPE incidence between groups using Fisher's exact test (Bonferroni adjustment) for multiple comparisons. Longitudinal physiological responses will be analyzed using linear mixed-effects models. Time-to-event analyses for EIPE onset will be performed using Cox proportional hazards regression.
- **Conclusion:** This study introduces a novel diagnostic approach combining lung ultrasound and DLCO to detect EIPE during exercise. The findings aim to improve identification of at-risk athletes and enhance understanding of exercise-induced cardiopulmonary interactions, providing a basis for future preventive and diagnostic strategies.

SP-01-10 STUDY PROTOCOL NR. 291

Westenberger J, Dieter V, Missios P, Böhm J, Polauke E, Martus P, Nieß AM, Bitzer M

Effekte einer bewegungsbasierten Prähabilitation auf Tumorstabilität und Immunmilieu unter neoadjuvanter Chemo-Immuntherapie bei Tumoren des Magens und gastroösophagealen Übergangs („PRIME-GI“)

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Hintergrund:** Bei lokal fortgeschrittenen, noch nicht metastasierten Tumoren des Magens und gastroösophagealen Übergangs (GEJ-Tumoren) konnte kürzlich gezeigt werden, dass die Hinzunahme einer Immuntherapie zu Operation und Chemotherapie die Behandlungsergebnisse verbessert. Sowohl Operation als auch Chemotherapie reduzieren die körperliche Funktionsfähigkeit und Lebensqualität, weshalb multimodale Konzepte der Prähabilitation entwickelt wurden. Bisherige Studien konzentrierten sich vorwiegend auf eine Reduktion perioperativer Komplikationen. Erste Hinweise zeigen, dass körperliche Aktivität durch eine Modulation des Immunsystems Auswirkungen auf das Tumorgewebe haben kann. Die beschriebene Studie soll untersuchen, ob eine Trainingstherapie die Wirksamkeit einer neoadjuvanter Chemo-Immuntherapie auf den Tumor selbst steigern kann. Primärer Endpunkt der Studie ist der Anteil vitaler Tumorzellen im Operationspräparat.
- **Methodik:** 40 Patientinnen und Patienten mit einem Magen- oder GEJ-Tumor mit $\geq cT2$, $cN0-4$, $cM0$ werden über eine Rekrutierungszeit von 24 Monaten in die monozentrische randomisierte kontrollierte Studie eingeschlossen. In der Interventionsgruppe wird zwischen Therapiebeginn und Operation über einen Zeitraum von 9–13 Wochen ein personalisiertes Trainingsprogramm mit einer Kombination aus Ausdauer- (Dauer- und Intervallmethode) und Krafttraining durchgeführt. Das Training findet überwacht und heimbasiert statt. Ergänzend wird in beiden Studienarmen eine Ernährungsberatung stattfinden. In den initial gewonnenen Gewebsbiopsien und aus dem OP-Präparat sind u.a. Proteomanalysen, intratumorale Mikrobiomanalysen und eine Multiplex-Immunfluoreszenzmikroskopie geplant. Weiterhin soll vor und nach der Interventionsphase eine Mikrobiomanalyse sowie eine Charakterisierung von Immunzellpopulationen im peripheren Blut erfolgen. Geplant ist weiterhin die Erfassung von Dosis- und Nebenwirkungen der Chemo-Immuntherapie sowie Veränderungen der Lebensqualität und körperlichen Leistungsfähigkeit.
- **Ergebnisse:** Die Studie befindet sich in der Beantragungsphase, der Studienstart ist für 2027 geplant.
- **Diskussion:** Neben der Untersuchung klinisch relevanter Parameter ermöglicht die Studie durch ein umfangreiches translationales Begleitprogramm die Analyse direkter Effekte einer Trainingsintervention auf das Tumorgewebe unter neoadjuvanter Chemo-Immuntherapie. Dies kann dazu beitragen, die biologischen Mechanismen eines möglicherweise verbesserten Ansprechens auf die präoperative Therapie besser zu verstehen.

SP-02-12 STUDY PROTOCOL NR. 135

Donatius J, Chaabene H, Müller M, Müller P, von Salzen L, Königstein K

Zusammenhang von Frühgeburtlichkeit, vaskulärer Gesundheit und körperlicher Fitness im Jugendalter

MEDIZINISCHE FAKULTÄT / UNIVERSITÄTSKLINIKUM MAGDEBURG, Germany

- **Hintergrund:** Frühgeborene haben ein erheblich erhöhtes kardiovaskuläres Lebenszeitrisko: Das Risiko einer Herzinsuffizienz im jungen Erwachsenenalter ist 17-fach, das einer arteriellen Hypertonie 2,5-fach erhöht. Eine prä- und perinatale Prädisposition für chronisch-entzündliche Aktivität, erhöhten oxidativen Stress, epigenetische Modifikationen und mikrobielle Dysbiose werden als Ursachen für das Wirken der Frühgeburtlichkeit als Akzelerator des biologischen kardiovaskulären Alterns diskutiert. Eine hohe körperliche Fitness, sowie sportliche Aktivität, können hier präventiv wirken, wurden im Zusammenhang mit Frühgeburtlichkeit aber noch nicht untersucht.
- **Methodik:** In $n=60$ Jugendlichen, körperlich uneingeschränkt belastbaren, Früh- und Reifgeborenen (10–17 Jahre, Gestationsalter ≥ 28 Schwangerschaftswochen) erfolgt eine kardiovaskuläre Phänotypisierung mittels Pulswellengeschwindigkeit, flussinduzierter Vasodilatation, retinaler Gefäßanalyse, Carotis-Intima-Media Dicke, linksventrikulärem longitudinalen Strain. Der zugrundeliegende molekulare Fingerprint wird anhand von Biomarkern aus Blut, Speichel, Wangenepithelien und Stuhl (extrazelluläre Vesikel, Marker vaskulärer Inflammation, Epigenomik, Proteomik, Mikrobiom) analysiert. Lebensstil und assoziierte kardiovaskuläre Risikofaktoren werden mittels Fragebögen und weiteren Analysen bestimmt (Body-Mass-Index, Blutdruck, HbA1c, Cholesterinprofil, Triglyceride, Rauchen). Die Bestimmung der körperlichen Fitness erfolgt mittels Spiroergometrie (VO2peak), Handkraftmessung und Standweitsprung. Die statistische Analyse einer Assoziation zwischen Gestationsalter und kardiovaskulärem Phänotyp erfolgt mittels Hauptkomponentenanalyse und multivariater Regressionsmodelle. Ein moderierender Einfluss der körperlichen Fitness wird mittels Interaktionstermen analysiert. Zur Analyse der vaskulären Responsivität bei Frühgeborenen auf einen intensiven Belastungsreiz erfolgt unmittelbar nach der Spiroergometrie eine erneute Messung vaskulärer (Pulswellengeschwindigkeit, retinale Gefäßanalyse, Carotis-Intima-Media Dicke) und molekularer (extrazelluläre Vesikel, Marker vaskulärer Inflammation) Biomarker.
- **Erwartete Ergebnisse und Schlussfolgerungen:** Wir erwarten, dass ein niedrigeres Gestationsalter bereits im Jugendalter mit klinischen und molekularen Veränderungen im Sinne eines akzelerierten biologischen kardiovaskulären Alterns assoziiert ist. Diese Assoziation wird durch eine höhere kardiorespiratorische Fitness abgeschwächt. Die vaskuläre Responsivität auf eine intensive körperliche Belastung zeigt keine Abhängigkeit vom Gestationsalter. Wir erwarten somit, dass die PreVAFit-Studie eine erhöhte Prädisposition für ein akzeleriertes biologisches kardiovaskuläres Altern bei adoleszenten Frühgeborenen demonstriert, welches durch eine frühzeitige Förderung einer regelmäßigen sportlichen Aktivität und guten körperlichen Fitness verlangsamt werden kann.

SP-02-13

STUDY PROTOCOL

NR. 181

Haigis D, Vek J, Allgaier K, Schmidt J, Janßen P, Dürrwächter U, Renner T

Anorexia nervosa bei Kindern und Jugendlichen – Pilotstudie eines standardisierten Krafttrainings als erweiterter Therapieansatz im stationären Setting

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Hintergrund:** Die Anorexia nervosa (AN) ist eine schwere psychische Störung, welche hauptsächlich im Kindes- und Jugendalter eine lebensbedrohliche Erkrankung darstellt. Angesichts der Schwere der Erkrankung und potenziellen Langzeitfolgen, ist eine frühzeitige, intensive und interdisziplinäre Behandlung erforderlich. Ein möglicher und innovativer Therapieansatz stellt das Muskelaufbautraining dar. Bisher gibt es keine Untersuchungen, die intensives Krafttraining bei Heranwachsenden mit extremem Untergewicht untersuchen. Ziel des beantragten Projekts ist die Prüfung eines individualisierten und supervidierten 12-wöchigen Muskelaufbautrainings für Mädchen und junge Frauen mit AN im stationären Setting.
- **Methoden:** Primäre Ziele der Pilotstudie ist die Untersuchung der Adhärenz, Sicherheit und Verträglichkeit sowie die Zufriedenheit der Patientinnen. Weitere sekundäre und explorative Ziele stellen die Motivation und Zunahme der Muskelkraft der Patientinnen dar. Die Rekrutierung erfolgt im stationären Setting der Kinder- und Jugendpsychiatrie des Universitätsklinikums Tübingen. Eingeschlossen werden stationäre AN-Patientinnen im Alter von 12-18 Jahren. Es werden Routinedaten und Laborparameter erhoben. Zudem werden sportwissenschaftliche Assessments und Assessments zur Bestimmung der Zufriedenheit und Motivation der Patientinnen durchgeführt. Die geplante 12-wöchige Intervention wird im Anschluss einer zweiwöchigen Gewöhnungsphase an stationären Kraftgeräten durchgeführt. Die Trainingssteuerung erfolgt mittels 6-Repetition-Maximum-Test und nach dem subjektiven Belastungsempfinden. Das Muskelaufbautraining wird dreimal wöchentlich absolviert.
- **Zusammenfassung:** Im Rahmen des Kongresses soll die Pilotstudie diskutiert werden. Die Machbarkeit einer Trainingsintervention im stationären Setting muss geprüft werden, um dadurch die Grundlage für eine weiterführende randomisiert-kontrollierte Studie bieten zu können.

SP-02-15

STUDY PROTOCOL

NR. 185

López Gilberte M, Bissig V, Geiger J, Heinzelmann V, von Versen-Hoeyneck FM, Gerber M, Ludyga S, Hauser C, Hanssen H

Der Einfluss von körperlicher Aktivität und Fitness, Herzkreislauf- und psychische Gesundheit auf die künstliche Befruchtung – Studienprotokoll der REPRO-FIT Studie

UNIVERSITÄT BASEL, Switzerland

- **Hintergrund:** Infertilität ist eine komplexe multifaktorielle Erkrankung, die weltweit 8-12% der Paare im gebärfähigen Alter betrifft und für die betroffenen Personen eine körperliche sowie psychologische Herausforderung darstellt. Zur Behandlung kommen assistierte Reproduktionstechniken wie In-vitro-Fertilisation (IVF) oder intrazytoplasmatische Spermieninjektion (ICSI) zum Einsatz. Körperliche Aktivität, Fitness, Stress, psychische Gesundheit, Schlaf und kognitive Funktion könnten den Erfolg dieser Verfahren beeinflussen. Ein Verständnis dieser Faktoren in Zusammenhang mit den Therapien kann einen Beitrag zur Optimierung des Erfolgs dieser Therapien durch die Integration verschiedener Aspekte leisten.
- **Methoden:** Diese prospektive Kohortenstudie rekrutiert 115 Frauen im Alter von 18-43 Jahren, die einen Stimulationszyklus mit IVF/ICSI planen. Die Stichprobengröße gründet auf einer Power-Analyse unter der Prämisse einer Korrelation von $r = 0.30$ und einem Signifikanzniveau von $p = 0.05$, um bei einer Regression mit einem Prädiktor und zwei Kovariaten eine Aussagekraft von 80 % zu erzielen. Vor Stimulationsbeginn und beim 1. Trimenon werden Körperzusammensetzung sowie retinale Gefäße als kardiovaskulärer Marker analysiert. Die Leistungsfähigkeit wird vor Stimulationsbeginn mittels Spiroergometrie erfasst. Körperliche Aktivität und Kognition werden mittels Akzelerometrie vor und während der Stimulation dokumentiert. Psychosoziale Faktoren werden mittels validierter Fragebögen erhoben und umfassen ein Screening von depressiver- und Angstsymptomen (PHQ-9 und GAD-7), Stress (PSS), Körperbild (BAS-2), Schlaf (ISI), Lebensqualität (WHO-5 Well Being Index) und Ernährung (mini-EAT).
- **Resultate:** Diese Studie befindet sich seit Januar 2026 in der Rekrutierungsphase. Die Studie analysiert den Zusammenhang zwischen körperlicher Aktivität sowie Fitness mit der Schwangerschaftsrate nach einer IVF/ICSI. Sekundäre Endpunkte umfassen Veränderungen in der psychosozialen Gesundheit und Bewegungsverhalten während der Therapie sowie reproduktive Parameter wie Zell- und Embryonenqualität, Schwangerschaftskomplikationen und Zeit bis zur Schwangerschaft.
- **Schlussfolgerung:** Die Ergebnisse könnten neue Einblicke in den Einfluss von Lebensstil und körperliche Aktivität auf reproduktionsmedizinische Therapien liefern. Somit könnten bessere Lebensstilempfehlungen für Frauen während der IVF/ICSI Therapieplanung erfasst werden.

SP-02-14

STUDY PROTOCOL

NR. 184

Manzke C, Wiewelthove T, Heydenreich J

Saisonale Veränderungen der Energie- und Makronährstoffzufuhr sowie ernährungsbezogener Gesundheitsrisiken bei männlichen Nachwuchsleistungsfußballern - ein Studienprotokoll

LEIPZIG UNIVERSITY, Germany

- **Hintergrund:** Eine bedarfsgerechte Energie- und Nährstoffversorgung ist eine zentrale Voraussetzung für die langfristige Entwicklung von Leistungsfähigkeit und Gesundheit im Nachwuchsleistungssport. Bislang fehlen jedoch längsschnittliche Feldstudien, die saisonale Veränderungen der Ernährungsweise unter realen Trainings- und Wettkampfbedingungen systematisch erfassen. Ziel dieser Beobachtungsstudie ist es daher, saisonale Veränderungen der Energie- und Makronährstoffzufuhr sowie ernährungsbezogene Gesundheitsrisiken bei männlichen Nachwuchsleistungsfußballern zu erfassen und mit aktuellen sporternährungswissenschaftlichen Empfehlungen zu vergleichen. Ergänzend werden Aktivitäts- und Gesamtenergieverbrauch sowie die Körperzusammensetzung erfasst.
- **Methoden:** Ca. 25 männliche Fußballspieler aus der A-Junioren-Bundesliga (U19; Alter: ≥ 18 Jahre) werden an drei Messzeitpunkten untersucht: Allgemeine Vorbereitungsphase (T1), Wettkampfphase (T2) und Übergangsphase (T3). Die habituelle Energie- und Nährstoffaufnahme wird mittels eines validierten digitalen 3-Tage-Schätzprotokolls ("Nutr-e-Screen"-Verzehrprotokoll) an drei konsekutiven Tagen erfasst, wobei die Dokumentationszeiträume jeweils einen spielfreien Wochentag sowie zwei Wochentage (Do-Sab bzw. So-Di) umfassen. Zur Verbesserung der Datenqualität erfolgt vorab eine Übungserhebung mit individuellem Feedback. Der Aktivitäts- und Gesamtenergieverbrauch wird parallel mittels kombinierter Akzelerometrie- und Herzfrequenzmessung (Polar Ignite 3) bestimmt. Ergänzend werden die Körperzusammensetzung (bioelektrische Impedanzanalyse) sowie ernährungsbezogene Gesundheitsrisiken („Nutr-e-Screen“-Screeningbogen) erfasst. Saisonale Veränderungen werden mittels 1-faktorieller ANOVA mit Messwiederholung (bzw. Greenhouse-Geisser-Korrektur) analysiert. Die Übereinstimmung mit Empfehlungen wird deskriptiv ($M \pm SD$) berichtet.
- **Erwartete Ergebnisse:** Es wird erwartet, dass Energie- und Nährstoffzufuhr sowie Energieverbrauch und Körperzusammensetzung im Saisonverlauf variieren. Zudem ist davon auszugehen, dass die Ernährungsweise in einzelnen Saisonphasen nicht vollständig den aktuellen sporternährungswissenschaftlichen Empfehlungen entspricht. Während ausgeprägte Risikokonstellationen einer niedrigen Energieverfügbarkeit im Fußball weniger wahrscheinlich sind, könnten suboptimale Versorgungsmuster und potenzielle ernährungsbezogene Risiken identifiziert werden.
- **Schlussfolgerung:** Die Studie liefert erstmals längsschnittliche Felddaten zur Ernährungsweise im Nachwuchsleistungsfußball und ermöglicht eine differenzierte Bewertung saisonaler Versorgungsmuster. Die Ergebnisse sollen zur evidenzbasierten Optimierung von Monitoringstrategien und zur gezielten Weiterentwicklung der Ernährungsbetreuung in Nachwuchsleistungszentren beitragen.

SP-02-16

STUDY PROTOCOL

NR. 196

Gala FCR, Trapletti M, Bersezio E, Cardone A, Giacomini A, Cè E, Repetto C

Virtual reality-based cognitive training to enhance decision-making accuracy in youth soccer players

UNIVERSITÀ CATTOLICA DEL SACRO CUORE, Italy

- **Background:** Virtual reality (VR) offers a promising method for training perceptual-cognitive skills by providing sport-specific simulations of real performance contexts. However, empirical evidence on its effectiveness remains limited. This study investigates the effectiveness of VR-based cognitive training on decision-making accuracy in youth soccer players and explores potential transfer to underlying cognitive functions.
- **Methods:** Twenty-eight youth soccer players from a professional academy participate in a within-subjects study conducted during the competitive season. The sample size is calculated using G*Power ($f = 0.25$, $\alpha = 0.05$, power = 0.80). Assessments take place at baseline (T0), after 4 weeks of control (T1), and after 4 weeks of VR-based cognitive training (T2). Training sessions (3 times per week for 4 weeks) consist of viewing fifteen 180° immersive videos from a first-person perspective using a Meta Quest 3 headset. Each video stops at a critical decision point, after which players verbalize their intended action and visualize themselves executing the optimal response. Primary outcome, decision-making accuracy, is assessed at T0, T1, and T2 using a VR-based test consisting of 20 unique scenarios, with 1.5 seconds allowed for each response. No feedback is provided. Responses are scored by experts as optimal (2), acceptable (1), or null (0). Secondary outcomes include processing speed, cognitive flexibility, and inhibitory control, assessed using the Vienna Test System (Trail Making Test and Go/No-Go) at T0, T1, and T2. Subjective VR experience, including embodiment, presence, usefulness, and ease of use, is also assessed. Repeated-measures F tests, using parametric or non-parametric methods as appropriate, are applied, with post hoc comparisons conducted in case of significant effects.
- **Conclusion:** We hypothesize that VR-based training improves decision-making accuracy in soccer players, with high levels of embodiment and presence. With a rigorous methodology, this study contributes to the literature on the effectiveness of VR-based perceptual-cognitive training in sports.

SP-02-17

STUDY PROTOCOL

NR. 105

Hänisch T, Kaleta A, Mancke C, Heydenreich J, Carlsohn J

Untersuchung potenzieller zyklus-assoziiierter Verzerrungen von Ernährungserhebungen bei Athletinnen - Nutr-e-Bias Studie

HAW HAMBURG / UNIVERSITÄT TÜBINGEN, Germany

- **Hintergrund:** Das Internationale Olympische Komitee empfiehlt im Rahmen der sportmedizinischen Jahreshauptuntersuchung die Erfassung von ernährungsbezogenen Gesundheits- und Leistungsrisiken bei Athlet*innen. Potenzielle Verzerrungen der Gesundheitsscreenings im Zusammenhang mit dem Menstruationszyklus von Athletinnen sind bislang unberücksichtigt, werden aber von Akteur*innen der Sportpraxis (z.B. Trainer*innen und Athlet*innen) als notwendig erachtet. Aus Perspektive der Sportpraxis und der Forschung erscheint es daher unabdingbar, zu prüfen, ob zyklusabhängige Ernährungserhebungen bei Athletinnen systematische Verzerrungen in gesundheits- und leistungsbezogenen Parametern verursachen.
- **Methoden:** Im Rahmen einer prospektiven Kohortenstudie (Kohorte 1: Wettkampfsportlerinnen mit regelmäßigem Zyklus, Kohorte 2: Nicht bis moderat aktive Personen mit regelmäßigem Zyklus) wird untersucht, ob gesundheits- und leistungsbezogene Ernährungserhebungen bei Athletinnen durch einen Menstruationszyklus-Bias beeinflusst werden. Zu diesem Zweck kommen zu drei verschiedenen Zykluszeitpunkten (Menstruation, Ovulation, Lutealphase) jeweils validierte Ernährungserhebungsinstrumente zum Einsatz (Nutr-e-Screeningbogen, Nutrescreen-Verzehrprotokoll, LEAF-Fragebogen, EDE-Q). Darüber hinaus wird der Energieverbrauch im Sport (Akzelerometrie) sowie die Körperkomposition (FFM, FM, Körperwasser mittels BIA) standardisiert in den drei Zykluszeiträumen gemessen. Die erste Datenerhebung erfolgt dabei beginnend an Zyklustag 1 (Einsetzen der Menstruation), die zweite Erhebung am Ende der Follikelphase bzw. in der Mitte des individuellen (zuvor getrackten) Zyklus mit erhöhten Östrogenkonzentrationen (bestätigt durch einen positiven Ovulationstest als Urinest), und die dritte Erhebung findet am 8. Tag nach positivem Ovulationstest statt. Zur Validierung der jeweiligen Zyklusphasen werden mittels Trockenblutanalyse, die Hormonkonzentrationen (LH, Estradiol, Progesteron) erfasst. Die statistische Auswertung erfolgt über Bland-Altman-Plots und Varianzanalysen.
- **Diskussion/Konklusion:** Die Erhebung wird wichtige Erkenntnisse liefern, ob es bei Athletinnen zu zyklusabhängigen Differenzen bei der Beurteilung von leistungssportlich und gesundheitlich relevanten Ernährungselementen kommt. Im Falle von möglichen Verzerrungen, sollte das beim Einsatz der genannten Instrumente berücksichtigt werden und zukünftig eine Zyklusphasen standardisierte Vorgehensweise in Betracht gezogen werden.

SP-02-19

STUDY PROTOCOL

NR. 266

Schwarz C, Bizjak DA, Mentz L, Schwarz E, Wohlfahrt D, Kirsten J, Schulz SVW, Jerg A

MitoZyk: Influence of the female menstrual cycle on mitochondrial function and physical performance

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- This prospective pilot study ("MitoZyk") investigates the influence of the female menstrual cycle on mitochondrial function and physical performance. Twenty-four healthy, physically active women (18–30 years) are assessed at two time points: early follicular phase (days 1–2) and peri-ovulatory/luteal transition (days 14–16). Primary outcomes include spirometric performance parameters (VO₂peak, workload, respiratory quotient, perceived exertion) and circulating mitochondrial biomarkers (e.g., PGC-1α, NRF2, mtDNA/nDNA ratio). Hormonal profiles (FSH, LH, estradiol, progesterone) are analyzed to explore correlations with mitochondrial function. Secondary outcomes include subjective well-being and perceived performance. We hypothesize that performance and mitochondrial activity are enhanced around ovulation and positively associated with estrogen levels. This study aims to provide mechanistic insight into cycle-dependent performance variability and contribute to more individualized approaches in sports and preventive medicine.

SP-02-18

STUDY PROTOCOL

NR. 261

Hensler S, Hecksteden A

Leistungsfähigkeit und Wohlbefinden von Langstreckenläuferinnen über den Menstruationszyklus – Eine partizipative Citizen-Science Studie

MEDIZINISCHE UNIVERSITÄT INNSBRUCK, Austria

- Im Laufe des Menstruationszyklus (MZ) variieren die Konzentrationen weiblicher Sexualhormone, die auch leistungsphysiologisch bedeutsame Effekte haben. Unterschiede in der Leistungsfähigkeit erscheinen daher plausibel. Viele Athletinnen berichten zudem über zyklusabhängige Unterschiede in Wohlbefinden und Leistungsfähigkeit. Im Gegensatz dazu konnten in empirischen Studien bisher keine klaren systematischen Unterschiede in der physischen Leistungsfähigkeit zwischen den MZ-Phasen nachgewiesen werden. Methodische Limitationen (z.B.: Probandenzahl und Zyklusphasenbestimmung) spielen hier sicherlich eine Rolle. Darüber hinaus könnte eine biopsychosoziale Perspektive sowie die gezielte Berücksichtigung inter-individueller Unterschiede zu einem besseren Verständnis der Diskrepanz zwischen physiologischen Erwägungen basierend auf den direkten biologischen Effekten der weiblichen Geschlechtshormone, der Eigenwahrnehmung der Athletinnen und objektiven Leistungstests führen.
- Methodisch sind hier zwei gegensätzliche Erfordernisse in Einklang zu bringen: Einerseits die valide Bestimmung der MZ-Phasen und andererseits Studiendesign und Fallzahl (Anzahl von Athletinnen und Zyklen pro Athletin). In dieser Studie wird daher ein partizipativer Ansatz mit einer Datenaufnahme im Sinne von Citizen Science gewählt. Im Zentrum stehen dabei von den Athletinnen selbstständig durchgeführte Leistungstests über mehrere MZs.
- Diese Studie untersucht die physische Leistungsfähigkeit und das Wohlbefinden hinsichtlich des MZ bei wettkampforientierten Hobbyläuferinnen. Ziel ist es praxisnahe fundierte Erkenntnisse zu gewinnen, die als Entscheidungsgrundlage im Sport dienen können. Ein partizipativer Ansatz trägt zur Festlegung von Ziel- und Kontrollvariablen sowie der Methoden zur Datenerhebung, Rekrutierung und Verbreitung bei. Die Einbeziehung mehrerer Zyklen pro Probandin ermöglicht es, neben systematischen Unterschieden zwischen den Zyklusphasen auch individuelle, eventuell sogar gegenläufige Muster zu identifizieren. Die Studie umfasst drei Phasen: In Phase 1 erfolgt die partizipative Entwicklung des Studienprotokolls. In Phase 2 werden an festgelegten Zyklustagen über 2–6 Zyklen 2000 m Lauftests sowie Hormontests per LH Sticks durchgeführt, per Smartphone überwacht und anschließend analysiert. Phase 3 umfasst die Diskussion der Ergebnisse mit der Gemeinschaft und deren Verbreitung.

SP-02-20

STUDY PROTOCOL

NR. 270

Frohberg F, Reuschel F, Wüstenfeld J, Rüdrieh P, Wolfarth B

Funktionelle Erweiterung der orthopädischen Grunduntersuchung – Studienprotokoll zur Machbarkeitsevaluation

INSTITUT FÜR ANGEWANDTE TRAININGSWISSENSCHAFT (IAT), Leipzig, Germany

- **Hintergrund:** Die orthopädische Teiluntersuchung der sportmedizinischen Grunduntersuchung des sportmedizinischen Grunduntersuchung des Deutschen Olympischen Sportbundes (DOSB) erfasst vorrangig die statisch-strukturelle Integrität des Bewegungsapparates. Dynamisch-funktionelle Parameter wie neuromuskuläre Kontrolle, Kraftasymmetrien und Bewegungskontrolle, die international als relevante Prädiktoren kontaktloser Überlastungsschäden gelten, werden im Basisprotokoll nicht standardisiert erhoben. Obwohl vergleichbare funktionelle Testverfahren im bezahlten Mannschaftssport bereits etabliert sind, fehlt bislang ein systematischer Ansatz zur Integration solcher Verfahren in die bundesweit standardisierte Kaderuntersuchung des olympischen Einzelsports. Ziel dieses Studienprotokolls ist die Evaluation der Machbarkeit und Durchführbarkeit einer ergänzenden funktionellen Testbatterie im Rahmen der routinemäßigen Kaderuntersuchung.
- **Methodik:** In einer prospektiven Pilotstudie sollen ab Juli 2026 Judoathletinnen und -athleten des Landes- und Nachwuchskaders (angestrebte Stichprobe n = 40, Alter 15–19 Jahre) im Rahmen der regulären Kaderuntersuchung am Institut für Angewandte Trainingswissenschaft Leipzig zusätzlich zur orthopädischen Standarduntersuchung eine standardisierte funktionelle Testbatterie absolvieren. Diese umfasst fünf sportartübergreifende Domänen: (1) quantitative Beweglichkeitsmessung mittels markerlosem Motion-Capture, (2) posturale Kontrolle im Einbeinstand über Center-of-Pressure-Analyse, (3) isometrische Kraftdiagnostik der unteren Extremität und Griffkraftmessung, (4) Rumpfstabilität in der Transversalebene und (5) Bewegungsqualitätsanalyse unter dynamischer Last. Aus der Zusammenschau orthopädischer und funktioneller Befunde soll in einem weiteren Schritt ein individualisierter Gesamtreport mit indikationsspezifischen Übungsempfehlungen generiert werden. Die Machbarkeit wird anhand vorab definierter Kriterien evaluiert: zeitlicher Mehraufwand von maximal 30 Minuten pro Athlet*in, Vollständigkeitsrate der Testbatterie über 80 Prozent sowie Akzeptanz auf Athlet*innen- und Untersucher*innenseite mittels standardisierter Likert-Skalen. Die Auswertung erfolgt deskriptivstatistisch.
- **Ergebnisse:** Es wird erwartet, dass die funktionelle Testbatterie innerhalb des definierten Zeitrahmens in die Untersuchungsroutine integrierbar ist und hohe Vollständigkeits- sowie Akzeptanzraten erzielt. Die erhobenen Daten sollen erstmals eine systematische Gegenüberstellung statisch-orthopädischer Befunde mit quantitativen funktionellen Parametern in einer jugendlichen Kaderpopulation ermöglichen.
- **Schlussfolgerung:** Das Studienprotokoll liefert die konzeptionelle Grundlage zur Weiterentwicklung der sportmedizinischen Kaderuntersuchung hin zu einem integrativen Screening-Ansatz. Bei positiver Machbarkeitsevaluation ist die Überführung in die bestehende bundesweite Untersuchungsstruktur, die Auswertung auf weitere Sportarten und größere Kohorten sowie die Entwicklung sportartspezifischer Zusatzmodule vorgesehen.

OP-01-01 ORAL PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 176

Mooren JM, Mooren FC, Teschler M, Bloch W, Javelle F, Heidecke H, Wahl P

Association of autoantibodies targeting G protein coupled receptors towards endurance training status – A pilot study considering sex and age

GERMAN SPORT UNIVERSITY COLOGNE, Germany

- **Background:** G Protein coupled receptors (GPCRs) are key contributors in physiological responses to stress, exertion, and immunity. Recently, autoantibodies (AABs) against GPCRs have been found in healthy individuals with their regulatory function in endurance-trained (ET) populations remaining unclear. Therefore, this study investigated whether ET status, age, and their interaction are associated with differences in circulating GPCR-AAB levels, emphasizing sex-related patterns.
- **Methods:** Serum from 59 healthy, non-smoking participants (28 female) was collected alongside anthropometric data and cardiopulmonary exercise testing. Participants were assigned to four groups according to ET status (Trained (T) ≥ 7 h ET/week, Untrained (U) ≤ 2 h) and age (Young (Y), 18-30 years; Old (O), 55-70 years): trained young (TY), trained old (TO), untrained young (UY), and untrained old (UO). GPCR-AAB levels were quantified using enzyme-linked immunosorbent assay (ELISA). Data were analyzed by Mann-Whitney-U-, Kruskal-Wallis, and Spearman tests. Total AAB counts were analyzed after z-transformation.
- **Results:** Across all AABs, a trend towards higher levels in T compared to U groups appeared ($p=0.067$). A sex-dependent effect was found with higher AAB levels in males ($p=0.0003$), while no age-dependent effect was observed ($p=0.147$). TY displayed higher levels than UY ($p=0.016$), and UO likewise exceeded UY ($p=0.037$). Notably, higher levels in men and reduced inter-individual variance in women were observed within the ET group, as well as across both age groups ($p\leq 0.024$). Analyzing individual AABs, a significant higher level of CXCR3-AABs was found in men ($p=0.05$). Additionally, inside the trained group, 6 out of 7 AABs targeting receptors involved in autonomic cardiovascular regulation were higher in males ($p\leq 0.039$).
- **Conclusion:** These findings indicate distinct training- and sex-related patterns in GPCR-AABs, with consistently higher levels in ET men. This raises the question of whether ET is associated with reduced autoreactivity in females. Additionally, CXCR3 differing between sexes potentially reflects anti-inflammatory effects in females.

OP-01-03 ORAL PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 162

Wenzel C, Kalaycik B, Billig A, Trebing S, Joisten N, Kolodziej M, Braun M, Lippelt L, Gerharz A, Millard M, Wieder O, Kipper K, Jebel A, Groll A, Walzik D, Zimmer P

Targeted saliva multi-omics captures recent exercise and captures recovery

TU DORTMUND UNIVERSITY, Germany

- **Background:** Saliva-based targeted multi-omics offers a non-invasive approach to assess physiological responses to physical stress, however, its potential to capture exercise-related strain and recovery dynamics in applied settings remains unexplored. The present work investigated whether physiological information contained in a single saliva sample can distinguish exercise and control, and whether these signals can be integrated into a quantitative metric reflecting internal strain.
- **Methods:** Saliva samples from a laboratory crossover study with 12 female participants were analysed, comparing an exercise day (maximal exhaustion) with a control day. Samples collected immediately after exercise and 24 hours later were used to train supervised classification models distinguishing exercise from control. Model performance was assessed using the area under the receiver operating characteristic curve (ROC-AUC). The same framework was applied to a longitudinal real-world cohort of 50 male elite football players, with samples collected 12-24 hours after exercise (match) and control (≥ 3 days of rest). Predicted probabilities were integrated into an internal strain metric (ISM) representing the likelihood of prior exercise exposure. Model generalisability was further assessed using held-out validation samples.
- **Results:** In the laboratory setting, discrimination between exercise and control was high immediately after exercise (ROC-AUC = 0.95) and remained robust after 24 hours (ROC-AUC = 0.85). Applied to the real-world cohort, the framework maintained stable predictive performance despite variable sampling times (ROC-AUC = 0.84; Validation ROC-AUC = 0.82). The derived ISM separated exercise and control samples and reflected exercise exposure, with higher values following longer match duration and progressively lower values with longer recovery intervals. Discriminatory performance remained stable across different post-exercise sampling windows.
- **Conclusion:** Single-timepoint targeted saliva multi-omics profiles can detect recent exercise both immediately and on the following day. The proposed ISM translates model predictions into a practical metric of physiological strain, highlighting the potential of saliva-based multi-omics for real-world athlete monitoring.

OP-01-02 ORAL PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 255

Stiebler M, Tiedemann S, Piechowiak C, Kunz N, Lading Y, Arndt P, Medunjanin S, Mattern H, Chakrabarty S, Rauwolf T, Schreiber S, Braun-Dullaues R, Müller P

Physical fitness modulates the acute Klotho response to exercise in young and older adults

KLINIK FÜR KARDIOLOGIE UND ANGIOLOGIE, Universitätsklinik Magdeburg, Germany

- **Background:** Physical exercise improves cardiovascular and metabolic health through pleiotropic mechanisms, partly mediated by exercise-induced signaling molecules known as exerkines. One such exerkine, the anti-aging protein Klotho, declines with age and has been linked to morbidity, mortality, and physical function. While acute exercise increases circulating Klotho levels, it remains unclear whether the magnitude of this response is influenced by physical fitness.
- **Methods:** We investigated serum Klotho responses to a single bout of high-intensity exercise in healthy young ($n = 20$, 25.0 ± 4.25 years) and older adults ($n = 19$, 69.0 ± 2.5 years). Participants performed a cardiopulmonary exercise test (CPET) to exhaustion on a cycle ergometer. Serum Klotho concentrations were assessed at baseline and 30 minutes post-exercise. Cardiorespiratory fitness ($\text{VO}_{2\text{peak}}$), maximal workload (Watts), and grip strength (kg) served as markers of physical fitness.
- **Results:** Baseline serum Klotho levels were lower in older compared to younger adults (729.5 ± 314.7 vs. 976.1 ± 717.6 pg/mL; $p = 0.013$, Cohen's $d = 0.62$). Baseline and post-exercise Klotho concentrations were positively associated with $\text{VO}_{2\text{peak}}$ (T1: Spearman $r = 0.36$, $p = 0.02$; T2: $r = 0.39$, $p = 0.013$). In contrast, the relative increase in Klotho following acute exercise was significantly associated with maximal workload ($r = 0.36$, $p = 0.03$) and grip strength ($r = 0.33$, $p = 0.05$), but not $\text{VO}_{2\text{peak}}$ ($r = 0.16$, $p = 0.29$). When integrating all fitness parameters into a composite fitness score, individuals with higher overall fitness demonstrated a significantly greater exercise-induced Klotho response (0.103 ± 0.064 vs. 0.061 ± 0.069 ; $p = 0.025$, Cohen's $d = 0.73$), while baseline Klotho did not differ between composite fitness groups ($p = 0.319$).

OP-01-04 ORAL PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 115

Quermann A, Heß C, Rittweg M, Brockhaus M, Friedmann-Bette B

Enhanced satellite cell activation and differentiation after heavy resistance exercise with eccentric overload

UNIVERSITY HOSPITAL HEIDELBERG, Germany

- Eccentric-overload training (CON/ECC+) has been shown to induce enhanced satellite cell (SC) activation and proliferation. However, it is not known whether this type of training also induces SC differentiation.
- **PURPOSE:** 1) To determine whether heavy CON/ECC+ increases SC activation and differentiation in a within-subject comparison with conventional CON/ECC exercise to eliminate effects of inter-individual variability; 2) to find out if high and low responder regarding the myogenic response to CON/ECC+ can be identified.
- **METHODS:** 23 recreationally strength-trained male subjects (24.7 ± 4 years, 182 ± 5.3 cm, 81 ± 8.2 kg) performed one bout of exhaustive leg extension exercise of CON/ECC+ with one leg and one bout of equivalent CON/ECC exercise with the contralateral leg in randomized order. Muscle biopsies were obtained from the vastus lateralis of both legs in rested state seven days prior and seven days after exercise. Immunohistochemical analyses were performed to quantify activated (Pax7+/MyoD/DAPI, SCact) and differentiating (Myogenin/DAPI, SCdif) SCs. Data were analyzed using linear mixed models including CON/ECC+ as fixed factor, baseline as covariate and subjects as random intercept. For high and low responder analysis, participants at or above the 90th percentile were compared with participants at or below the 25th percentile for corresponding parameters using Mann-Whitney U test.
- **RESULTS:** Significant main effects were observed for CON/ECC+ for both differentiating (SCdif, $p=0.007$) and activated (SCact, $p=0.005$) SCs. Post-hoc tests revealed significant increases in both CON/ECC+ (SCdif: $p<0.001$; SCact: $p<0.001$) and CON/ECC (SCdif: $p=0.01$; SCact: $p<0.002$). Significant differences between high and low responders for Δ myogenin-SCs in the CON/ECC+ leg were observed for baseline peak torque at an angular velocity of $180^\circ \cdot s^{-1}$ ($p=0.010$) and for countermovement jump height ($p=0.038$).
- **CONCLUSION:** Exhaustive CON/ECC+ enhanced SC activation and differentiation, indicating elevated muscle regeneration. Individuals characterized by higher explosive power characteristics may be predisposed to a more robust early myogenic response to eccentric overload.

OP-01-05 ORAL PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 268

Kalemba LGD, van den Berg E, Schomakers B, van Weeghel M, Jaspers RT, Wüst RCI

Exercise rewires glucose towards anabolism in cultured skeletal muscle fibers

VU AMSTERDAM, Netherlands, The

- **Background:** Low-grade inflammation contributes to skeletal muscle loss during aging and chronic disease, thereby reducing physical function and quality of life. Skeletal muscle relies on glucose metabolism to support both energy production and anabolic processes required for growth and maintenance. However, how inflammatory and contraction-like stimuli reprogram intracellular glucose fluxes remains incompletely understood.
- **Methods:** We study how lipopolysaccharide-induced inflammation and electrical pulse stimulation (EPS) affect metabolic flux in cultured C2C12 myotubes. Following treatment, cells were incubated with [¹³C₆]glucose to trace intracellular carbon fluxes through glycolysis, biosynthetic pathways, and the tricarboxylic acid (TCA) cycle. Western blotting, qPCR, and diameter measurements will complement metabolic data for functional inferences.
- **Preliminary results:** Directly after EPS, incorporation of glucose-derived carbon into the pentose phosphate pathway increased (i.e., sedoheptulose-7-phosphate from 20 to 57%) and decreased in the TCA cycle intermediate malate (from 30 to 22%). Glycolytic metabolites upstream of pyruvate kinase M2 (PKM2) were more enriched 16 hours after EPS (e.g., Serine (p<0.0001); Ribose-5-Phosphate (p=0.03); UDP-N-acetylglucosamine (p=0.001)), whereas downstream metabolites were less enriched (e.g., Citrate (p=0.0002); Lactate (p=0.007)). This indicates that EPS redirects glucose-derived carbon toward anabolic pathways (pentose phosphate, serine biosynthesis, and hexosamine biosynthesis pathways). Lipopolysaccharide increased carbon enrichment in pyruvate (p=0.015) and lactate (p=0.003), with less incorporation into the hexosamine biosynthesis pathway (UDP-N-acetylglucosamine (p=0.035)).
- **Conclusion:** We conclude that EPS caused a specific block at PKM2, reducing downstream metabolic flux into the TCA cycle while increasing the incorporation of glucose into biomass at rest. This redirection of glucose towards anabolism was attenuated after exposure to lipopolysaccharide. These data provide novel insights into how inflammation reprograms glucose metabolism and into the potential of exercise to counteract inflammation-induced anabolic resistance.

OP-02-01 ORAL PRESENTATION – COVID-19/TRAINING INTERVENTION NR. 204

Beyer S, Mackenrodt S, Radziwolek L, Zachen M, Tegtbur U, Häckl S, Thomas NH, Rummel KD, Klawonn F, de Zwaan M, Haufe S, Nöhre M

Comparison of telemedicine-assisted psychotherapy, exercise therapy, or a combination of both in patients with post-COVID syndrome (TelPoCo): A randomized controlled therapy trial

HANNOVER MEDICAL SCHOOL, Germany

- **Background:** Post-COVID syndrome occurs in up to 10% of all individuals infected with SARS-CoV-2. The course of post-COVID syndrome is heterogeneous and is associated with significant limitations in daily life. The hypothesis of the randomized controlled trial was that a 3-month combined psychotherapy and exercise therapy treatment would improve fatigue symptoms more effectively than psychotherapy or exercise therapy treatment alone.
- **Methods:** The study enrolled 195 patients with post-COVID syndrome (mean 56 male/139 female/47.4 ± 11.6 years/BMI 27.4 ± 5.9 kg/m²). They were randomly assigned to one of three groups: psychotherapy (n=66), exercise therapy (n=65), or combination therapy (n=64). The intervention consisted of six 50-minute sessions via video. The primary endpoint, fatigue, was assessed with the Fatigue Assessment Scale. Secondary endpoints were changes in various domains of fatigue, anxiety and depression, health-related quality of life. To address the research question, an ANCOVA was performed for each variable, with the covariates FAS at baseline, gender, and body mass index (<30/≥30).
- **Results:** For the primary endpoint, exercise therapy demonstrated a significant benefit over combination therapy (p=0.017). However, no significant difference was found between combination therapy and psychotherapy (p=0.468) or between exercise therapy and psychotherapy (p=0.102). The secondary endpoints exhibited no statistically significant differences between the various groups. Trends were observed between exercise therapy and combination therapy for the Chalder Fatigue Scale total fatigue (p=0.074), mental fatigue (p=0.087), and physical fatigue (p=0.087).
- **Conclusion:** The study's initial hypothesis, which postulated that combination therapy is superior to monotherapies involving psychotherapy or exercise therapy, could not be substantiated. Exercise therapy has been demonstrated to alleviate fatigue symptoms. Further research is essential to identify predictors for responders and non-responders, enhancing the standard of care.

OP-01-06 ORAL PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 279

Gehlert S, Kuppusami M, Jacko D, Schaaf K, Sieger S, Gupta R, Bersiner K, Zacher J, Bloch W, Hüsken P, Höpfeld J

Repeated resistance exercise reshapes sarcomeric damage in human skeletal muscle via mechanosensitive protein networks

UNIVERSITY OF HILDESHEIM, Germany

- Although resistance exercise (RE) improves strength and muscle mass it also induces myofibrillar damage. Damage-resolving mechanisms are essential because skeletal muscle growth requires a preceding reduction of damage. However, the molecular mechanisms that preserve, mark, degrade, and restore damaged proteins to keep skeletal muscle working under repeated RE are incompletely understood. We analyzed acute molecular and structural responses to RE-induced damage in repeatedly sampled human skeletal muscle in the unadapted, adapted and deadadapted state. Repeated and interrupted RE induce a significant increase and decrease in sarcomeric lesions, marked by accumulation of Xin actin-binding repeat-containing proteins (XIRP). This spatial damage response illustrating the cellular basis of the repeated-bout effect is associated with dynamic changes of the protein landscape at the sarcomeric cytoskeleton and within myofibrillar lesions. These events correlate with changes in phosphorylation as part of a larger molecular signaling footprint indicative of adaptation and deadadaptation. RE-stimulated damage mainly affects a protein network linked to the muscle maintenance protein BAG3, which comprises the mechanosensory proteins PDLIM3 and XIRP1 and the small heat shock proteins HSPB1 and HSPB5. These mechanosensory network components cooperate in the recognition of strained skeletal muscle structures and the degradation of damaged proteins through chaperone-assisted selective autophagy (CASA). However, under acute and severe mechanical stress, CASA activity is attenuated, leading to reduced autophagic degradation and accumulation of damaged proteins at sarcomeric lesions, likely prioritizing early structural stability of damaged sites. In contrast, XIRP proteins remain subject to turnover, suggesting a BAG3-independent residual autophagy which highlights a central role of XIRPs in regulating muscle proteostasis. Our data highlight previously unrecognized key regulators of skeletal muscle homeostasis in human skeletal muscle subjected to resistance exercise. We further expand the roles of largely unknown XIRP proteins in sarcomeric damage control and introduce a molecular footprint of the repeated-bout effect.

OP-02-02 ORAL PRESENTATION – COVID-19/TRAINING INTERVENTION NR. 223

Krüger A-L, Haiduk B, Grau M

Effects of a structured, individualized training program on exercise capacity, fatigue, and red blood cell morphology in Long COVID

DEUTSCHE SPORTHOGHSCHULE KÖLN, Germany

- **Background:** Exercise-based rehabilitation can improve fatigue and exercise capacity in Long COVID (LC), but underlying physiological mechanisms remain unclear. Altered red blood cell (RBC) morphology has been proposed as a contributing factor.
- **Methods:** In this prospective, single-arm, longitudinal, observational study, participants were enrolled in a personalized, phase-specific multidisciplinary training approach. Sixteen participants (6 female, 10 males; age 46.2 ± 14.6 years) completed all phases and were included in the analysis. The intervention followed a progression-based model, with training intensity systematically increased and the final phase targeting ≥2 W·kg⁻¹ body weight. Pre-post comparisons of symptoms (Post COVID syndrome Score (PCS), FACIT-Fatigue), exercise capacity (1-minute sit-to-stand test (1MSTST, repetitions), watt performance (W)), and RBC morphology (% abnormal cells) were analyzed using paired t-tests and Cohen's d. Associations between functional and morphological parameters were assessed using Spearman correlation.
- **Results:** PCS (26.3 ± 11.9 vs. 16.3 ± 12.9; p = .005, d = 0.81), fatigue (25.2 ± 6.8 vs. 39.5 ± 8.8; p < .001, d = 1.78), 1MSTST (25.6 ± 7.8 vs. 40.8 ± 12.4 repetitions; p < .001, d = 1.37), and watt performance (59.3 ± 29.5 vs. 179.9 ± 29.5 W; p < .001, d = 4.09) showed significant changes. RBC morphology also differed between assessments (15.3 ± 13.2 vs. 7.0 ± 6.3 %; p = .018, d = 0.75). Associations between changes in RBC morphology and functional outcomes varied across analyses and were not consistently observed. The marked increase in watt performance was consistent with the structured progression criteria.
- **Conclusion:** A structured, individualized exercise program improved fatigue and exercise capacity in LC patients and was accompanied by significant improvements in RBC morphology. Although fatigue and RBC morphology are generally associated, their relationship to functional recovery remains unclear. These findings support individualized exercise as a rehabilitation strategy and highlight the need for further research.

OP-02-03 ORAL PRESENTATION – COVID-19/TRAINING INTERVENTION NR. 201

Schneider L, Weber V, Geiß C, Zentgraf S, Tomaskovic A, Brahmer A, Hillen B, Simon P, Neuberger E

Platelet-poor plasma mitochondrial DNA, but not platelet-free plasma or cell-free DNA discriminates post-COVID-19 condition from matched healthy controls during cardiopulmonary exercise testing

JOHANNES GUTENBERG UNIVERSITY OF MAINZ, Germany

- **Background:** Circulating cell-free nuclear DNA (cf-nDNA) and mitochondrial DNA (cf-mtDNA) have emerged as promising biomarkers across a broad spectrum of acute and chronic diseases. According to the literature, individuals with post-COVID-19 condition (PCC) exhibit elevated levels of both cf-nDNA and cf-mtDNA compared to healthy controls.
- **Methods:** Nineteen PCC patients and 19 age-, sex-, and BMI-matched controls performed cardiopulmonary exercise test on a bicycle ergometer. Controls stopped at the PCC-defined exhaustion time point (Post), with optional continuation to their individual maximum (Post_CON). EDTA blood was collected Pre, Post, and Post_CON. Platelet-poor plasma (PPP) was obtained by two centrifugation steps (2,500 × g, 15 min), and platelet-free plasma by an additional 10,000 × g step, 30 min. Cf-nDNA and cf-mtDNA were quantified by in-house qPCR assay with or without prior cfDNA isolation (QIAamp DNA Micro Kit, QIAGEN). Platelets were measured by flow cytometry using CD61+ antibody (BioLegend). Data were log-transformed and analyzed using linear mixed-effects models with Holm correction.
- **Results:** In PPP, cf-mtDNA differed significantly between the groups ($F_{1,45.0} = 26.32$, $p < .001$), while exercise until exhaustion had no effect on cf-mtDNA ($p > .05$). After additional 10,000 × g centrifugation and cfDNA isolation, no group differences remained. CD61+ platelet concentration showed similar patterns and correlated with cf-mtDNA concentration ($\rho = 0.74$, $p < .001$). From Pre to Post, cf-nDNA increased ~1.5-fold with exercise in both groups ($p < .05$), without group differences. In the healthy group cf-nDNA increased ~2.3-fold after volitional exhaustion.
- **Conclusion:** cf-mtDNA in PPP distinguishes individuals with PCC from controls. The differences are attributable to different platelet counts in PPP, likely reflecting underlying platelet biology. In contrast, the similar Pre levels and increases in cf-nDNA observed in both PCC patients and controls at similar exercise load suggest a non-specific physiological response to exertion rather than PCC-related pathology.

OP-02-05 ORAL PRESENTATION – COVID-19/TRAINING INTERVENTION NR. 167

Straub D, Englert T, Beller A, Stadelmaier J, Stahl M, Kilian J, Borzym J, Rotermund C, Akbuga-Schön T, Krakau S, Czernmel S, Weiler S, Pettenkofer M, Pettenkofer J, Maser U, Dammeier S, Nieß AM, Enderle MD, Nahnsen S

Resistance Training Reshapes the Gut Microbiome in a Longitudinal 8-Week Intervention in Sedentary Adults

ERBE ELEKTROMEDIZIN GMBH, Germany

- **Background:** The gut microbiome plays a critical role in metabolism, immunity, and aging. While endurance training has been shown to beneficially modulate the microbiome, the effects of resistance training remain less clear, with some studies reporting minimal changes. This project aims to investigate whether structured resistance training elicits significant changes in gut microbiome composition and diversity in sedentary, healthy adults.
- **Methods:** 150 participants (85 female, 63 male), between 24 and 61 years of age, completed an 8-week supervised resistance training program between May 2022 and July 2023 in the cities of Tübingen and Rottenburg, Germany. Session-level training data, including weights and repetitions, were recorded alongside metrics like load and compliance. Fecal samples were collected throughout the study period at designated timepoints for 16S rRNA gene amplicon sequencing to assess microbiome composition and for metabolomics analyses to evaluate microbial metabolic activity.
- **Results:** No differences in microbial diversity were observed, and there were no significant changes in microbial community composition or fecal metabolomics across all participants post-training. However, within-individual microbial community changes significantly correlated with strength improvement (Pearson correlation coefficient $r = 0.167$, $p = 0.0004$), and significantly stronger shifts in beta diversity were observed in participants with $\geq 33\%$ average strength gains compared to those with $\leq 12.2\%$ gains (Kruskal-Wallis rank sum test, $p = 0.08$). In these high responders, differential abundance analysis revealed time-dependent microbial changes, with 27 taxa enriched or depleted by week 8 of training (ANCOM-BC2, ≥ 2 -fold change, $p \leq 0.05$). Notably, Faecalibacterium and Roseburia hominis—both associated with a healthier, anti-inflammatory microbiome—were significantly enriched. Many differentially abundant taxa belonged to the Lachnospiraceae family.
- **Conclusions:** Resistance training drives significant, time-dependent gut microbiome changes, particularly in those demonstrating greater improvements in strength. These shifts mirror endurance training effects and may reflect improved overall health.

OP-02-04 ORAL PRESENTATION – COVID-19/TRAINING INTERVENTION NR. 106

Blechschiem R, Röcker K, Centner C, Girard O, Granacher U

Effects of Low-Load Blood Flow Restriction Training Versus High-Load Resistance Training on Lower-Limb Strength, Aerobic and Anaerobic Power, and Cycling Performance in Trained Male Mountain Bikers

ALBERT-LUDWIGS-UNIVERSITÄT FREIBURG, Germany

- **INTRODUCTION:** Performance in Olympic mountain biking depends on aerobic and anaerobic capacity and lower-limb strength. In trained athletes, additional resistance training is limited by high overall training loads. Low-load blood flow restriction (BFR) training may induce adaptations at lower mechanical loads than high-load resistance (HL) training. This study compared the effects of BFR and HL on strength, power, aerobic and anaerobic capacity, and cycling performance in trained male mountain bikers.
- **METHODS:** Twenty-eight trained (Tier 2) male mountain bikers were randomly assigned to HL ($n = 13$) or BFR ($n = 15$). Both groups completed two lower-limb resistance sessions per week for eight weeks alongside cycling training. HL trained at 70–85% one-repetition maximum (1RM); BFR at 20–30% 1RM with cuffs inflated to 60% limb occlusion pressure. Maximal leg strength and power were assessed via instrumented leg press. Aerobic and anaerobic capacity were assessed via incremental ramp testing; anaerobic glycolytic capacity via Wingate. Cycling performance was assessed during a 3.6-km time trial. A mixed ANOVA was performed.
- **RESULTS:** Significant group-by-time interactions were observed for peak power at the lactate thresholds (aerobic [LT]: $p = 0.019$, $d = 0.98$; anaerobic [LAT]: $p = 0.019$, $d = 0.98$) and mean time-trial power ($p = 0.007$, $d = 1.27$). Following BFR, power at LT increased +19.6% ($p = 0.001$, $d = 1.0$), IAT +16.5% ($p < 0.001$, $d = 1.43$), and time-trial power +12.4% ($p = 0.003$, $d = 1.0$), whereas HL showed no significant changes. Significant main time effects were detected for maximal leg strength, power, Wingate power, and time-trial outcomes, with no between-group differences.
- **CONCLUSION:** BFR and HL produced similar gains in strength and anaerobic performance. However, only BFR improved power at the lactate thresholds and mean time-trial power. These findings support BFR as a viable low-mechanical-load resistance training strategy in competitive mountain biking.

OP-02-06 ORAL PRESENTATION – COVID-19/TRAINING INTERVENTION NR. 300

Petersen C, Scullard CD, Meyer T, Reinsberger C

The effect of a 6-week neuroathletic training intervention on the vestibulo-ocular reflex in football players

INSTITUTE OF SPORTS MEDICINE / PADERBORN UNIVERSITY, Germany

- **Background:** The ability to spontaneously react and adapt to changes on the pitch is important for the game of football. The vestibulo-ocular reflex (VOR) is an objective assessment of vestibulo-ocular function that cannot be voluntarily controlled by the athlete and has been shown to exhibit exercise-associated modifications. It primarily contributes to gaze stabilization and tracking objects while the head and/or environment is/are in motion. Neuroathletic (or neurocentric) training (NAT) has been gaining increasing attention, as it attempts to specifically stimulate neurological systems (such as vestibulo-ocular) in combination with traditional athletic training. This study explores the effects of a NAT intervention on the VOR of male football players.
- **Methods:** Forty-two male (semi-)professional football players (age 20.48 ± 2.28 years) of two German football teams (Regionalliga) were recruited for a randomized crossover study and performed a six-week NAT (intervention) and conventional football training (control). VOR testing (Video Head Impulse Test, ICS Impulse System, Otometrics, Taastrup, Denmark) was performed before and after the NAT and control situation. A Linear Mixed Model was calculated to evaluate the difference in VOR gains in each semicircular canal between the two conditions.
- **Results:** No significant differences in pre-post changes were found between the intervention and control conditions in any of the outcome variables (p values between 0.27 and 0.79). Effect estimates ranged from -1.102 to 0.796, all 95% confidence intervals included zero, and standard errors were between 0.009 and 1.332.
- **Conclusion:** The six-week NAT intervention was not associated with significant changes in the VOR among male professional football players as compared to conventional training. In future research, additional measures of the vestibulo-ocular and other systems in combination with football-specific performance measures could be included to evaluate potential effects of NAT beyond VOR modification.

OP-03-01 ORAL PRESENTATION – ELITE SPORTS

NR. 280

Schlosser O, Weike N, Reinsberger C

Normative values of neurophysiological and neuropsychological tests in soccer, basketball and handball athletes

INSTITUTE OF SPORTS MEDICINE PADERBORN UNIVERSITY, Germany

- **Background:** Concussion as the mildest version of a mild traumatic brain injury is a common injury in contact sport. Comparison of clinical test results with individual baseline values facilitates the accurate diagnosis, but in the absence of baseline data, normative values provide an important reference. As neurophysiological and neuropsychological assessments of athletes may differ from non-athletes, sport-specific normative data to evaluate potential differences across various types of sport have been obtained.
- **Method:** Neurophysiological and neuropsychological baseline testing was performed twice per year from January 2017 to November 2025 in soccer, handball and basketball athletes at various levels. Data was obtained by computerized neuropsychological testing (CNS Vital Signs (CNSVS)), stability evaluation test (SET, Fa. Neurocom), dynamic visual acuity test (DVAT, Fa. Neurocom) and video head impulse test (vHIT, Fa. Otometrics). Between groups effects were performed by Kruskal-Wallis tests, since the data did not follow a normal distribution.
- **Results:** 752 athletes were evaluated (506 soccer, 188 basketball, 58 handball) (male n= 648; female n= 104). 490 athletes completed the CNSVS, 635 the DVAT, 745 vHIT and 599 the SET. Significant sport-related differences were identified for the processing speed domain at CNSVS ($p=0.03$), DVA loss in the right lateral plane ($p<0.001$), the right and left anterior semicircular canal in vHIT testing ($p<0.001$) and in five out of six conditions in the SET.
- **Conclusion:** This study provides sport-specific normative data for neurophysiological and neuropsychological baseline testing in soccer, handball and basketball athletes. Some values differ significantly between type of sport, particularly in processing speed, vestibular-ocular function and balance measures. Using sport-specific reference rather than comparison to the general population may be more specific in the assessment of sport associated concussion.

OP-03-03 ORAL PRESENTATION – ELITE SPORTS

NR. 300

Gorgoni G, Hauzel F, Meyer T

Head Injury Management in Football: A Qualitative Study of Referees in Germany

SAARLAND UNIVERSITY, Germany

- **Background:** Head injuries in football are relatively infrequent but carry significant health-related risks if mismanaged. Despite standardized assessment tools (e.g., SCAT6, CRT6) and international guidelines, discrepancies persist between recommended protocols and real-world on-pitch decision-making. Referees play a central role in recognizing and managing potential head injury situations, often under time pressure and contextual constraints. However, limited qualitative evidence exists on how these stakeholders experience and navigate such situations in practice.
- **Objective:** To explore the perceptions, experiences, and decision-making processes of referees in Germany regarding the recognition and management of head injury events in football.
- **Methods:** A qualitative exploratory design was employed using semi-structured one-to-one interviews. Nine participants (referees) from different levels of football in Germany participated. Interviews were conducted online and analyzed using reflexive thematic analysis following Braun and Clarke (2019). Analysis focused on identifying patterns related to managing head injuries situation during matches.
- **Results:** Four key themes were identified: (1) recognition and response, reflecting challenges in identifying head injury events, particularly when signs are subtle or delayed; (2) external pressures and challenges, including the influence of match context, game flow, and player reactions on decision-making; (3) confidence in recognizing injuries, highlighting differences in referees' self-perceived ability to identify and act upon suspected head injuries, often relying on visible cues and player behavior; and (4) training, rules, and federation support, encompassing inconsistencies in education and awareness of protocols.
- **Conclusion:** Referees' decision-making in head injury situations is influenced by a complex interplay of contextual pressures and structural constraints. These findings highlight the need for targeted education, clearer protocols, and systemic support to improve adherence to concussion management guidelines and enhance player safety.

OP-03-02 ORAL PRESENTATION – ELITE SPORTS

NR. 300

Ehmer R, Barsch F, Krumm O, Pretin S, Maier P, Sahlmann J, Morath O, Deibert P

Acute effects of mouth taping during physical exertion in elite athletes - Results of the Taped mouth Performance Differences study (TaPeD study)

UNIVERSITY HOSPITAL OF FREIBURG, Germany

- **Background:** Mouth taped training emerges, driven by promotion via (social) media. Current evidence indicates that altered breathing conditions during exercise affect various performance parameters. In this context there is limited data for elite athletes, especially regarding maximal physical exertion.
- **Methods:** In a monocentric, prospective, sequence-randomized, controlled crossover study (TRN: DRKS00032599; ethics approval number: 23-1430-S) acute changes of peak oxygen uptake capacity ($\dot{V}O_{2peak}$), maximum power output (Pmax), maximum heart rate (HRmax) and various breathing and metabolic parameters, training zones, rating of perceived exertion (RPE) and peak nasal inspiratory flow were assessed in a cardiopulmonary exercise test (CPET) on a bicycle ergometer in a cohort of elite athletes (N=24) aged 18 to 35 years. Athletes performed CPET at two temporally separated visits with their mouth taped shut (intervention) and without (control). Intraindividual differences were calculated and compared using an unpaired t-test or Wilcoxon rank-sum test. Correlations were analyzed between various parameters.
- **Results:** At maximum physical exertion $\dot{V}O_{2peak}$, Pmax, maximum minute ventilation and HRmax were significantly lower in the intervention than in the control condition. Furthermore, blood lactate concentration, RPE and various secondary parameters significantly differed in between the conditions. CPET-derived training zone prescription revealed no significant changes in training zones based on heart rate or power output. Correlations show that larger intervention-induced decreases in minute ventilation were associated with greater declines in performance capacity. During the intervention visit, five subjects terminated CPET due to fear of suffocation.
- **Conclusion:** The results show that mouth taping significantly reduce maximum performance in elite athletes, which is best explained by an intervention-induced limitation of minute ventilation. The results raise awareness for a thoughtful approach to mouth taped training. Future studies should focus on metabolic changes and long-term training effects of the intervention in elite athletes.

OP-03-04 ORAL PRESENTATION – ELITE SPORTS

NR. 110

Forster S, Brandts M, Meyer T

Postponing early morning training for swimmers – the effect on sleep, performance and fatigue (SleepTrain)

UNIVERSITÄT DES SAARLANDES, Germany

- Previous research has shown that swimmers sleep less prior to early morning training compared to a rest day. However, it is unknown whether delaying early morning training can extend sleep or how this affects performance and recovery. This study examined the impact of postponed morning training on sleep, performance, and perceived fatigue in swimmers.
- This randomized cross over study included 27 national level youth swimmers completing two 8 day training camps with either early (7:00: ET) or late (9:00: LT) morning sessions. Sleep was assessed daily using ActiGraph wGT3X BT and a sleep diary, and perceived fatigue using the Short Recovery and Stress Scale for Sport. Performance (100 m and 800 m all out) was tested at the beginning (Pre) and end (Post) of each camp. Sleep and fatigue outcomes were analyzed with multilevel linear models, and performance with two way ANOVA. Data are reported as mean $\pm$ SD.
- Sleep duration was significantly greater in ET compared to LT (6.9 ± 0.7 h vs. 7.9 ± 0.7 h; mean difference (md): 1.0 ± 1.7 h; $P < 0.001$; $\eta^2 p = 0.27$). No significant intervention x training camp interaction effect was observed for 100 m performance ($F(1,20) = 0.72$; $P = 0.41$; $\eta^2 p < 0.01$) or 800 m performance ($F(1,20) = 0.02$; $P = 0.88$; $\eta^2 p < 0.01$). Perceived stress was significantly lower (ET 3.4 ± 1.0 ; LT: 2.5 ± 0.9 ; $P < 0.001$; $\eta^2 p = 0.13$) and perceived recovery significantly higher (ET: 2.7 ± 0.8 ; LT: 2.9 ± 0.7 ; $P = 0.027$; $\eta^2 p = 0.01$) in LT compared to ET.
- Postponing early morning training by 2 hours increases total sleep time and improves perceived fatigue but does not acutely affect performance. However, extended sleep may still be important long term, given the role of sleep loss and fatigue in the development of non functional overreaching.

OP-03-05 ORAL PRESENTATION – ELITE SPORTS

NR. 189

Hacker S, Reichert L, Lenz C, Henne S, David F, Heilmann-Heimbach S, Zentgraf K, Krüger K

Individualized approaches to vitamin D optimization: Integrating genetic and non-genetic determinants in elite athletes

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN, Germany

- **Background:** An adequate vitamin D status is essential for bone metabolism, immune function, and muscle performance. Serum 25-hydroxyvitamin D [25(OH)D] concentrations are influenced by genetic and non-genetic determinants, including ultraviolet B (UVB) exposure and supplement intake. However, gene–environment interactions underlying vitamin D status have rarely been examined in high-performance athletes. This study investigated the contribution of a polygenic score (PGS) while accounting for key non-genetic determinants.
- **Methods:** Serum 25(OH)D levels (nmol/L) were measured in 473 German national squad athletes. Genetic polymorphisms were genotyped using the Illumina Global Screening Array (Illumina Inc., San Diego, CA, USA), and a PGS was calculated using PRSice-2. Linear regression models were applied to compare the predictive performance of a full model (PGS plus covariates) against a null model (covariates only). Covariates included age, sex, competition environment (indoor/outdoor), ambient UVB exposure, and supplementation status. Performance of the PGS was evaluated using five-fold cross-validation. Moreover, potential interactions with environmental variables were explored.
- **Results:** Serum 25(OH)D levels were associated with the standardized PGS ($b = 4.04$), age ($b = 8.59$), supplementation status ($b = 20.86$), and UVB exposure ($b = 7.18$, all $p < .05$). The full model accounted for 31.7% (12.1%) of the variance (adjusted $R^2 = .235$). The PGS provided an additional 1% explanatory value. No significant interactions were observed for PGS $\times$ UVB exposure, PGS $\times$ supplementation status, and PGS $\times$ competition environment.
- **Conclusion:** The findings indicate that genetic factors account for a small proportion of the total variance in vitamin D status. Stronger predictors are non-genetic factors such as supplementation, UVB exposure, and age, highlighting the predominant role of environmental influences. Genetic predisposition to low vitamin D levels appears to be a relevant but minor contributor to individualized management strategies, which should primarily focus on modifiable factors such as sun exposure and supplementation.

OP-03-06 ORAL PRESENTATION – ELITE SPORTS

NR. 126

Nolte S, Lenz C, Fink A-K, Klügel S, Hacker S, Krüger K

Low Relative Energy Intake is Linked to Iron Depletion in Elite Athletes: Evidence from a National Squad Field Study

JUSTUS-LIEBIG UNIVERSITÄT GIESSEN, Germany

- **Background:** Iron deficiency is highly prevalent in elite athletes and may impair performance even without anemia. While iron intake is essential, emerging evidence suggests that energy availability can critically affect iron metabolism. This study investigated whether relative energy and nutrient intake predict serum ferritin levels in elite athletes under real-world training conditions.
- **Methods:** One hundred forty-nine national squad athletes (80 females, 69 males) from nine sports disciplines completed three-day food record, analyzed against individualized recommendations. Iron status was classified by serum ferritin and hemoglobin; fractional absorption was estimated using a predictive model. Multiple linear regression identified predictors of ferritin concentration.
- **Results:** Most athletes failed to meet recommendations for calories (87%), carbohydrates (95%), and iron (39%). Biochemical iron deficiency (iron depletion or iron-deficient erythropoiesis) was present in 42% of athletes, with a marked female predominance. Relative caloric intake, iron supplementation, and age significantly predicted ferritin concentration ($R^2 = 0.34$, $p < 0.001$), whereas carbohydrate intake and sex showed non-significant trends. Low energy intake was associated with higher risk of iron deficiency ($r = 0.57$, $p < 0.001$). Consistently, actual iron absorption differed between groups ($p < 0.001$), with higher uptake in the iron-depletion group (2.56 ± 1.02 mg) and the iron-deficient erythropoiesis group (3.48 ± 0.91 mg) versus normal iron status (2.05 ± 1.0 mg).
- **Conclusion:** Relative energy intake emerged as the strongest determinant of systemic iron availability in elite athletes. Integrated nutrition strategies that address both energy sufficiency and iron intake are essential to prevent subclinical deficiency and sustain high-performance capacity.

OP-04-01 ORAL PRESENTATION – SPORTS PEDIATRICS

NR. 131

Bissig V, Müller L, Hauser C, Hanssen H

Effects of Aerobic and Resistance Exercise Interventions on Cardiovascular Health in Children and Adolescents with Overweight or Obesity: An Umbrella Review

UNIVERSITY OF BASEL, Switzerland

- **Background:** Childhood obesity is a global public health concern linked to other cardiovascular (CV) risk factors, including low cardiorespiratory fitness (CRF), hypertension, and poor vascular health that often track into adulthood. While exercise is known to improve CV health, the magnitude and robustness of its effects on CV risk factors in children and adolescents with overweight or obesity remain inconclusive. In this umbrella review, we aimed to summarize the effects of exercise interventions on body composition, CRF, blood pressure (BP), and vascular health in this population.
- **Methods:** We conducted an umbrella review of systematic reviews and meta-analyses evaluating aerobic and resistance exercise interventions on CV health in children and adolescents (6–18 years) with overweight or obesity in accordance with PRISMA guidelines. We searched MEDLINE, Embase, SPORTDiscus, Epistemonikos, and Cochrane Library from inception to July 2025. Methodological quality was assessed using AMSTAR-2, and results were synthesized narratively.
- **Results:** We included 47 systematic reviews and meta-analyses, comprising 854 primary studies and 58,330 participants. Across reviews, exercise interventions were generally associated with improvements in body mass index (BMI), body fat percentage, CRF, and reductions in systolic BP. Effects on diastolic BP and fat-free mass were less consistent. The evidence on macrovascular health suggested a positive effect, but certainty of evidence was low due to the limited number of reviews. No review met the inclusion criteria for microvascular health. Most reviews were rated as “low” or “critically low” using AMSTAR-2, primarily due to lack of protocol registration and inadequate risk-of-bias assessment.
- **Conclusion:** Exercise interventions in children and adolescents with overweight or obesity are associated with improvements in CV health through changes in BMI, body fat percentage, CRF, and systolic BP. However, low-quality evidence limits confidence in findings. Further studies analyzing microvascular health, long-term interventions, and specific exercise protocols defining intensity and duration are needed.

OP-04-02 ORAL PRESENTATION – SPORTS PEDIATRICS

NR. 159

Eghbali SP, Engel T, Atay S, Brogan C, Sonnenburg D, Mayer F

Is Low Body Fat a Marker of Low Energy Availability in Adolescent Athletes? A Sex-Specific Analysis

UNIVERSITY OF POTSDAM, Germany

- **Background:** Low energy availability (LEA) is a health concern in adolescent athletes, affecting growth, hormones, and performance. Additionally, body fat percentage (%FM) is commonly used to estimate energy status. However, its validity for estimating LEA remains unclear. Nevertheless, it can be discussed that %FM reflects cumulative energy stores and energy availability (EA) represents short-term energy balance. This study examined the relationship between %FM and EA in adolescent athletes, considering sex differences.
- **Methods:** This retrospective study analysed data from 330 adolescent athletes (12–18 years). Energy intake was taken from 5-day dietary records, and %FM estimated from skinfold measurement. EA was calculated as (energy intake - exercise energy expenditure)/fat-free mass ($\text{kcal} \cdot \text{kg}^{-1} \cdot \text{FFM} \cdot \text{day}^{-1}$) with EEE estimated using a Physical Activity level (PAL) of 1.8. Multiple linear regression examined associations between EA and %FM adjusting for sex, age group, and sport category. Exploratory analyses compared %FM across EA categories (<30 , $30-45$, $>45 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{FFM} \cdot \text{day}^{-1}$), and likelihood of LEA with very low %FM (sex-specific lowest quartile).
- **Results:** Across regression models, %FM was not associated with EA ($\beta = -0.30$, $p = 0.11$), while females showed lower EA than males ($\beta = -2.7$ to -3.3 , $p \leq 0.00$). %FM did not differ across EA categories (males: $p = 0.29$; females: $p = 0.31$). Most athletes were classified below recommended EA thresholds (critical <30 , suboptimal $30-45$, adequate $>45 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{FFM} \cdot \text{day}^{-1}$; $n = 212$, 79 , 39). However, athletes with very low %FM were not more likely to fall below EA thresholds ($p = 0.10$).
- **Conclusion:** %FM did not reflect current EA. Consequently, interpreting body fat as an indicator of LEA may be misleading. LEA appeared to be highly prevalent across groups despite substantial variation in %FM. Moreover, current EA thresholds might not be valid when screening adolescent athletes.

OP-04-03 ORAL PRESENTATION – SPORTS PEDIATRICS NR. 292

Dettenhofer M, Wagner J, Freilinger S, Mühlbauer F, Engl T, Köhle K, Ledergerber R, Niemeyer M, Takken T, Schmidt-Trucksäss A, Oberhoffer R, Königstein K*, Knaier R*
(*contributed equally)

VO₂ plateau detection is protocol-dependent and yields frequent false positives: evidence from a pediatric cohort

TECHNICAL UNIVERSITY OF MUNICH, Germany

- **Background:** The VO₂ plateau is traditionally used to confirm attainment of maximal oxygen uptake in cardiopulmonary exercise testing (CPET). In pediatric CPET, however, reported plateau incidences vary widely, and the validity of commonly used identification criteria remains uncertain. The aim was to systematically evaluate VO₂ plateau detection in children.
- **Method:** We retrospectively analyzed 699 CPETs in children and adolescents (age 14.3 ± 2.2 years; 29.9% female) with individualized ramp rates of 10–40 W·min⁻¹ (target duration 8–10 min). Plateau identification was based on the ratio of the VO₂-work rate slope in the end-exercise segment to that in a submaximal reference segment (plateau criterion: ratio <0.5). End-exercise windows of 120, 90, 60, and 30 s were evaluated. Specificity was operationalized by applying the criterion to rolling submaximal windows to quantify false-positive classifications. The influence of ramp rate was examined across these window durations.
- **Results:** The submaximal VO₂-work rate relationship was highly linear (mean slope 10.14 ± 1.45 mL·min⁻¹·W⁻¹; mean R² 0.88 ± 0.12). With shorter end-exercise windows, plateau incidence increased (120 s: 5%; 90 s: 10%; 60 s: 23%; 30 s: 39%), with a concurrent increase in false-positive classifications in submaximal windows (120 s: 17%; 90 s: 50%; 60 s: 92%; 30 s: 100%), consistently exceeding plateau incidence. False-positive rates were strongly dependent on ramp rate, decreasing from 69% at 10 W·min⁻¹ to 0% at 40 W·min⁻¹ (120 s window).
- **Conclusion:** VO₂ plateau detection in pediatric CPET is highly dependent on methodological factors and frequently identifies plateau-like patterns under clearly submaximal conditions. These findings suggest that plateau detection may be driven more by protocol characteristics than by underlying physiological mechanisms, raising concerns about the practical applicability of VO₂ plateau criteria in children.

OP-04-05 ORAL PRESENTATION – SPORTS PEDIATRICS NR. 242

Tomaskovic A, Blümer V, Gauß G, Dieckelmann M

Current Practice and Implementation Gaps in Exercise-Therapy Assessments in Pediatric Oncology: Stakeholder Survey Across the Network Activeoncokids

UNIVERSITY MEDICINE FRANKFURT, Germany

- **Background:** Exercise-therapy assessments are increasingly recognized as an essential component of pediatric oncology care, supporting clinical decision-making, individualized exercise prescription, and monitoring of functional outcomes. However, their implementation in routine practice remains unclear, and best-practice recommendations are lacking.
- **Methods:** A cross-sectional stakeholder survey was conducted between October 6 and December 8, 2025, among 37 pediatric oncology clinics and rehabilitation sites within the Activeoncokids network. Data were collected at the site level using a structured, theory-informed online questionnaire based on the Consolidated Framework for Implementation Research. Due to the modular design and adaptive routing, response numbers varied across items. Descriptive analyses were performed to characterize current practices, contextual determinants, and future perspectives.
- **Results:** A total of 26 sites provided evaluable responses. Exercise-therapy assessments were conducted at 50% (13/26) of sites, while 35% (9/26) reported no assessments and 15% (4/26) used alternative approaches. Main reasons given for non-implementation were limited resources (66%, 6/9) and lack of perceived necessity (33%, 3/9). Among sites performing assessments, substantial heterogeneity was observed, with only 25% (4/16) reporting integration into routine care. Assessments were most commonly conducted during acute treatment (67%, 10/15) and follow-up care (40%, 6/15), typically lasting 30–45 minutes (47%, 7/15). Adaptation of assessments to patient-specific characteristics was reported by 62% (8/13) of sites. Standardization was limited, with 42% (5/12) reporting guideline use and none reporting institutional SOPs. Time and personnel were the main barriers. Despite this, 86% (16/21) supported assessments and emphasized structured integration (56%, 10/18), standardization (e.g., manuals 83%, 15/18), and flexible, patient-centered approaches.
- **Conclusions:** Exercise-therapy assessments are considered relevant in pediatric oncology but remain inconsistently implemented in routine care. Addressing this gap requires data- and practice-informed best-practice recommendations that balance standardization with clinical feasibility and individualization. These recommendations will be developed based on the present findings, literature review and expert consensus.

OP-04-04 ORAL PRESENTATION – SPORTS PEDIATRICS NR. 198

Cassel M, Engel T, Lopez-Gomez F, Beckendorf C, Mayer F

Effects of bracing on return to sport and healing of lumbar bone stress injuries in adolescent athletes

UNI POTSDAM, Germany

- **Background:** Pars interarticularis lumbar bone stress injuries (LBSI) are prevalent among adolescent athletes (AA) causing prolonged healing and absence from athletic activity. Early treatment strategies include rest with or without bracing combined with physical therapy. The study aims to retrospectively analyze LBSI cases of AA at an Olympic sports medicine center and evaluates benefits of bracing for return to sport (RTS) time, bone healing and recurrent pathology.
- **Methods:** The medical charts of 206 AA (m/f: n=119/87) from 15 Olympic sports undergoing MRI diagnostics (1.5 Tesla) for clinically suspected LBSI were retrospectively assessed. Follow-up MRI diagnostics were analyzed to differentiate between healing and the development of spondylolysis. MRI-sequences included T2 Short-Tau-Inversion-Recovery in three planes and 3-dimensional T1 thin-slice gradient-echo to differentiate for grades of acute LBSI (bone marrow edema [1], stress fissure [2], stress fracture [3]) or chronic spondylolysis. Bracing was recommended for grades 2 and 3 but self-allocated (upon AA/legal guardians). Group differences were analyzed by unpaired t-test, Wilcoxon-test, ANOVA followed by post-hoc testing and Fisher's exact test (α=0.05).
- **Results:** LBSI was diagnosed in 77 AA (m/f: n=55/22; 15.2 years, 176 ± 11 cm, 64 ± 13 kg, 6.2 ± 2.6 training years, 9 ± 3 units/week) out of eleven sports. In 95% lumbar levels L5 (56%) and L4 (39%) presenting 18% bilateral cases were detected. Pathology grades were distributed to [1] in 32%, to [2] in 38%, and to [3] in 30%. RTS time was significantly different in dependence of grade (p<0.001), showing shortest time for grade [1] (96 ± 40 days) and longest for [3] (180 ± 53 days). Use of bracing (35% of cases) did neither significantly reduce RTS time nor influence development of spondylolysis (17%) or recurrent LBSI (9%) (p>0.05).
- **Conclusion:** RTS time following LBSI is influenced by pathology grade, not by bracing. This underlines the necessity for early and focused diagnostics of clinically suspicious AA. Early active loading protocols should be prospectively evaluated.

OP-04-06 ORAL PRESENTATION – SPORTS PEDIATRICS NR. 238

Schneider AC, Anzeneder S, Rehbein L, Ciaccioni S, Brack E, Schmidt M, Benzing V

Physical Activity and Physical and Mental Health in Pediatric Cancer Patients and Survivors: A Systematic Review and Meta-Analysis

UNIVERSITY BERN, Switzerland

- **Introduction:** Pediatric cancer patients (PCP) are at risk of acute and long-term impairments in physical and mental health resulting from disease and treatment. Physical activity (PA) is increasingly recognized as a strategy to address these challenges. This systematic review and meta-analysis aimed to evaluate the effects of PA on multiple indicators of physical and mental health in PCP during and after treatment.
- **Method:** A systematic search was conducted in APA PsycINFO, PubMed, SPORTDiscus, Web of Science, Embase, and Scopus. The search was completed in April 2020 and updated in May 2025. Randomized controlled trials (RCTs) and clinical controlled trials (CCTs) on PA interventions in PCP during or after treatment, assessing physical and mental health outcomes, were included. Two authors independently screened all studies for eligibility, extracted data, and assessed risk of bias. Separate random-effects meta-analyses for each outcome domain are ongoing and will be presented.
- **Results:** Of 9,952 studies identified, 44 RCTs and CCTs were included; 6 were secondary analyses and excluded from analysis. The studies involved 1,843 patients aged 3–18 years. Participants included survivors (n = 18), inpatients (n = 16), or both (n = 4), with mixed diagnoses (n = 20), leukemia only (n = 13), or brain/CNS tumors only (n = 5). Interventions comprised, among others, endurance, strength, and multimodal training, lasting 4 to 945 days, and varied in delivery mode (e.g., exergaming), additional components (e.g., nutritional recommendations), and supervision (with supervision: n = 26; without: n = 12). No adverse effects were reported.
- **Conclusion:** PA interventions in PCP during and after treatment appear safe and are characterized by substantial heterogeneity in intervention design. The ongoing meta-analysis will help identify beneficial intervention components and potential moderators of effect.

OP-05-01 ORAL PRESENTATION – IMMUNOLOGY

NR. 247

Walzik D, Joisten N, Proschinger S, Schenk A, Wenzel C, Zimmer P

Cardiorespiratory fitness shapes the proteomic landscape of human immune cells

TU DORTMUND UNIVERSITY, Germany

- **Background:** Immunological health is central to healthy ageing, and recent evidence suggests that lifestyle factors such as exercise play a key role in mediating immune competence. Here, we dissect the associations between cardiorespiratory fitness (CRF) and the proteome of peripheral blood mononuclear cells (PBMCs) to identify potential molecular mediators of immune function.
- **Methods:** We analyzed data from a randomized crossover study with 23 young adults, in which we had previously characterized proteomic alterations in PBMCs in response to high-intensity interval versus moderate-intensity continuous exercise (1). Proteins reliably associated with peak oxygen uptake (VO2peak) were identified from two repeated baselines using Pearson correlation ($r_P \geq 0.3$ or ≤ -0.3). We stratified participants into two groups using a sex-adjusted VO2peak median split (VO2peak: 51.68 $\pm$ 2.73 vs. 61.6 $\pm$ 4.81 ml/min/kg). Variance partitioning and gene set enrichment analyses (GSEA) were applied to link proteomic differences between fitness groups to molecular pathways in immune cells.
- **Results:** Across both baselines, 17 proteins were positively correlated with VO2peak (all $p \leq 0.05$), while diacylglycerol kinase ϵ demonstrated a negative correlation (mean $r_P = -0.42$, $p \leq 0.05$). Variance partitioning revealed that VO2peak explained more variance in participants with higher CRF for 75.3 % of the proteome (binomial test $p < 0.0001$). Using GSEA we identified several differentially regulated pathways in participants with higher CRF, including cytoplasmic translation ($p = 0.011$) and actin cytoskeleton organization ($p = 0.034$), which are integral to immune function.
- **Conclusion:** Our results shed light at the molecular impact of CRF. We conclude that CRF shapes the PBMC proteome by altering the variance structure of protein expression, resulting in increased regulation of molecular pathways related to immune function.

OP-05-02 ORAL PRESENTATION – IMMUNOLOGY

NR. 154

Ringleb M, Bloch W, Dreisigacker F, Puta C, Javelle F

From myokines to cellular response: an integrative meta-analysis of acute exercise-induced immunoregulation

DEUTSCHE SPORHOCHSCHULE KÖLN, Germany

- **Background:** Exercise is increasingly recognized as a key modulator of immune function, linking metabolic stress to molecular signaling and cellular immune adaptations. Acute exercise induces transient but heterogeneous responses in immunoregulatory myokines and immune cells. No meta-analytical synthesis has systematically examined the effects of acute resistance and endurance exercise on myokines and immune cells, including the influence of key moderators such as exercise intensity and duration.
- **Methods:** Three systematic reviews and meta-analyses conducted over the past two years investigated: (1) acute effects of resistance exercise on immunoregulatory myokines, (2) acute effects of endurance exercise on these myokines, and (3) acute effects of resistance and endurance exercise on T helper (Th) 1 and Th2 cells. Random-effects meta-analyses were performed for each outcome, and potential moderators were assessed.
- **Results:** Both endurance and resistance exercise induced significant effects on immunoregulatory myokines, like interleukin (IL)-6, IL-1ra, IL-15, and tumor-necrosis-factor (TNF)- α . However, endurance exercise induced much higher effect sizes compared to resistance exercise and was moderated by exercise intensity, duration, and dose. Alongside these myokine changes, high effect sizes were also found for immune cells, namely Th1 cells.
- **Conclusion:** Acute exercise induces significant immune alterations at messenger and immune cell level. The magnitude and kinetics of these responses are strongly influenced by exercise type, exercise dose, including intensity and duration, suggesting that different exercise modalities may differentially shape immune outcomes. Moreover, immune cell proliferation and their actual functional change may differ to a great extent. By linking exercise release with Th cell dynamics, it is highlighted how acute exercise acts as a coordinated stimulus that bridges metabolic demand and immune adaptation.

OP-05-03 ORAL PRESENTATION – IMMUNOLOGY

NR. 123

Gebhardt K, Klügel S, Adamzik M, Sitek B, Bayer M, Koos B, Ziehe D, Krüger B, Krüger K

Time-Driven Immune Responses with Modality-Specific Signatures in Inflammation, Proteome, Oxidative Stress, and Mitochondrial Regulation

JLU GIESSEN, Germany

- **Background:** Exercise induces time-dependent oxidative, inflammatory, and proteomic responses, but modality-specific kinetics remain insufficiently characterized. This study compared these responses following controlled downhill (DR) and level running (LR).
- **Methods:** In a randomized crossover design, thirty-two healthy males (24 $\pm$ 3 years; VO2max: 51.1 $\pm$ 5.4 ml/min/kg) completed DR (-12% decline) and LR (+1% incline) for 45-minutes at 70% of VO2max. Blood samples were collected pre, post, 3h post, and 24h post exercise. Reactive oxygen species (ROS), cytokines, and proteomic profiles were analyzed in serum. Mitochondrial transcription factor A (TFAM) was exploratory assessed in PBMCs as a marker of mitochondrial signaling (n=5).
- **Results:** A pronounced, time-dependent activation of the innate immune response was observed following exercise, with distinct kinetic patterns between protocols.
- In the early phase, both protocols showed increases in IL-6, MCP-1, and myoglobin, while IL-8, CCL3, IL-16, IL-21, IL-23, and IL-27 increased only after LR (all $p < .05$). MPO, IL-10, CD163, and HSP90 increased after DR (all $p < .01$).
- In the delayed phase, myoglobin, MCP-1, MPO, CD163, and IL-6 increased in DR, while IL-6, IL-21, and IL-23 increased in LR (all $p < .05$).
- In the late phase, CRP, MPO, CD163, and myoglobin increased in DR, while IL-6, MCP-1, MPO, myoglobin, IL-8, and TNF- α decreased, and IL-16, IL-21, and IL-23 increased in LR (all $p < .05$).
- Time $\times$ protocol interactions were observed for MCP-1, MPO, myoglobin, IL-27, and CRP (all $p < .05$). ROS positively correlated with IL-10 in both protocols, and with MPO in DR ($p < .05$). Proteomics revealed consistently higher immunoglobulin-related and immune-associated protein signals after DR across time points. Exploratory descriptive analysis of TFAM expression in PBMCs suggested differing temporal patterns between protocols, with indications of a more pronounced decline following DR.
- **Conclusion:** DR appears to induce a more pronounced, damage-driven immune response, whereas LR elicits a more regulated inflammatory profile, suggesting differences in physiological stress and recovery dynamics.

OP-05-04 ORAL PRESENTATION – IMMUNOLOGY

NR. 152

Proschinger S, Walzik D, Wenzel C, Winker M, Linnig M, Krüger M, Zimmer P

Time-of-day effects of exhaustive exercise on the cellular and plasma-proteomic signature of lymphocyte trafficking

TU DORTMUND UNIVERSITY, Germany

- **Background:** Acute endurance exercise leads to the redeployment of lymphocytes, i.e. effector cells, and affects the plasma proteome. Time-of-day fluctuations in hormones and expression of clock genes result in enhanced patrolling of cells during night. So far, it is unknown how exercise during day and night differentially affects redeployment of lymphocytes, the plasma proteome, and whether the migratory potential of lymphocytes is reflected in plasma protein composition.
- **Methods:** In a randomized crossover study, twenty subjects (sex ratio 1:1, 31.6 $\pm$ 10.7 years, 23 $\pm$ 2.7 kg $\cdot$ m⁻², 46.8 $\pm$ 8.25 mL $\cdot$ kg⁻¹ $\cdot$ min⁻¹) performed an exhaustive exercise session at 12a.m. and 12p.m., respectively. Blood was drawn at three timepoints (pre, post, 1h post). A standardized meal was provided 4h before intervention. Flow cytometry-based immune cell phenotyping (20 colors) and LC-MS/MS-based plasma proteome analysis (4,321 proteins) was conducted.
- **Results:** Despite higher baseline levels at night ($p < .001$), exercise-induced increases in lymphocyte counts, i.e. effector CD8⁺ T-cell subsets, were higher during night ($p = .009$), whereas no differences were observed in CD4⁺ T-cell subsets. Similarly, circulating lymphocytes decreased more pronounced at 1h post during night ($p = .001$) which was mainly driven by naive and regulatory CD4⁺/CD8⁺ subsets. Exercise-induced changes in plasma proteins over time were mainly observed during night (n=360; day: n=68). Weighted-Gene-Correlation-Network-Analysis (WGCNA) identified a module containing 1,315 proteins characterized by Gene Ontology (GO) terms that are associated with cell adhesion/migration and its regulation. The module score was higher at night compared to day ($p = .035$), decreased only after exercise at night ($p = .007$), and returned to baseline at 1h post ($p = .004$).
- **Conclusion:** Plasma-proteomic changes and the redeployment of lymphocytes were more pronounced during night exercise, involving both effector (mainly mobilization) and naive/regulatory cell types (mainly migration). For the first time, combined WGCNA and GO overrepresentation analysis of the plasma proteome linked its composition to the increased migratory potential of lymphocytes during night as well as the exercise recovery period.

OP-05-05 ORAL PRESENTATION – IMMUNOLOGY

NR. 122

Gebhardt K, Abromeit V, Adamzik M, Sitek B, Bayer M, Koos B, Ziehe D, Krüger K, Krüger B

Transcutaneous Vagus Nerve Stimulation Alters Inflammatory Profile and Proteome Signatures after Eccentric Endurance Exercise

JLU GIESSEN, Germany

- **Background:** The vagus nerve plays a central role in the neural regulation of immune function via the cholinergic anti-inflammatory pathway, but its role in regulating inflammatory recovery after exercise remains unclear. Using eccentric endurance exercise as a model of sterile inflammation, this study aimed to determine whether transcutaneous vagus nerve stimulation (taVNS) modulates the resolution of inflammation and associated recovery processes.
- **Methods:** In a single-blind randomized crossover design, twelve healthy male participants (age: 25 ± 3; VO2max: 49.6 ± 4.9 ml/min/kg) completed two bouts of eccentric endurance exercise (45 minutes of downhill running with 12% slope at 70% of VO2max), followed by either taVNS (cymba conchae) or sham stimulation (earlobe). Circulating reactive oxygen species (ROS), pro-inflammatory cytokines (IL-6, TNF-α, IL-8), heart rate variability (HRV), and serum proteomics were assessed before exercise, directly after, 3h after, and 24 h after exercise.
- **Results:** taVNS induced a trend toward increased parasympathetic activity during stimulation, indicating vagal engagement. Condition×time interactions were observed for IL-6 (F=3.721, p=0.027), but not for ROS or other cytokines. taVNS reduced early ROS responses (t=-1.547, p=.078) and a more pronounced decline of IL-6 (t=-2.826, p=.011) during late recovery. Early ROS changes were positively associated with TNF-α resolution under taVNS only (r=.801, p=.003). Proteomic analyses revealed that the most robust condition-dependent differences emerged at 24 h post-exercise, characterized by lower expression of classical complement components (C1q subunits) and higher levels of alpha-1-acid glycoprotein (ORM1) and immunoglobulin gamma-1 heavy chain (IgG1) following taVNS.

OP-05-07 ORAL PRESENTATION – IMMUNOLOGY

NR. 252

Hoseinpor AN, Javelle F, Saremi M, Bloch V

Exercise training as a modulator of inflammasomes in neurodegenerative and neuropsychiatric disorders: a systematic review

DEUTSCHE SPORHOCHSCHULE KÖLN, Germany

- **Introduction:** Inflammasomes are intracellular multiprotein complexes that regulate neuroinflammation and are named after their sensor proteins. Among them, the NOD-, LRR- and pyrin domain-containing protein 3 (NLRP3) inflammasome is implicated in neurodegenerative and neuropsychiatric disorders by promoting the release of pro-inflammatory cytokines, including interleukin-1β (IL-1β) and IL-18. Exercise training has emerged as a potential non-pharmacological strategy to modulate inflammatory pathways; however, its effects on brain-related inflammasome signaling remain unclear and lack comprehensive synthesis. This review was conducted to evaluate the effects of chronic exercise training on inflammasome activity and its implications for neurodegenerative and neuropsychiatric disorders.
- **Methods:** This review was conducted following PRISMA guidelines and registered in PROSPERO (CRD420251177689). A systematic search of PubMed, Web of Science, and Google Scholar was performed by two independent reviewers. Studies were included based on PICOS criteria, focusing on human and animal models of neurodegenerative or psychiatric conditions, or general neuroinflammation. Eligible interventions involved chronic exercise (≥1 week) across all exercise modalities, with outcomes assessing inflammasome markers. Study selection, data extraction, and quality assessment were independently performed by two reviewers using the TESTEX scale.
- **Results:** Twenty animal studies met the inclusion criteria, examining treadmill running, voluntary wheel running, resistance-like protocols, and high-intensity interval training, lasting 1 to 12 weeks. Despite heterogeneity, eighteen studies (90%) reported that exercise significantly attenuated inflammasome activation, shown by reductions in NLRP3 expression, caspase-1 activity, and downstream cytokines IL-1β and IL-18 across multiple brain regions. These findings support a robust anti-inflammatory effect of chronic exercise.
- **Conclusion:** Chronic exercise training appears to suppress inflammasome activity and mitigate neuroinflammation, supporting its potential in neurodegenerative and neuropsychiatric disorders. Effect sizes vary across studies, likely due to heterogeneity in exercise protocols, duration, and intensity. Well-designed human studies are needed to determine optimal exercise prescriptions and clarify underlying mechanisms.

OP-05-06 ORAL PRESENTATION – IMMUNOLOGY

NR. 139

Leuchte K, Luu TV, Bech Horsted C, Fresnillo Saló S, Stensøe Oksen M, Moretto Krog S, Madsen K, Ottosen LH, Pries Olsen A, Christiansen AB, Kramer Mikkelsen M, Lorentzen T, Ragle A-M, Becker J, Nielsen DL, Vinther A, Fredberg Persson G, Straten PT, Holmen Olofsson G

The clinical and immunological effects of 6-week high-intensity interval training in metastatic lung cancer patients receiving immunotherapy

COPENHAGEN UNIVERSITY HOSPITAL HERLEV, Denmark

- Exercise has proven safe and effective to improve patient-related outcomes in cancer patients. Recent data indicate that it additionally reduces cancer incidence and recurrence, potentially mediated by modulating the anti-tumor immune response. Naturally elicited anti-cancer immunity leads to infiltration of immune cells into tumors, which influence disease progression, including overall survival and response to immune checkpoint inhibitor (ICI) therapy. ICI has revolutionized cancer treatment, but a relevant proportion of patients do not respond. The profound immune modulation following high-intensity exercise suggests that exercise improves immunity and may serve as a valuable therapy modality in combination with immunotherapy.
- The randomized controlled HI AIM study investigated six weeks of high-intensity interval training (HIIT) in patients with metastatic non-small cell lung cancer (mNSCLC) receiving standard-of-care therapy. Patients in the intervention arm underwent supervised, group-based HIIT three times per week for six weeks. Data on exercise performance, cardiorespiratory fitness, therapy course, psychological distress, and disease outcomes were collected. Peripheral blood samples were obtained before and after acute HIIT sessions and longitudinally for immunological analyses.
- Between August 2020 and October 2023, 54 patients were randomized. HIIT resulted in non-habituating mobilization of NK and T cells into peripheral blood. At the 12 week timepoint, circulating NK cells normalized to baseline were significantly higher in the exercise group compared to control. Beyond that, the intervention has shown to be safe (no severe adverse events) and feasible (attendance rate median of 94% of sessions). VO2 peak, an independent predictor of overall survival, increased in the intervention group but not in controls, as did maximal power output. Fewer patients experienced therapy dose reductions (26.7% vs. 57.9%) or unplanned hospital admissions. A trend toward improved survival was seen, especially in ICI monotherapy.
- This study shows that HIIT is not only safe and feasible, but promotes immune activation.

OP-06-01 ORAL PRESENTATION – ORTHOPEDICS & BIOMECHANICS

NR. 202

Schwalm L, Mai J, Fohrmann D, Schaffarczyk M, Menge C, Rückemann L, Gronwald T, Hollander K

Does habituation change running economy benefits in advanced footwear technology? – A 12-week randomized controlled trial

MSH MEDICAL SCHOOL HAMBURG, Germany

- **Background:** Advanced footwear technology (AFT) can improve running economy (RE) compared to traditional footwear. Previous research has examined acute RE benefits across AFT, whereas this 12-week longitudinal randomized controlled trial (RCT) aimed to investigate the effects of regular AFT training on RE.
- **Methods:** Seventy trained runners participated in this RCT. On the first laboratory visit (PRE), they completed 6x5min running trials in different shoe conditions: 1) an AFT (L_AFT), 2) a NonAFT (L_nAFT), and 3) an identical model of the AFT (I_AFT, for the intervention group) or NonAFT (I_nAFT, for the control group). L_AFT and I_nAFT remained in the laboratory for the second visit after the 12-week intervention period (POST), whereas the third shoe was provided to the participants. During the intervention, the participants continued their habitual training and increased the percentage of mileage in the provided shoe. We used linear mixed-effects models with random intercepts for participants and calculated estimated marginal means to examine the effects of time (PRE-POST), shoe condition (L_AFT, I_nAFT), group allocation and their interactions on energetic cost of transport (ECOT) while controlling for sex and trial order as covariates.
- **Results:** Final analysis included 60 participants (27 females; 32.4 ± 8.2 years; BMI: 22.3 ± 2.2 kg·m⁻², 14.3% dropout-rate). The three-way interaction of group×time×shoe condition was not significant (estimate = -0.017 kg·m⁻¹, 95% CI [-0.087, 0.120], p = 0.751), providing no evidence that the 12-week habituation moderated the energetic benefit of AFT shoes. L_AFT shoes reduced ECOT compared to I_nAFT shoes across groups and visits (differences ranging from 2.5 to 3.2%, all p ≤ 0.001). No significant effects of time or group allocation were observed.
- **Conclusions:** Regular training in and habituation to AFT did not change their benefits in RE, indicating that regular AFT training is neither necessary nor detrimental regarding RE benefits. Nevertheless, runners should be aware of the distinct implementation, familiarization, and adaptation processes that may accompany AFT use.
- **Conflicts of interests:** L.S. is the co-founder and co-owner of an endurance sports coaching company named 'Nordlicht-Ausdauer-Coaching'. KH serves as Chief Medical Officer (honorary position) for the German Athletics Association (DLV), which receives sponsorship from NIKE, and as Team Physician for the German Ski Association.

OP-06-02 ORAL PRESENTATION – ORTHOPEDICS & BIOMECHANICS NR. 161

Engel T, Stoll J, Joost T, Risch L, Mayer F

Effectiveness of an eccentric and perturbation-based training for the prevention of sports-related injuries in adolescent athletes before entering a competitive sports career

UNIVERSITY OF POTSDAM, Germany

- **Background:** Admission to an elite sports school during childhood and adolescence is frequently accompanied by a sudden and significant increase in training load. This demand affects a developing, structurally vulnerable musculoskeletal system, increasing the risk of sports-related injuries. The objective was to assess the effectiveness of a structured eccentric and perturbation-based preparatory training to reduce incidence and prevalence of sports related injuries in adolescent athletes.
- **Method:** A prospective, randomised controlled trial was conducted. Prior to school entry, N=156 athletes were allocated 2:1 to either an eccentric and perturbation-based training group (ECC; progressive structured eccentric program, three months, two weekly sessions) or a comparison group (COM; volume-matched, non-structured progressive training increase). N=161 additional athletes formed a control group (CTRL; regular training). Occurrence of injuries was recorded over two school years (grades 7-8); incidence and prevalence rates, relative risk, and group differences (Chi-Square, ANOVA, $\alpha=0.05$) were analysed. Adherence and feasibility were documented by protocol and questionnaire.
- **Results:** Overall, prevalence of injuries across all groups within the two school years was 93%, with a mean incidence of 1.8 events per athlete. The ECC group showed a statistically significant reduction in prevalence compared to CTRL ($\chi^2(1)=8.50$; $p=0.004$). No significant between-group differences were detected in absolute incidence or prevalence numbers. The relative risk of ECC versus CTRL was 0.93 (95% CI: 0.84–1.04), and for COM vs CTRL 0.98 (95% CI: 0.86–1.10) respectively. Feasibility and adherence were rated high.
- **Conclusion:** Sports-related injuries are very common during the transition into elite youth sport. Both interventions proved feasible and demonstrated measurable, though modest, preventive effects. Injury prevention must be recognised as essential and thus implemented as early in the sports career as possible. Whether a specific training protocol or solely the progressive increase in training load is required for injury reduction remains to be investigated.

OP-06-04 ORAL PRESENTATION – ORTHOPEDICS & BIOMECHANICS NR. 227

Fohrmann D, Schwalm L, Mai J, Schaffarczyk M, Menge C, Rückemann L, Gronwald T, Dalos D, Hollander K

Into the (Track and) Field: Biomechanical Changes during a Competitive 5000m Race Captured by Markerless Motion Capture

MSH MEDICAL SCHOOL HAMBURG, Germany

- Running-induced fatigue leads to changes in running biomechanics. Most research is based on controlled laboratory environments, and it remains unclear whether these findings translate to competitive racing, where pacing strategies and accumulated fatigue interact. The aim of this study was to investigate changes in running biomechanics over the course of a 5000m race.
- A total of 53 adult runners competing in an official 5000m state championship consented to participate. Kinematic data of all 12.5 laps were recorded using 12 calibrated high-speed video cameras (85Hz) covering a 10m segment before the finish line. Video data were processed using AI-based markerless motion capturing software (Theia3D). Biomechanical parameters were computed using Python scripts. Linear mixed effects models were used to analyse the effect of time (laps) on biomechanical parameters.
- We analysed 51 runners who finished the race (13 female, 33.0±11.3 years, BMI: 21.0±2.1 kg/m², finish time: 17:05±2:09 min). Compared to lap 1, running speed decreased by 2.6 to 7.1% in laps 2 to 12 and increased by 8.9±10.5% in the final lap. Step rate (-1.1 to -3.4%; final lap: +4.3±4.6%) and step length (-1.3 to -4.0%; +5.9±5.7%) followed this pattern. Contact time increased by 4.6 to 11.2% and then decreased by 2.1±8.9%. Flight time and vertical pelvis motion were stable until lap 12 but decreased significantly in lap 13 (-2.5±3.8% and -10.1±8.6%). Trunk flexion, lower limb joint angles, and overstriding steadily increased over the 13 laps.
- This was the first study using markerless motion capture to measure biomechanical changes during a competitive 5000m race. Our findings revealed changes from both muscular fatigue and pacing strategies. While trends in spatiotemporal parameters reversed during the final lap sprint, changes in joint kinematics progressed throughout. Coaches, athletes, and health professionals should account for the increased demands of the final sprint under accumulated fatigue in training design.

OP-06-03 ORAL PRESENTATION – ORTHOPEDICS & BIOMECHANICS NR. 132

Sammoud S, Negra Y, Bouguezzi R, Prieske O, Königstein K, Müller P, Hachana Y, Chaabene H

Horizontal speed deceleration distance: a practical tool for manipulating eccentric training load in male youth soccer players

UNIVERSITY HOSPITAL MAGDEBURG; OTTO-VON-GUERCKE UNIVERSITY, Magdeburg, Germany

- **Background:** A mounting body of evidence supported the systematic integration of eccentric training in youth athletes, given its effectiveness in enhancing various physical fitness attributes. This study investigated the effects of different horizontal speed deceleration training (HSDT) distances on measures of physical fitness in male youth soccer players.
- **Methods:** Twenty-nine postpubertal players were randomized to 5-m (HSDT5m; n=15) or 8-m (HSDT8m; n=14) deceleration groups, performing six weeks (two sessions/week) of horizontal sprints with 20-m accelerations and controlled deceleration over the assigned distance, alongside regular soccer training. Physical fitness was assessed pre- and post-intervention using linear sprints (5-m, 20-m), 505 change-of-direction (CoD) speed, countermovement (CMJ) height, and standing-long-jump (SLJ) distance.
- **Results:** ANCOVA revealed significant between-group differences at post-test across all performance measures, favoring HSDT5m ($p < 0.05$; $\eta^2 = 0.162-0.520$). Considering baseline-adjusted post-test values, both groups improved their linear sprint performance significantly from pre- to post-test. However, percentage improvements were greater in HSDT5m for the 5-m (6.68% vs. 3.87%) and 20-m sprints (4.40% vs. 3.16%) compared with HSDT8m, respectively. For CoD speed, CMJ-height, and SLJ-distance, results showed greater improvements in HSDT5m (5.62%, 9.64%, and 4.23%) compared with HSDT8m (2.32%, 5.48%, and 2.37%), respectively. Individual response analysis indicated that improvements exceeding the smallest-worthwhile-change threshold occurred in 93–100% of participants in HSDT5m and 78–100% of participants in HSDT8m across all outcomes.
- **Conclusion:** These findings suggest that shorter horizontal speed deceleration distance induced superior adaptations in sprinting, CoD speed, and jumping performance in male youth soccer players. Therefore, deceleration distance represents a practical tool for manipulating eccentric training load in this population.

OP-06-05 ORAL PRESENTATION – ORTHOPEDICS & BIOMECHANICS NR. 301

Henze A-S, Deutsch V, Bottke P, Schwarz E, Matits L, Bizjak DA, Schulz SVW, Kirsten J

Functional shoulder screening does not predict throwing-related shoulder problems in amateur handball

UNIVERSITY HOSPITAL ULM, Germany

- **Objectives:** Throwing-related shoulder problems such as pain are common in handball and may represent early stages of overuse preceding structural shoulder pathology. This prospective observational study investigated associations between functional shoulder parameters and both the presence and short-term incidence of throwing-related shoulder problems in amateur handball players.
- **Methods:** In the 2024/2025 season, 168 amateur handball players of both sexes underwent a comprehensive functional shoulder assessment including range of motion, strength testing, Upper Quarter YBalance Test (YBT-UQ), and surface electromyography of the trapezius muscles. Representative variables within each functional domain were selected to reduce multicollinearity: total range of motion, normalized isometric external rotation strength, YBT-UQ composite score, and upper/lower trapezius activation ratio. Shoulder problems were assessed using the Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRCO2). Cross-sectional associations were analyzed using multivariable logistic regression adjusted for age, sex, and weekly training load. Players without baseline problems were followed for 12 weeks, and incident problems were analyzed using age-adjusted logistic regression.
- **Results:** At baseline, 61 of 168 players (36%) reported throwing-related shoulder problems. None of the functional shoulder parameters (odds ratios (ORs) per one standard deviation increase ranged from 0.82 to 1.04) or covariates showed an independent association with existing shoulder problems. Of 107 asymptomatic players, 59 completed follow-up; 47% of these developed new problems. No functional shoulder parameter demonstrated a statistically significant association with incident shoulder problems.
- **Conclusions:** Functional shoulder parameters were neither associated with existing nor predictive of short-term shoulder problems. These findings highlight the multifactorial nature of overuse-related shoulder problems in overhead sports and the limited value of isolated functional screening. Screenings seem to be integrated into longitudinal, load-sensitive, and symptom-based monitoring frameworks.

OP-06-06 ORAL PRESENTATION – ORTHOPEDICS & BIOMECHANICS NR. 259

Wolter I, Brixius K

Perspectives and limitations of extended reality (XR)-based sport therapy on chronic non-specific low back pain: Systematic review and meta-analysis

UNIVERSITÄT ZU KÖLN, Germany

- **Introduction:** XR technologies recently gained attention as innovative therapeutic approaches. This work analyses the effectiveness of XR therapy compared to conventional non-pharmacological treatments for chronic non-specific low back pain (CNSLBP), with a focus on differences between non-immersive and fully immersive Virtual Reality (VR) and factors influencing treatment outcomes.
- **Methods:** A systematic review and meta-analysis following the PRISMA guidelines was conducted. Randomised controlled trials were extracted from meta-analyses in PubMed and supplemented by a direct search for individual studies. Two independent reviewers performed study selection based on predefined inclusion and exclusion criteria followed by data extraction, risk-of-bias assessment, and meta-analyses with subgroup analyses (23 studies included). Certainty of evidence was assessed using GRADE (Grading of Recommendations, Assessment, Development, and Evaluation).
- **Results:** XR therapy produced a statistically significant (MD=-1.31; 95% CI: -1.89 to -0.72; $p<0.0001$) but not clinically meaningful pain reduction in CNSLBP. Non-immersive VR therapy (n=18 studies) showed significant superiority over standard therapy (MD=-1.24; 95% CI: -1.86 to -0.62; $p=0.0004$), while fully immersive VR therapy (n=6) showed no additional benefit (MD=-1.63; 95% CI: -3.89 to 0.63; $p=0.12$). XR therapy was more effective than no active control, core exercises, pelvic tilt exercises, interactive virtual cognitive behavioural therapy (CBT), and watching 2D virtual walking. Factors positively influencing the reduction of CNSLBP are XR therapies consisting of yoga, chest/hip/pelvis movements, interactive virtual CBT, and watching 2D virtual walking. Significant effects were observed for intervention durations <60 minutes and 300-600 minutes, with sustained effects at short- and medium-term follow-up.
- **Conclusion:** XR therapy is a promising treatment modality for CNSLBP, particularly in non-immersive formats. However, current evidence is limited by heterogeneity and low certainty. The non-significant results for fully immersive VR are likely due to the limited number of studies. Further high-quality RCTs are needed to confirm a potential benefit before clinical implementation.

PLENARY 2 HOT TOPICS IN ELITE SPORT NR. 182

Krüger K, Guerra Minuzzi L, Hacker S, Roffler A, Zentgraf K, Lenz C

Sex-specific and shared endocrine signatures of REDs severity in a large cohort of German elite athletes

UNIVERSITY OF GIESSEN, Germany

- **Background:** Relative Energy Deficiency in Sport (REDs) is characterized by systemic endocrine and metabolic perturbations. While its multifactorial nature is well established, sex-specific biomarker profiles across different levels of REDs risk remain insufficiently defined in elite sports.
- **Methods:** In this cross-sectional analysis, 681 German elite athletes (287 females, 394 males; 18.6 ± 4.3 years) underwent standardized, multidisciplinary diagnostics within the in:prove project. REDs risk was quantified using an adapted IOC RED-CAT2. Athletes were scored on indicators (0 = none; 3+ = moderate to high). Endocrine and metabolic markers were analyzed across REDs risk categories and by sex using two-way ANOVA models including interaction terms. Statistical significance was set at $p<0.05$.
- **Results:** Fifty-seven percent of athletes exhibited ≥1 REDs indicator, with a higher prevalence in females than males (71% vs. 47%, $p<0.001$). In male athletes, 15% and 23% presented clinically low or borderline low testosterone, respectively. Across increasing REDs risk categories, free triiodothyronine (FT3) showed a robust, stepwise decline independent of sex (main effect $p<0.0001$; interaction $p=0.903$), supporting its value as a marker of energy deficiency. In contrast, significant REDs risk×sex interactions were observed for leptin ($p<0.0001$): Females demonstrated a pronounced decrease in leptin with increasing REDs severity (all $p<0.0001$), whereas leptin remained unchanged across categories in males. Growth hormone, IGFBP-1, and insulin exhibited significant main effects of REDs risk (all $p<0.001$) without sex interaction, indicating shared endocrine adaptations. Ferritin displayed a sex effect only, independent of REDs risk classification.
- **Conclusion:** Higher REDs risk is associated with both sex-independent (FT3, insulin, IGFBP-1, growth hormone) and sex-specific (leptin) endocrine signatures. Our data highlight FT3 as a robust central marker of low energy availability while leptin provides additional sensitivity in female athletes. These findings underscore the necessity of sex-stratified, multi-marker screening approaches for accurate REDs risk assessment in elite sport.

PLENARY 2 HOT TOPICS IN ELITE SPORT NR. 245

Gräfings M, Melin A, Schmidt-Trucksäss A, Hoffman E, Steiner T, Bucher E, Klungland Torstveit M

Effects of a 16-Week Digital Intervention on Sports Nutrition Knowledge, Behavior and Low Energy Availability Markers Among Swiss National Team Cross-Country Skiers and Biathletes

UNIVERSITY OF BASEL, Switzerland

- **Background:** Endurance athletes with high training loads have increased risk of low energy availability (LEA). This study evaluated a 16-week digital nutritional intervention on sports nutrition knowledge, behavior, and LEA markers in worldclass athletes.
- **Methods:** Swiss national team cross-country skiers and biathletes (n=34: 21 females, 13 males; age: 24±4 years; VO2max: 63±8 ml/kg/min) completed the FUEL program, consisting of 16 weekly online lectures and bi-weekly individual counseling. Pre- and post-intervention assessments included a validated 78-item nutrition knowledge questionnaire, 4-day dietary/training records, exercise energy expenditure (EEE) via incremental testing, and LEA/Relative Energy Deficiency in Sport (REDs) markers via the IOC Clinical Assessment Tool (CAT) 2. Data were analyzed using McNemar, Wilcoxon signed-ranks, and dependent t-tests.
- **Results:** Athletes categorized with LEA/REDs decreased from 35% (n=12) at PRE to 21% (n=7) at POST ($p=0.180$). Nutrition knowledge improved significantly in all athletes ($p<0.001$). In the REDs group, EDE-Q global scores decreased ($1.1±0.9$ vs. $0.5±0.6$; $p=0.02$), while male testosterone levels increased ($14±6$ vs. $20±4$ nmol/L; $p=0.01$). Female athletes with menstrual dysfunction decreased from 24% (n=5) to 10% (n=2). For the REDs group, average energy availability (EA) and carbohydrate (CHO) intake increased ($32±7$ vs. $39±7$ kcal/kg FFM/day, $p=0.022$; $5.4±1.6$ vs. $6.4±1.6$ g/kg, $p=0.039$) while no changes in EEE were found. On hard training days, EA and CHO intake also increased for the REDs group ($24±7$ vs. $34±5$ kcal/kg FFM/day, $p=0.004$; $5.9±1.5$ vs. $7.5±1.9$ g/kg, $p=0.038$). No changes in body weight, body composition, triiodothyronine (T3), protein intake and fat energy% were found in either group.
- **Conclusion:** The FUEL program effectively improved nutrition knowledge, increased EA and carbohydrate intake, and reduced eating disorder pathology in athletes with REDs without affecting body weight. Improved testosterone levels (males) and menstrual status (females) indicate a reduced clinical risk of LEA/REDs, though larger studies are required for confirmation.

PP-01-01 POSTER PRESENTATION 1 - ELITE SPORTS NR. 250

Beckendorf C, Engel T, Cassel M, Mayer F

Cross-Sectional and Longitudinal Echocardiographic Changes in Competitive Rowers: Evidence for Development-Related Cardiac Adaptation and Age-Specific Reference Ranges

UNIVERSITY OF POTSDAM, Germany

- **Background:** Distinguishing physiological remodeling from clinically relevant morphological abnormalities in young athletes remains challenging. We evaluated whether echocardiographic cardiac dimensions change systematically across athlete development in competitive rowers and whether preliminary age-specific reference ranges can be derived.
- **Methods:** This combined cross-sectional and longitudinal analysis included 66 competitive rowers, with equivalent training workload. In the cross-sectional cohort children aged 11–14 years (n=31), adolescents aged 15–18 years (n=23), and adults aged ≥19 years (n=15) were compared. The longitudinal cohort comprised 45 examinations from twelve athletes with a median follow-up of 7±2 years. Group differences were analyzed using Kruskal–Wallis tests and ANCOVA adjusted for body surface area and sex. Within-athlete change was assessed using Wilcoxon signed-rank tests and fixed-effects regression.
- **Results:** Median LVEDD increased from 46.0 to 51.5 to 55.0 mm across children, adolescents and adults; IVSd increased from 8.0 to 9.0 to 10.0 mm and heart volume increased from absolute 670 ml (relative 10.63 ml/kg) to 824 ml (10.23 ml/kg) to 901.9 ml (11.52 ml/kg). Cross-sectionally, IVSd ($p<0.001$), LVPWd ($p<0.001$), LVEDD ($p<0.001$), RVEDD ($p<0.001$), left atrial diameter ($p<0.001$), and absolute heart volume ($p<0.001$) differed significantly between age groups. After adjustment, IVSd ($p=0.012$) and absolute heart volume ($p=0.0078$) remained significant. Longitudinal first-to-last comparisons showed increases in LVEDD (+4.45 mm, $p=0.0015$), IVSd (+1.28 mm, $p=0.0127$), LVPWd (+1.43 mm, $p=0.0171$), and absolute heart volume (+149 ml, $p=0.0034$). Fixed-effects models demonstrated annual increases in absolute heart volume (+15.2 ml/year, $q=0.036$) and relative heart volume (+0.23 ml/year, $q=0.036$).
- **Conclusions:** Competitive rowing is associated with development-dependent cardiac remodeling. Age-specific echocardiographic reference ranges appear feasible, but require validation in larger cohorts stratified by body size and sex.

PP-01-02 POSTER PRESENTATION – ELITE SPORTS

NR. 207

Zhumagaliyeva D, Bacheva I, Ibrayeva L, Rybalkina D

Determinants of body composition in elite athletes: from anthropometric thresholds to genetic markers (CART analysis)KARAGANDA MEDICAL UNIVERSITY, *Kazakhstan*

► **Objective:** To identify key anthropometric thresholds and genetic markers associated with body composition variability in elite athletes. Materials and Methods. A cross-sectional observational study included 91 elite male athletes aged 20–30 years, comprising 48 ice hockey players and 43 combat sports athletes. Body composition was assessed using bioimpedance analysis. Molecular genetic testing included 8 single nucleotide polymorphisms: IL6 rs1800795, VDR rs731236, KCNJ11 rs5219, ADRB2 rs1042713, ADRB2 rs1042714, TRHR rs16892496, MSTN rs1805086, and UCP3 rs1800849. Predictive modeling of fat-free mass (FFM) was performed using Classification and Regression Tree (CART) analysis. Model optimization followed the one-standard-error rule to reduce overfitting. Statistical analyses were conducted separately for combat sports athletes and ice hockey players. Results: In combat sports athletes, skeletal muscle mass (SMM) was identified as the primary determinant of FFM. The main decision threshold was SMM=41.40kg. Athletes above this value demonstrated a mean FFM of 79.36kg, whereas those with SMM≤41.40kg showed a mean FFM of 65.31kg. At lower muscle mass levels, the rs1042713 polymorphism was associated with FFM variability: carriers of the G/A genotype demonstrated lower mean FFM compared with G/G or A/A genotype carriers. In athletes with higher muscular development, the rs5219 polymorphism influenced FFM, where the presence of the T allele (C/T and T/T genotypes) corresponded to higher FFM values compared with C/C homozygotes. Among ice hockey players, FFM was the primary predictor of SMM. The principal threshold was FFM=64.65kg, separating athletes with higher SMM from those with lower SMM. Within the FFM range of 59.20–67.90kg, the rs1042714 polymorphism showed a modulatory effect, with G/C genotype carriers demonstrating slightly higher SMM than C/C carriers. Conclusions. CART modeling revealed a hierarchical structure of body composition determinants in elite athletes, where anthropometric thresholds serve as primary predictors and genetic polymorphisms refine phenotypic variability, supporting individualized athlete assessment and performance optimization.

PP-01-03 POSTER PRESENTATION – ELITE SPORTS

NR. 302

Burger J, Latzel R, Voit T, Moser O, Henze A-S

In-season changes in athletic performance of young professional basketball players: an observational studyUNIVERSITY HOSPITAL ULM, *Germany*

► **Objectives:** Athletic performance testing is a central component of monitoring and development in professional basketball. However, longitudinal data on in-season performance changes, particularly in young professional players, remain limited. This study investigated in-season changes in key athletic performance parameters across a competitive season.

► **Methods:** In this longitudinal observational study, 16 young professional male basketball players (18.4 ± 2.0 years) competing in the German professional system were assessed at four time points (pre-season, post-preparatory phase, mid-season, end of regular season) during the 2023/24 season. A standardized testing battery evaluated upper-body strength endurance (pull-ups), lower-body power (broad jump), sprint performance (20 m), change-of-direction ability (Lane Agility Test), and intermittent endurance (Yo-Yo IR2). Linear mixed-effects models were used to analyze effects of time and playing position (perimeter vs. interior).

► **Results:** Upper-body strength endurance improved across the season, with gains established during pre-season and maintained thereafter. Change-of-direction performance also improved, with highest values at the end of the regular season. In contrast, sprint performance, jump performance, and intermittent endurance remained stable. Playing position showed significant effects: perimeter players outperformed interior players in sprint, change-of-direction, and endurance performance. No significant time × position interactions were observed.

► **Conclusions:** In young professional basketball players, most athletic performance parameters remained stable across the competitive season, while improvements were observed in upper-body strength endurance and change-of-direction ability. These findings suggest that maximal speed and power are primarily maintained in-season, whereas selected capacities remain trainable. Positional differences highlight the need for role-specific performance profiling and targeted monitoring strategies.

PP-01-04 POSTER PRESENTATION – ELITE SPORTS

NR. 250

Schimweg P, Nolte S, Schwalm L, Kastner T, Wüstenfeld J, Walter N, Fleckenstein D, Relogio A, Stauber T, Krüger K, Hollander K

Infection-induced iron restriction impairs erythropoiesis during altitude training in elite athletesMSH MEDICAL SCHOOL HAMBURG, *Germany*

► **Background:** Altitude training triggers an increase in erythropoiesis, enhancing the oxygen-carrying capacity of the blood. This adaptation may favor sea-level performance improvements in elite endurance athletes. The hypoxia-induced increase in erythropoiesis relies on increased iron availability. However, during infection, iron availability is restricted as pro-inflammatory cytokines induce elevated hepcidin levels leading to sequestration of iron within macrophages. This analysis aimed to examine whether infection limits iron availability for altitude-induced erythropoiesis.

► **Methods:** In this prospective cohort study with a post-hoc subgroup analysis, four cohorts of elite running and race-walking athletes who participated in live-high-train-low altitude training camps under similar conditions were compared. Athletes spent 21 days in a normobaric altitude house accumulating a hypoxic dose of at least 750km·h. Blood was sampled at six timepoints (pre, post and weekly (T1-T4) at altitude). One cohort (infection group, n=6) developed a gastrointestinal infection confirmed by hematological markers, leaving the remaining athletes as healthy controls (healthy group, n=15).

► **Results:** In the infected group, CRP significantly changed over time (p<0.001; $\eta^2=0.667$). Repeated measures ANOVA revealed significant time-by-group interactions for ferritin (p=0.021; $\eta^2=0.056$), soluble transferrin receptor (sTfR) (p=0.008; $\eta^2=0.120$) and hematocrit (p=0.011; $\eta^2=0.028$). Due to data availability, reticulocyte hemoglobin content was analyzed for T1, T3 and T4 (n=9 healthy, n=4 infected), showing a significant time-by-group interaction (p=0.001; $\eta^2=0.145$). Holm-Bonferroni post-hoc tests demonstrated significant differences between groups at T4 for ferritin (pHolm=0.043; d=-1.461) and at pre (pHolm=0.017; d=-1.341) and post (pHolm=0.001; d=-1.740) for sTfR.

► **Conclusion:** Infection-induced restriction of iron availability was associated with a lower hemoglobin content in reticulocytes, possibly limiting erythropoiesis at altitude. Elevated sTfR levels in the infection group 11 days post training camp indicate a sustained increase in iron demand. This suggests that restoration of iron homeostasis may have been delayed, potentially due to the compounded physiological stress of hypoxia and infection.

PP-01-05 POSTER PRESENTATION – ELITE SPORTS

NR. 281

Rückemann L, Gronwald T, Schaffarczyk M

Influence of Menstrual Cycle Phases and Psychometric Well-being on Heart Rate Variability in Female AthletesMSH MEDICAL SCHOOL HAMBURG, *Germany*

► **Background:** The menstrual cycle regulates physiological and psychological processes through the influence of steroid hormones on a variety of body systems. Research on its effects on vagally modulated heart rate variability (e.g., RMSSD) while accounting for additional variation in psychometric well-being (e.g., Hooper Index) is limited. The aim of this study was to examine these complex interactions in the early follicular (EFP), ovulatory (OP) and mid luteal phase (MLP).

► **Method:** Over four months, 22 naturally menstruating women (29.9 ± 4.9 yr and a VO2PEAK 43.4 ± 6.1 mL·kg⁻¹·min⁻¹) documented their menstrual cycle (incl. days of menstruation, positive ovulation) and the Hooper Index (7 point scale – 1: very, very good, 7: very, very bad; sleep quality, stress, fatigue, muscle pain). RMSSD was calculated from pulse rate variability in the morning while seated using the Welltory smartphone app and included in the documentation. The data (aggregated per EFP, OP and MLP) were then analyzed using a mixed linear model (RMSSD as the dependent variable), taking into account the cumulated Hooper-Index and the cycle phases as fixed effects in three linear mixed models.

► **Results:** The Hooper-Index had only a marginal, non-significant effect on RMSSD (F = 3.64, p = 0.06, $\eta^2_p = 0.04$). Menstrual-cycle phase, in contrast, showed a significant main effect (F = 3.79, p = 0.03, $\eta^2_p = 0.10$) with RMSSD 8.83 ± 3.22 ms higher in the EFP than in the MLP (p = 0.03, 95% CI = 0.92–16.73). When both predictors were included together, all effects remained small and non-significant (p > 0.05, $\eta^2_p = 0.02–0.07$).

► **Conclusion:** HRV fluctuates significantly in female athletes over the course of the menstrual cycle, with the lowest values during MLP, indicating a potential period of increased physiological perturbation. In contrast, psychometric well-being did not significantly influence HRV, highlighting the specific impact of hormonal phases on autonomic regulation. However, future research should employ refined, phase aligned analytical approaches, to better capture complex interactions.

PP-01-06 POSTER PRESENTATION – ELITE SPORTS

NR. 137

Nolte S, Maier C, Klügel S, Hacker S, Lenz C, Malhan D, Klemmer A, Kastner T, Walter N, Fleckenstein D, Keck J, Gebhardt K, Weyh C, Stauber T, Relógio A, Hollander K, Krüger K

Iron Metabolism in Athletes: A Network Physiology Perspective Across Hypoxia, Immunity, Energy Availability and Sex Specific Aspects

JUSTUS-LIEBIG UNIVERSITÄT GIESSEN, Germany

- **Background:** Iron plays a central role in oxygen transport, energy metabolism, and immune function, making it critical for athletic performance. Its involvement across multiple systems creates a platform for influencing factors, increasing susceptibility to disrupted iron homeostasis. Athletes may therefore be particularly vulnerable. This integrative work examines how iron metabolism responds to key athletic influencing factors from a multi-systems perspective.
- **Methods:** Data from three complementary studies addressing key influencing factors were integrated: (i) a longitudinal study in elite endurance athletes (n = 15) undergoing 3 weeks of simulated altitude exposure (hypoxia), (ii) an observational study in eumenorrhic female football players (n = 11) examining menstrual cycle phases and blood loss (menstrual blood loss), and (iii) a cross-sectional cohort of national squad athletes (n = 149) assessing energy availability and iron status (energy availability). Associations between iron markers, erythropoiesis, immune parameters, and energy intake were analyzed using repeated-measures and regression-based approaches.
- **Results:** Across different physiological contexts, iron metabolism reflected coordinated system-level interactions rather than isolated regulation. Increased erythropoietic drive during altitude exposure was accompanied by enhanced iron turnover and reduced inflammatory activity, with inverse associations between erythropoiesis, iron indices, and immune markers ($r = -0.76$ to -0.80 , $p < 0.05$). In female athletes, menstrual blood loss quantity was positively associated with reticulocyte count and ferritin index, but negatively with ferritin, indicating increased iron demand alongside reduced iron stores; hepcidin was inversely related to erythropoietin ($r = -0.71$), reflecting coordinated regulation of iron distribution. In the larger cohort, 42% of athletes exhibited iron deficiency, while relative iron intake (diet and supplements) was positively correlated with relative energy intake ($r = 0.57$, $p < 0.001$).
- **Conclusion:** Findings support dynamic interactions between erythropoietic, immune, and metabolic systems under different athletic influencing factors. Accordingly, iron biomarkers should consider systemic context across interacting physiological systems.

PP-01-08 POSTER PRESENTATION – ELITE SPORTS

NR. 250

Plein N, Sayahpour B, Haarer J, Reichert L, Zentgraf K

Prevalence of Oral Health among German National Squad athletes

GOETHE UNIVERSITY FRANKFURT, Germany

- **Purpose:** This study examined German elite athletes to (1) assess their oral health and the prevalence of deficiencies and (2) identify key factors contributing to the need for improved oral hygiene (home oral care, season, sport discipline).
- **Methods:** This cross-sectional study included a total of 220 athletes (93 female), aged 13 to 31 years (average age: 16.85 years), from six Olympic disciplines. Oral health was assessed using DMF-T (Decayed, Missing, Filled Teeth Index), GBI (Gingival Bleeding Index) and PSI (Periodontal Screening Index). Information on occlusion, condition of the head, face and neck muscles and the temporomandibular joint (TMJ) was collected using the CMD short screening form provided by the DGFDT (German Society of Craniomandibular Function and Disorders). A comparison was also made based on age, gender, season (summer vs. winter) and discipline (indoor vs. outdoor).
- **Results:** In total, 22% (n = 48) of the athletes had an elevated DMF-T score compared to the reference group. Furthermore, approximately 18% (n = 40) showed signs of gingival and/or periodontal inflammation. Notably, around 39% (n = 87) reported pain in the TMJ or masticatory muscles.
- **Conclusion:** This study highlights significant oral health challenges among German elite athletes, with 20% presenting elevated DMF-T scores and 16% exhibiting signs of gingival or periodontal inflammation. Additionally, nearly 40% reported pain in the temporomandibular joint (TMJ) or associated musculature, underscoring the prevalence of functional complaints alongside dental issues. These findings point to a clear need for improved oral hygiene practices and preventive care within this population. Factors such as the type of sport (indoor vs. outdoor), training season (summer vs. winter) and individual oral care habits emerged as potential contributors to oral health disparities. Given the impact of oral health on overall performance and well-being, interdisciplinary strategies involving dental professionals, coaches and athletes are warranted to promote long-term oral and general health in elite sports contexts.

PP-01-07 POSTER PRESENTATION – ELITE SPORTS

NR. 254

Haigis D, Wagner S, Nieß AM, Kopp C, REDs register study team

Is the Phase Angle a predictor of Low Energy Availability? An exploratory view of the Relative Energy Deficiency in Sport (REDs) register study among female competitive athletes in Germany

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Background:** Low Energy Availability (LEA) is closely associated with Relative Energy Deficiency in Sport (REDs). REDs often leads to negative consequences, such as performance losses and related illnesses among athletes. Phase Angle (PhA) is a body composition measure of cell quality and function, which decreases when long-term energy availability is reduced. This study aims to determine whether PhA can be used as a predictor of LEA among female competitive athletes (cA) during their mandatory annual preparticipation screening (PPS).
- **Method:** Female cA were included in the REDs register study as part of their PPS. Inclusion criteria were an age ≥ 12 years and membership of federal or state squad in Germany. The Low Energy Availability in Female Questionnaire (LEAF-Q) was used to determine REDs risk. Body composition was also measured using bioelectrical impedance analysis to determine PhA. Linear regression was used to establish whether PhA could be used as a predictor of LEA and REDs risk.
- **Results:** In total, 63 female cA (age median = 16 years, range 13–27) were included in this study. LEAF-Q (score median = 5 points, range 0–18) showed that 21 female cA (33.3%) have a REDs risk. PhA has a mean value and standard deviation of $6.7 \pm 0.6^\circ$ (range 5.5–9.0). Linear regression examined the association between PhA and LEAF-Q score ($F(1, 61) = 15.773$, $p < .001$). The corrected degree of certainty of the estimate is 19.2%.
- **Conclusion:** Based on the REDs register study among cA in Germany, the potential of PhA to predict LEA was investigated. Results show that PhA can help to identify female cA at risk of REDs at an early stage, enabling further steps to be taken in the assessment and intervention of LEA and REDs. Further research is needed on the use of PhA as a predictor in populations among cA at high risk of REDs.

PP-01-09 POSTER PRESENTATION – ELITE SPORTS

NR. 212

Gondwe B, Meyer T, Frenger M

Structures of Medical and Performance Departments in Professional German Football

INSTITUTE OF SPORTS AND PREVENTIVE MEDICINE, Saarbrücken, Germany

- **Background:** Medical and performance departments play a central role in maintaining player availability and supporting performance in professional football. While increasing attention has been given to injury prevention and return-to-play processes, less is known about how these departments are organisationally structured within professional clubs. Understanding organisational design is essential, as it influences communication, decision-making, and the coordination of multidisciplinary teams. This study aimed to provide a comprehensive overview of the organisational structures and operational practices of medical and performance departments in professional German football clubs.
- **Methods:** A cross-sectional online survey was distributed to all 36 clubs competing in the Bundesliga and 2. Bundesliga during the 2024/2025 season. A total of 32 clubs responded (response rate: 88.9%). The questionnaire captured information on organisational structure, staffing, knowledge management, research activities, data management, and return-to-play procedures. Organisational structures were classified into flat, functional, divisional, and matrix models. Descriptive statistics were used to summarise current practices across clubs.
- **Results:** Formal structures were reported by 68.8% of clubs. Among clubs reporting a structure, flat (n = 8; 36.4%) and matrix (n = 7; 31.8%) models were most common, followed by functional (n = 5; 22.7%) and divisional structures (n = 2; 9.1%). Medical and performance departments were typically multidisciplinary. The most commonly reported staffing levels per club were 2–4 medical doctors (range: 1–8), 3–4 physiotherapists (range: 0–10), and 1–2 athletic trainers (range: 0–6). Data analysts (0–2; range: 0–4) and dedicated return-to-play specialists (typically 1; range: 0–3) were less consistently represented. Most clubs ($\geq 75\%$) reported established knowledge management practices, and structured data management systems were present in 23 clubs (71.9%). Return-to-play processes involved multidisciplinary collaboration across all phases, with physicians and physiotherapists involved in 30 clubs (93.8%) and performance staff in at least 25 clubs (78.1%).
- **Conclusion:** Medical and performance departments in professional German football exhibit a range of organisational structures, with no single dominant model. Despite structural variation, key operational processes such as knowledge sharing, data management, and multidisciplinary return-to-play decision-making appear to be consistently implemented across clubs. These findings suggest that organisational effectiveness may depend less on formal structure and more on how interdisciplinary collaboration and communication are managed in practice.

PP-01-10 POSTER PRESENTATION – ELITE SPORTS

NR. 191

Brandts MME, Stehle JH, Wiewelhove T, Markov A

The effect of race scheduling on swimming performance in major events: A retrospective analysis

IST UNIVERSITY OF APPLIED SCIENCES, Germany

- **Background:** Athletic capacity is time-of-day dependent while peak performance during competition is influenced by chronotype and time elapsed since awakening. In competitive swimming, heats often take place in the morning, while semi-finals and finals are scheduled in the evening. Generally, swimming performance improves across these consecutive competition rounds. We examined whether improved swimming performance throughout competition rounds is time-of-day dependent.
- **Method:** Swimming performance data were obtained retrospectively from two major events (i.e. Tokyo Olympic Games 2021 and Fukuoka World Championships 2023), which took place in the same time zone with opposing schedules: evening heats and morning (semi-)finals in Tokyo, and the reverse in Fukuoka. Only athletes who qualified for the finals were considered for analysis (Tokyo: n = 139; Fukuoka: n = 176). Swimming performance was standardized by calculating each athlete's mean time across the three competition rounds for each stroke, distance, and competition. Achieved round time was then expressed as a percentage deviation from this mean. A linear model was fitted with standardized swimming performance as dependent variable and competition rounds/major event and their interaction as predictors.
- **Results:** A significant competition round/major event interaction was observed ($F_{2,939} = 13.3$, $p < .001$). Swimming performance was significantly faster in semi-finals and finals compared to heats (all $p < .001$) in Tokyo (semi-finals: $-0.30 \pm 0.06\%$; finals: $-0.62 \pm 0.06\%$) and Fukuoka (semi-finals: $-0.69 \pm 0.05\%$; finals: $-0.85 \pm 0.05\%$). These differences were smaller in Tokyo compared to Fukuoka for both heats vs. semi-finals ($p < .001$) and heats vs. finals ($p = .004$).
- **Conclusion:** Our findings indicate that the timing of race scheduling influences swimming performance across competition rounds (i.e. heats, semi-finals, and finals) in major events. These results underscore the potential of applying chronobiological principles to optimize athlete adaptation to the competition schedule, considering their expected round of progression.

PP-02-01 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY

NR. 265

Jerg A, Bizjak DA, Bohr V, Arnold H, Eßlinger E, Schwarz E, Henze A-S, Kirsten J, Schulz SVW, Read C, Klaus J, Calzia E, Hentschel V, Kaltenbach T

An innovative comprehensive methodology to assess mitochondrial dysfunction in colonic epithelium of patients with ulcerative colitis

UNIVERSITY HOSPITAL ULM, Germany

- This study investigates mitochondrial function in enterocytes of patients with ulcerative colitis (UC), an area that has not been previously explored. Mitochondrial dysfunction is linked to various pathological conditions, but its role in intestinal cells remains unclear.
- In the first part of the study, mitochondrial function in enterocytes from 12 UC patients will be compared to 12 healthy controls using a combination of methods, including OXPHOS analysis, electron microscopy, ELISA, and digital droplet PCR. In the second part, UC patients will undergo a 12-week exercise intervention combining high-intensity interval training and strength training, after which the same measurements will be repeated.
- The study aims to provide the first comprehensive, multi-level assessment of mitochondrial performance in enterocytes and to evaluate the effects of exercise on these parameters. Findings may improve understanding of inflammatory bowel disease pathology and support the development of new therapeutic strategies, with potential applications to other diseases involving mitochondrial dysfunction.

PP-01-11 POSTER PRESENTATION – ELITE SPORTS

NR. 294

Groesser V, Most A, Sedighi J, Böttger P, Sossalla S, Bauer P

Vitamin D Status, Exercise Capacity and Cardiac Remodeling in 773 Elite Athletes: A Cross-Sectional Study

JUSTUS-LIEBIG UNIVERSITÄT GIESSEN, Germany

- **Background:** Vitamin D has been implicated in cardiovascular structure, vascular function, and skeletal muscle physiology. However, the relationship between vitamin D status, cardiac morphology, and aerobic performance in elite athletes has not been systematically investigated in large cohorts.
- **Methods:** This cross-sectional study included 773 male professional athletes from mixed team sports who underwent standardized sports cardiology screening including laboratory testing, echocardiography, and maximal exercise testing. Serum 25-hydroxyvitamin D [25(OH)D] levels were analyzed in relation to exercise capacity and cardiac morphology. Associations were assessed using correlation analyses, multivariable regression models, and mediation analysis evaluating potential mediators.
- **Results:** 25(OH)D concentrations were strongly associated with exercise capacity in maximal power output ($r = 0.446$, $p < 0.001$) and body weight-normalized performance ($r = 0.454$, $p < 0.001$). Athletes with 25(OH)D levels ≥ 30 ng/mL achieved higher maximal power than those with lower levels (389.5 ± 102.2 vs 305.1 ± 70.5 W, $p < 0.001$). Higher 25(OH)D levels were modestly associated with greater left ventricular mass and left ventricular mass index. 25(OH)D remained an independent determinant of exercise capacity in multivariable analysis. Segmented regression suggested a performance plateau at approximately 47 ng/mL, while mediation analysis showed that left ventricular mass explained only a small proportion of the association (~2%).
- **Conclusion:** Higher 25(OH)D status is strongly associated with greater aerobic exercise capacity in elite athletes and modestly larger cardiac dimensions. Exercise performance increased with rising 25(OH)D levels up to approximately 47 ng/mL, suggesting a potential optimal range, whereas cardiac remodeling explained only a small part of this relationship.

PP-02-02 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY

NR. 288

Eggelbusch M, Havers T, Meinhold M, Sing K, Okrojek R, Artati A, Witting, Lutter D, Starke C, More T, Hiller K, Dela F, Schönfelder M, Kafka A, Geisler S, Wackerhage H

Divergent skeletal muscle metabolite exchange in IGF-1-stimulated myotubes and resistance-exercised human muscle

TECHNICAL UNIVERSITY OF MUNICH, Germany

- Skeletal muscle hypertrophy requires a substantial nutrient influx for biomass accretion, but global metabolite exchange during growth is poorly characterized. Therefore, we profiled the metabolite uptake and release in IGF-1-stimulated C2C12 myotubes and human muscle 24h post-resistance exercise. Differentiated C2C12 myotubes were growth-stimulated with IGF-1 (100ng/mL, 24 h) or received vehicle control. To measure metabolite exchange, we analyzed fresh and spent media by GC-MS metabolomics. In a second experiment, seven untrained adults (3 males, 4 females; age 25.6 ± 3.2 years; BMI 23.8 ± 2.8 kg·m⁻²) performed single-leg hypertrophy-oriented resistance exercise, with the contralateral leg serving as control. After 24 h, we obtained arteriovenous blood samples in the post-absorptive state and analyzed plasma by untargeted LC-MS metabolomics, quantifying net muscle metabolite exchange. In vitro, IGF-1 increased uptake of serine, arginine, and pyridoxamine, while enhancing lactate release (all $p < 0.05$), reflecting anabolic, Warburg-like reprogramming. In vivo, 24h post-exercise showed modest global shifts (PCA: PC1 8.8%, PC2 6.3% variance) and no significant essential amino acid uptake. Nominal differences ($p < 0.05$) included increased uptake of peptide-related metabolites (acisoga, 2-amino-4-CP) and alpha-ketoglutarate, alongside release of C12:0 and C16:0 acylcarnitines. No in vivo differences persisted after FDR correction. While IGF-1 stimulation in vitro promotes coordinated nitrogen-rich metabolite uptake and lactate release, human muscle 24 h post-exercise in a post-absorptive state is characterized by increased peptide turnover and lipid release rather than net amino acid uptake. This indicates limited substrate accumulation and net biomass accretion in the absence of exogenous nutrients.

PP-02-03 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 150

Pracht M, Schulz SVW, Kirsten J, Tipl C, Bizjak DA

Haemoglobin Mass Reduction After a Whole Blood Donation and Its Impact on Endurance Performance and the Induction of the Hypoxia-Inducible-Factor-1-alpha Pathway: A Proof-of-Concept Study

UNIVERSITÄTSKLINIK ULM, Germany

- **Background:** Performance impairment is a common reason why athletes refrain from donating blood, though the reported duration varies considerably.
- **Purpose:** We aimed to establish a modified carbon monoxide (CO)-rebreathing protocol to determine haemoglobin mass (Hbmass), evaluate the feasibility of the study design and generate preliminary data on the effects of a blood donation (BD) on endurance performance.
- **Methods:** Sixteen participants (027 years) completed a preexisting and modified CO-rebreathing protocol in a randomised order. After a CO bolus, carboxyhaemoglobin (HbCO) was measured every 2 minutes for 14 minutes. Six participants were measured three times (one twice) to assess test-retest reliability. Six participants (027 years; 06.75 h/week) were tested one day before, 3–5 hours (T1), three (T2), seven (T3), and fourteen days (T4) after BD. Measurements included Hbmass, blood volume (BV), peak oxygen consumption (VO_{2peak}), ferritin, soluble transferrin receptor (sTfR), erythropoietin (EPO) and Hypoxia-inducible-factor-1-alpha (HIF-1-α).
- **Results:** The modified protocol showed a plateau in HbCO from minute 6–10 ($p = 0.539$), the preexisting protocol a significant decrease ($p = 0.039$). Test-retest reliability was superior in the modified protocol (TE 0.65% vs 4.2%). Significant changes over time were found for VO_{2peak} ($p = 0.001$), Hbmass ($p = 0.001$), ferritin ($p = 0.007$), sTfR ($p < 0.001$), and EPO ($p = 0.003$). VO_{2peak} was reduced at T1, Hbmass from T1 to T4 and ferritin at T3 and T4. EPO was significantly increased at T3 and T4. BV and HIF-1-α remained constant.
- **Conclusion:** The modified CO-rebreathing protocol is more reliable with stable HbCO kinetics. BD causes a short-term reduction in VO_{2peak} but a sustained decrease in Hbmass, indicating compensatory mechanisms. Ferritin decreases while EPO increases despite an absence of anaemia and hypoxia. Additional molecular markers and potential anaerobic mechanisms will be investigated with a greater number of participants using this study design.

PP-02-05 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 104

Schenk A, Claus M, Watzl C, Trebing S, Walzik D, Zimmer P, Joisten N

Influence of a single exhaustive exercise bout on effector protein expression in natural killer cells

TU DORTMUND UNIVERSITY, Germany

- **Background:** Natural killer (NK) cells belong to the innate immune system and build a first line of defense against tumor and virus-infected cells. They are one of the most exercise-responsive immune cells, showing a profound mobilization and redistribution after a single bout of exercise. Although these effects are well studied, little is known about effects of exercise on effector proteins of NK cells. Therefore, the influence of a single exercise bout on gene expression of the effector proteins granzyme A, B and K, as well as perforin was investigated in this study.
- **Methods:** 24 healthy male subjects were recruited and performed a single exhaustive exercise bout and a passive control condition in a randomized order on separate days. Blood samples were taken pre, post, 1h, 3h and 24h post exercise/control. Blood samples were used for NK cell isolation by fluorescence activated cell sorting, and subsequent RNA-extraction and RT-qPCR analysis.
- **Results:** In line with previous studies, circulating NK cells strongly increased immediately after exercise, before migrating to peripheral tissues and returning to baseline after 24h. Within the NK cells, the relative proportions of subsets show a decrease of CD56dim and an increase of CD56bright NK cells during the recovery period, which returned to baseline levels at 24h post. PCR analyses of the effector proteins are currently running and will be available at the time of the congress.
- **Conclusion:** The NK cell mobilization and redistribution match previously described patterns. Given that NK cells are one of the most responsive immune cells, the PCR analyses of granzyme A, B and K and perforin will shed new light into exercise induced alterations.

PP-02-04 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 130

Kalaycik B, Billig A, Trebing S, Joisten N, Kolodziej M, Braun M, Lippelt L, Gerharz A, Millard M, Wieder O, Kipper K, Jebel A, Groll A, Walzik D, Zimmer P, Wenzel C

High-frequency targeted multi-omics saliva testing: Reliability, 24-hour kinetics and response to physical exercise

TU DORTMUND UNIVERSITY, Germany

- **Background:** High-frequency assessment of physical exercise is crucial to monitor training and recovery, especially in elite athletes. Conventional measurement approaches such as blood-based biomarkers are limited by their invasiveness, low sampling frequency, or focus on isolated markers. Non-invasive, saliva-based targeted multi-omics samples reflect integrated physical states, but high-frequency profiling remains largely unexplored. We aim to assess the reliability of dense targeted saliva multi-omics sampling and to examine 24-hour kinetics of analytes after physical exercise.
- **Methods:** Twelve female football players completed a randomized laboratory crossover study with an exercise day (maximal cardiopulmonary exercise testing) and a control day (≥ 3 days without physical exercise). On both days, supervised saliva samples were collected at identical timepoints (2x baseline, 5x post-exercises within 1h), followed by 24h self-sampling every 2h at home (413 samples). Next, in a longitudinal study, saliva samples from 50 male elite football players were collected over 16 months, both 24h post-exercise (matchday) and under control conditions as in the laboratory study ($>10,000$ samples). Targeted multi-omics analyses quantified proteins, metabolites, and lipids in saliva samples (49–59 analytes). We conducted dimensional reduction using t-SNE, assessed baseline reliability via Pearson-correlation, and examined 24-hour kinetics using Linear Mixed Models (LMM) and Bayesian Additive Models (BAM).
- **Results:** In the laboratory study, t-SNE demonstrated high molecular individuality. Pearson-correlations indicated high intra-day reliability (day 1: $r = 0.75$, $p = 7.95 \times 10^{-100}$; day 2: $r = 0.75$, $p = 4.58 \times 10^{-118}$). BAM identified clear circadian rhythms e.g., in Kynurenine acid. LMM identified 13 exercise-responsive analytes acutely and 5 at 24 hours. In the longitudinal study, t-SNE showed seasonal and individual participant clusters across all analytes with moderate reliability ($r = 0.56$, $p = 6.90 \times 10^{-234}$).
- **Conclusion:** Together, high-frequency saliva-based targeted multi-omics provide a non-invasive approach to characterize individual profiles, circadian rhythms, and exercise-sensitive biomarkers with potential relevance for monitoring training and recovery.

PP-02-06 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 165

Enders K, Schwendner T, Haller N, Krüger K, Simon P, Neuberger E

Influence of exercise modality and energy expenditure on acute cfDNA release: meta-analysis and meta regression

JOHANNES GUTENBERG UNIVERSITY MAINZ, Germany

- **Background:** Cell-free DNA (cfDNA) has emerged as a promising biomarker to reflect acute exercise-induced physiological stress. While numerous studies have demonstrated substantial cfDNA elevations following acute exercise, the determinants impacting these responses – particularly exercise modality and energy expenditure (EE) – remain insufficiently understood. This meta-analysis with meta-regression evaluated whether exercise modality and EE predict the magnitude of cfDNA responses.
- **Method:** A systematic literature search (PubMed, Web of Science) revealed 268 studies. A total of 51 studies with 70 observations reporting cfDNA concentrations before and after acute exercise in healthy individuals were included for meta-analysis, covering running ($n = 32$), cycling ($n = 12$), strength training ($N = 14$), and other modalities ($N = 12$). Random-effects models were applied, and a mixed-effects meta-regression ($k = 36$) assessed the influence of exercise modality and estimated EE in running and cycling protocols.
- **Results:** Across all exercise modalities, cfDNA increased 4.8-fold (95%CI: 3.8–6.0, $p < 0.0001$) post-exercise. Subgroup analyses showed modality-specific responses: running (11.1-fold, 95%CI: 9.2–13.4), cycling (3.1-fold, 95%CI: 2.1–4.6), strength training (1.5-fold, 95%CI: 1.2–1.8), and other modalities (3.0 fold, 95%CI: 1.8–5.0).
- The meta-regression explained 67.5% of between-study heterogeneity, reducing residual τ^2 to 0.0364 ($I^2 = 86.5\%$). Both exercise modality and EE significantly contributed to cfDNA variability (QM(2) = 62.9, $p < 0.0001$). EE showed a positive association with cfDNA increases ($p = 0.0001$). After adjustment for EE, running was associated with higher cfDNA increases than cycling (estimate = 2.6-fold, 95%CI: 1.4–4.9, $p < 0.0001$).
- **Conclusion:** Exercise modality and EE strongly determine cfDNA responses to acute exercise. These findings highlight cfDNA as a load-responsive biomarker that reflects both exercise type and energetic demand. However, the high heterogeneity across studies and variability in assessment protocols warrant cautious interpretation. Future work should further address biological mechanisms of cfDNA release to improve the interpretability across diverse exercise settings.

PP-02-07 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 155

Trebing S, Zimmer P, Watzl C

Kinetics of immune age, as assessed by the Immune Age Index, following acute exercise: a transient rejuvenation effect

TU DORTMUND UNIVERSITY, Germany

- **Background:** Immunosenescence progresses at a rate that varies between individuals. The Immune Age Index (IMMAX) is a flow cytometry-based metric for quantifying immune age and is suitable for assessing both short- and long-term kinetics. Physical activity has been proposed as a modulator of immunosenescence. Acute exercise induces well-characterized changes in immune cell populations included in the IMMAX calculation. Therefore, this exploratory study aimed to assess the responsiveness of IMMAX to a single exercise bout and its subsequent return to baseline.
- **Methods:** Twenty-four recreational athletes completed a regular 40-minute high-intensity endurance (E) or hypertrophy strength (S) training session. Blood samples were collected before (t0) and one hour post-exercise (t1) for IMMAX calculation and blood count. A third time point was assessed either 6 hours (t2, n = 12) or 23 hours (t3, n = 12) post-exercise. Time- and group-dependent effects (E vs. S) were analyzed using ANOVA with post-hoc testing. In addition, saliva samples were collected for subsequent proteomic analyses to explore associations with blood-based immunological ageing parameters. Statistical analyses were performed using Prism (version 11.0.0), with significance set at $p < 0.05$.
- **Results:** IMMAX was significantly reduced at t1 compared to baseline. This reduction persisted at 6 hours (t2), but was no longer detectable after 23 hours (t3). No differences were observed between endurance and strength training.
- **Conclusion:** A single bout of exercise induces a transient reduction in immune age, as assessed by IMMAX. This effect persists for at least six hours, is independent of exercise modality, and resolves within 24 hours. From a methodological perspective, recent physical activity should be controlled for when assessing baseline immune age, and individuals should refrain from moderate to vigorous physical activity for 24 hours prior to blood sampling.

PP-02-09 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 174

Becker LK, Starzynska K, Al Sadat L, Murr A, Wackerhage H, Hauner H

TauAge: Taurine Supplementation and Physical Performance in Older Adults: A Randomised, Double-Blinded Control Trial

TECHNICAL UNIVERSITY MUNICH, Germany

- **Introduction:** During ageing, muscle mass, strength, and endurance decline, contributing to increased morbidity and mortality. Regular physical activity lowers mortality risk and improves life expectancy. Taurine, a semi-essential amino acid, has proposed health- and performance-enhancing effects, and supplementation extends health- and lifespan in animal models. However, its effects on age-related physical decline in humans are unknown. One aim of the study was to determine whether six months of taurine supplementation affects muscle strength and cardiovascular fitness in older adults.
- **Methods:** 83 healthy adults (m=41; f=42; age=62.9 ± 5.7; BMI=25.2 ± 2.9 kg/m²) completed a randomised, double-blinded, placebo-controlled trial (NCT06613542). Participants received 4 g/day taurine or placebo for six months. Outcomes at baseline and follow-up included dominant-hand grip strength (kg; dynamometer), knee extensor torque (right, left; Nm; isometric dynamometer), and PWC130 relative to body mass (W/kg). We tested baseline differences with t-tests and analysed changes over time (time × group) using linear mixed-effects models adjusted for sex and baseline age.
- **Results:** Groups did not differ at baseline ($p > 0.05$). Model-estimated means indicated small declines in the placebo group and small improvements in the taurine group. However, time × group interactions were not significant. Estimated between-group differences in change favoured taurine but were small and non-significant: grip strength +1.67 kg (95% CI [-3.97, 0.64]; $p=0.154$), left-knee torque +7.1 Nm (95% CI [-19.4, 7.6]; $p=0.237$), right-knee torque +12.7 Nm (95% CI [-27.1, 149]; $p=0.079$), and PWC130 + 0.07 W/kg (95% CI [-0.19, 0.05], $p=0.269$). Sex did not modify effects.
- **Conclusion:** Six months of 4 g/day taurine did not significantly change grip strength, knee extensor torque, or PWC130 in healthy adults aged 55-75 years.

PP-02-08 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 199

Dreilich J, Hiensch A, May A, Daube N, Heyrman E, Rundqvist H, Bloch W, Clauss D, Gunasekara N, McCann A, Monnikhof E, Müller J, Schmidt M, Stuiver M, Ueland PM, van der Wall E, Wengström Y, Zopf E, Steindorf K, Zimmer P

Multimodal exercise and the kynurenine pathway as mediator in breast cancer – a subanalysis of the PREFERABLE-EFFECT trial

TU DORTMUND UNIVERSITY, Germany

- **Background:** Breast cancer, the most common malignancy in woman, is increasingly recognized as amenable to exercise as adjunctive medical therapy. Exercise exerts anti-inflammatory effects that can contribute to improved immune surveillance. The kynurenine pathway (KP), containing both pro- and anti-inflammatory metabolites, potentially shapes the tumour microenvironment influencing tumour growth and invasion. By shifting the KP towards an anti-inflammatory profile, exercise holds clear potential to enhance anti-tumour mechanisms when performed appropriately.
- **Methods:** This work utilizes data from the multicentre, randomised controlled PREFERABLE-EFFECT trial, which investigates the impact of a 9-month supervised combined aerobic and resistance exercise program in patients with metastatic breast cancer (NCT04120298). Blood sample collection was performed at baseline, 3- and 6-months. Targeted metabolomics were performed using liquid chromatography-tandem mass spectrometry to quantitate KP metabolites at Bevilal A/S (Bergen/Norway). KP enzyme expression was analysed with quantitative real-time polymerase chain reaction at TU Dortmund University (Dortmund/Germany). To assess exercise effects on systemic KP metabolite concentrations and enzyme expression, we perform mixed linear regression modelling adjusted for baseline values and stratification factors (i.e., study centre, line of treatment).
- **Results:** In total 357 participants were included in the trial. Of these, 343 participants are considered in our analysis for which blood samples and group allocation information were available. The intervention group holds 171 patients including one male (pre-/postmenopausal women: 23/147, age (years): 55.1 ± 11.6, BMI (kg/m²): 25.8 ± 5.1). The control group holds 172 patients also including one male (pre-/postmenopausal women: 15/156, age: 55.9 ± 10.6, BMI: 26.7 ± 5.3).
- **Conclusion:** Previous exercise studies have shown a shift from tumour-promoting metabolites (3-hydroxykynurenine, 3-hydroxyanthranilic acid, quinolinic acid) towards reduced general KP activity (kynurenine/tryptophan ratio, quinolinic acid/kynurenic acid ratio) in patients with breast cancer as well as healthy controls. We, therefore, hypothesize that 3- and 6-months of multimodal exercise will result in similar favourable KP modulation in metastatic breast cancer.

PP-02-10 POSTER PRESENTATION – MOLECULAR & CELL BIOLOGY NR. 287

Schaaf K, Bersiner K, Jacko D, Gehlert S

XIRP-Based Histology Reveals Training-Dependent Changes in Exercise-Induced Muscle Damage and a Strong Within-Subject Association with Myoglobin

UNIVERSITY OF HILDESHEIM, Germany

- Blood biomarkers such as creatine kinase (CK) and myoglobin are widely used in elite sports as point-of-care tools to assess exercise-induced muscle damage, yet their ability to reflect structural damage at the tissue level remains debated. This study evaluated XIRP-positive area as a histological marker of skeletal muscle damage and examined its association with circulating myoglobin across different training states.
- Muscle damage was assessed in n=5 active, but non-specifically resistance-trained participants after an acute bout of resistance exercise, after 6 weeks of training, and again after a 3-week detraining period. Muscle biopsies were obtained from the vastus lateralis 1 h post-exercise, and blood samples for serum myoglobin analysis were collected immediately prior to biopsy. Local structural damage was quantified by XIRP staining, and associations between tissue-level damage and serum myoglobin were analyzed using repeated-measures correlation.
- XIRP staining enabled clear identification and quantification of damaged muscle areas across all conditions. XIRP-positive area was highest after the initial exercise bout (S1: 3.42 ± 1.52%), decreased after training (S2: 0.78 ± 0.47%), and increased again after detraining (S3: 1.15 ± 0.75%), with significant differences between S1 and S2 and between S1 and S3.
- Serum myoglobin showed a similar pattern, with highest values at S1 (133.5 ± 42.3 ng/mL), lower values at S2 (34.08 ± 9.06 ng/mL), and a partial re-increase at S3 (50.25 ± 22.32 ng/mL), again with significant differences between S1 and S2 and between S1 and S3. Repeated-measures correlation revealed a strong within-subject association between XIRP-based damaged area and serum myoglobin. However, absolute myoglobin concentrations varied markedly between participants.
- In conclusion, XIRP provides a sensitive tissue-level marker of exercise-induced skeletal muscle damage, while circulating myoglobin mirrors the extent of structural damage across conditions. However, pronounced inter-individual variability limits interpretation of absolute myoglobin concentrations between subjects.

PP-03-01 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 234

Troschke I, Simon P, Enders K

Cardiopulmonary exercise testing in patients with major depressive disorder: identifying functional deficits and exercise limitations

JOHANNES GUTENBERG UNIVERSITY MAINZ, Germany

- **Background:** Reduced cardiorespiratory fitness in patients with major depressive disorder (MDD) is well documented, yet detailed cardiopulmonary exercise testing (CPET) profiles remain scarce. A more comprehensive assessment of CPET parameters may help identify specific functional impairments. This exploratory cross-sectional study aimed to characterize CPET responses in patients with MDD to detect possible disease-specific patterns.
- **Method:** The study included 14 patients with clinically diagnosed MDD (34.6 ± 13.3 years) under current psychiatric treatment including antidepressant medication. They performed a CPET on a cycle ergometer until volitional exhaustion using a standardized ramp protocol. Continuous monitoring included breath-by-breath respiratory gas analysis, electrocardiogram, and heart rate. Analyzed variables comprised peak workload, peak oxygen uptake, oxygen pulse, peak heart rate, and the slope of ventilation to carbon dioxide output (VE/VCO₂-slope). Results are presented as mean $\pm$ SD and as percentage of predicted norm values. Paired t-tests were performed comparing observed to predicted values which were derived by the CPET software.
- **Results:** The patients achieved $98.1 \pm 27.5\%$ of predicted peak workload, $81.8 \pm 18.7\%$ of predicted peak oxygen uptake, $92.6 \pm 18.2\%$ of predicted oxygen pulse, and $88.4 \pm 9.8\%$ of predicted peak heart rate. Oxygen uptake ($p = 0.012$) and heart rate ($p < 0.001$) were significantly lower than predicted, whereas oxygen pulse and workload showed no significant deviations. Only 5 out of 14 patients exhibited VE/VCO₂-slopes within the recommended range of 25–30, while the remaining patients showed either hypo- or hyperventilatory patterns.
- **Conclusion:** Patients with MDD demonstrate reduced cardiorespiratory fitness and suboptimal heart rate response, and frequent deviations in ventilatory efficiency. Considerable interindividual variability observed in CPET outcomes suggests the presence of distinct physiological response patterns. Detailed profiling including breath-by-breath trajectories and consideration of medication effects may help identify clinically meaningful subgroups and guide tailored exercise interventions to improve specific impairments.

PP-03-03 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 169

Römling F, Brixius K, Körner S

Developing a sport-specific framework for quality and safety in boxing training for Parkinson's disease

GERMAN SPORTS UNIVERSITY COLOGNE, Germany

- **Background:** Boxing-based exercise has gained increasing attention as a training approach for people with Parkinson's disease. However, it remains unclear what constitutes Parkinson-specific boxing. Existing research and practice often conflate neurodegenerative disease processes with functional and clinical training aims, while sport-specific content, safety principles, and quality criteria remain insufficiently defined. This conceptual heterogeneity limits interpretability, reproducibility, and implementation quality. The aim of this study was to develop a sport-specific reference framework for boxing training in Parkinson's disease.
- **Method:** This study applied a conceptual development and modelling approach based on the Medical Research Council framework for complex interventions. The framework was derived through an integrative synthesis of three sources: a systematic review of boxing-based interventions in Parkinson's disease, qualitative empirical findings from Parkinson-specific boxing practice in Germany, and international exercise guidelines and sport science principles of boxing. Donabedian's structure-process-outcome model and the RE-AIM framework were used to organise the quality dimensions.
- **Results:** The analysis resulted in the development of the Boxing Reference Framework for Parkinson's disease, a sport-specific reference framework comprising five interrelated domains: structural quality, process quality, safety and risk management, outcome orientation, and implementation feasibility. A central conceptual contribution of the framework is the explicit distinction between neurodegenerative disease processes and functional-clinical training aims, thereby addressing a central conceptual limitation in current research and practice.
- **Conclusion:** This framework provides a transparent and sport-specific basis for the design, evaluation, and implementation of boxing-based exercise in Parkinson's disease. It does not claim effectiveness, but establishes a methodological foundation for future empirical validation and may support ethically responsible, quality-oriented implementation in practice.

PP-03-02 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 173

Turner W, La Marca R, Infanger D, Brühl AB, Marschall K, Russmann T, Schulze B, Pfaff M, Böker H, Schmidt-Trucksäss A

Daily Physical Activity and Same-Day Mental Health Symptoms: An Ecological Momentary Assessment Study During Inpatient Treatment of Stress-Related Disorders

UNIVERSITY OF BASEL AND CLINICA HOLISTICA ENGIADINA, Switzerland

- **Background:** Physical activity (PA) has the potential to reduce mental health symptoms. However, both mental health symptoms and PA may fluctuate within individuals across days and may be dynamically associated over time, yet this dynamic relationship remain insufficiently understood, especially during clinical treatment. Therefore, this observational study investigated how ecological momentary assessments (EMA) of mood, mental exhaustion, physical tiredness, and tension change in relation to daily PA levels during a 6-week inpatient treatment of stress-related disorders.
- **Methods:** Patients ($n = 90$, aged 28–64 years, 52 females) diagnosed with burnout syndrome and either a depressive episode or an adjustment disorder undergoing 6-week inpatient treatment were included. During hospitalization, daily evening EMA of mood, mental exhaustion, physical tiredness, and tension were assessed on a smartphone and PA was continuously recorded using wrist-worn accelerometers. Associations between PA and EMA symptoms were examined using mixed-effect models.
- **Results:** Time had significant non-linear effects on mood, mental exhaustion, physical tiredness and tension, indicating that all symptoms improved over the 6-week inpatient treatment. Within-person models revealed significant non-linear associations between PA and mood, mental exhaustion, and tension. On days when participants engaged in more PA than their individual average PA level, mood was higher, while mental exhaustion and tension were lower.
- **Conclusion:** Beyond overall symptom improvement at the group level, mood, mental exhaustion, and tension differed on days when participants were more active than usual. Although causal direction cannot be inferred, daily deviations from individual PA levels were associated with same-day symptom ratings. These findings underscore the clinical relevance of considering patients' individual PA levels rather than relying on fixed PA recommendations when planning the treatment.

PP-03-04 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 133

Chaabene H, Alissa S, Müller P, Habacha H, Taubert M, Markov A, Braun-Dullaes R, Zimmer P, Königstein K

Exercise Intensity and Brain Health: A Multilevel Framework Integrating Molecular Signalling, Neuroadaptation, and Cognitive Outcomes in Youth

UNIVERSITY HOSPITAL MAGDEBURG; OTTO-VON-GUERICKE UNIVERSITY, MAGDEBURG, Germany

- **Background:** Physical exercise (PE) is widely recognized as a key determinant of youth brain health. However, the role of PE intensity remains poorly specified in current guidelines and research. This work synthesizes evidence on how different PE intensities relate to brain health in youth, conceptualized across three interconnected levels: molecular and cellular processes, structural and functional brain characteristics, and cognitive and mental outcomes. Methods: A narrative review of the existing literature. Results: Acute studies suggest that higher-intensity PE often elicits greater improvements in executive control and on-task classroom behavior than lower intensities, with effects moderated by baseline fitness level. Chronic interventions indicate that high PE may preferentially enhance cognition and academic performance, whereas moderate intensities appear more favorable for mental health, particularly when combined with self-selected intensities that support adherence and affective responses. Neuroimaging work, although rarely manipulating PE intensity directly, tentatively links moderate-to-high PE with greater white matter integrity, grey matter volume, and functional connectivity. At the molecular level, emerging youth data indicate intensity-dependent modulation of neuroplasticity-related markers, including BDNF and irisin, consistent with the adult literature. Integrating these findings, we propose a multilevel intensity-response framework in which increasing intensity amplifies neurobiological signalling but acts as a behavioral regulator, such that the "optimal" intensity varies by level and outcome. Conclusion: The current evidence does not support a single universally optimal intensity. Instead, mixed-intensity approaches may best combine biological efficacy with sustainable engagement. This framework is exploratory and hypothesis-generating rather than confirmatory. Therefore, rigorous longitudinal and mechanistic trials directly comparing different PE intensities are needed to refine this framework and inform future youth-specific PE guidelines.

PP-03-05 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 171

Spiliopoulou P, Eleutherakis-Papaikovou E, Migkou M, Kanellias N, Ntanasis-Stathopoulos I, Malandrakis P, Theodorakakou F, Fotiou D, Andreatou A, Rousakis P, Panteli C, Terpos E, Gavriatopoulou M, Tsitsilonis OE, Kastritis E, Dimopoulos MA, Terzis G

Fatigue in patients with multiple myeloma following first-line treatment: a descriptive study

NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS, Greece

► **Background:** Fatigue is a common symptom observed in multiple myeloma patients. Exercise training has been shown to reduce fatigue in cancer patients. However, fatigue levels may vary across disease stages, and therefore, the need for intervention may also differ. The aim of the present study was to describe the level of fatigue in patients with multiple myeloma following first-line treatment. Method: Seventeen patients with multiple myeloma (7 women, 10 men; age: 54.4±6.3 years; body mass: 77.8±15.0 kg) who had completed first-line treatment, including autologous hematopoietic stem cell transplantation, participated in the study. At 100 days post-transplantation, participants completed four questionnaires: Fatigue Assessment Scale (FAS), Fatigue Severity Scale (FSS), QLQ-C30 and SF-36. In addition, hematocrit and hemoglobin concentration were measured through standard blood analysis as biological markers of fatigue. Results: Fatigue, as assessed by the FAS, was 21.7±5.4 (scale 1–50) and was not clinically significant (<22). According to the FSS, fatigue was 3.9±1.3 (scale 1–7) and was also not clinically significant (<5). Based on the QLQ-C30, fatigue was 32.6±24.3%, again below the threshold for clinical significance (<40%). Similarly, fatigue derived from the SF-36 was 40.1±18.5%, which was not clinically significant (<50%). Hematocrit levels were 37.9±4% in men and 35.7±3.8% in women. Hemoglobin levels were 12.2±1.5 g/dL in men and 11.7±1.4 g/dL in women. Conclusion: The level of fatigue in patients with multiple myeloma was found to be low at this stage of the disease, as consistently indicated by all four questionnaires used. Hematocrit and hemoglobin levels were at the lower end of the normal range, which is likely attributable to disease-related symptoms such as anemia. An exercise program aimed at reducing fatigue may be more beneficial at other stages of the disease when fatigue is clinically significant, such as at the time of diagnosis.

PP-03-06 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 251

Görg D, Drost L, Dreisigacker F, Schulz C, Rißmayer M, Cyriax M, Ringleb M, Bloch W, Clare E, Cleef S, Kambeitz J, Lichtenstein T, Meißenburg J, Zimmer P, Javelle F

High-intensity interval training versus stretching in major depressive disorder: A 10-week randomized controlled trial on depressive symptoms, self-efficacy and exercise motivation

GERMAN SPORTS UNIVERSITY COLOGNE, Germany

► **Background:** Empirical evidence suggests that high-intensity interval training (HIIT) reduces depressive symptoms. However, the underlying mechanisms remain unclear. Recent findings propose these effects to be partly explained by cognitive factors such as self-efficacy and exercise motivation, which are enhanced through physical exercise. Therefore, this study compared effects of HIIT and stretching on depressive symptoms and examined the role of these cognitive factors.

► **Methods:** In this secondary analysis of the ongoing HealthFit randomized controlled trial, 55 outpatients with major depressive disorder (age=35.6±8.17; 56% female) were randomized to either HIIT (4x4min [85 to 95% HRmax]; n=27) or stretching (n=28) and trained 3 times weekly for 35 minutes over 10 weeks. Depressive symptoms, self-efficacy, and exercise motivation were respectively assessed using the Inventory of Depressive Symptomatology (IDS-C30), General Self-Efficacy Scale (GSE) and Behavioral Regulation in Exercise Questionnaire (BREQ-3) at baseline, week 5 and week 10. All analyses (univariate and moderation analyses) followed an intention-to-treat principle using linear mixed-models.

► **Results:** Depressive symptoms decreased in both groups over time, with a greater reduction in the HIIT group (p=.004, d=1.00). Self-efficacy increased across both groups (p<.001, $\eta^2_p=.20$), yet without an interaction effect. Its delta significantly predicted reductions in depressive symptoms (p=.044) independent of group interaction, while the group effect remained significant (p=.002). Exercise motivation increased from baseline to week 10 (p=.032, d=0.55). Its delta did not significantly predict changes in depressive symptoms (p=.061) and worsened the previously tested difference between HIIT and stretching.

► **Conclusion:** In line with previous studies, HIIT resulted in greater reductions in depressive symptoms than stretching, and self-efficacy and exercise motivation increased over the course of the intervention. Only changes in self-efficacy were associated with reductions in depressive symptoms, independent of group. Neither variable moderated the group effect, suggesting other mechanisms underlying the stronger antidepressive effects of HIIT.

PP-03-07 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 253

Dreisigacker F, Rißmayer M, Fabritius F, Joisten N, Bloch W, Javelle F

Kynurenine Pathway Dynamics and Affective Response to High- and Low-Intensity Resistance Exercise: A Randomized Crossover Trial

GERMAN SPORTS UNIVERSITY COLOGNE, Germany

► **Background:** The kynurenine pathway (KP) is activated by acute physical exercise, metabolizing kynurenine (KYN) to either kynurenic acid (KA) or quinolinic acid (QA). The ratios KA/KYN (neuroprotective index), QA/KYN (neurotoxic index) and QA/KA, thus, reflect the relative activity of these branches. While KP dynamics have been largely studied in endurance exercise, evidence in resistance exercise (RE) is limited. It remains unclear whether RE intensity modulates KP responses and whether these responses relate to affect.

► **Methods:** Twenty-four healthy RE-trained young men completed a randomized crossover trial comparing High-Intensity Interval Resistance Exercise (HIIRE; cluster-set design, 85% 1RM) and Low-Intensity Resistance Exercise (LIRE; 4x12 repetitions, 50% 1RM). Both protocols comprised the same four exercises and were designed to be duration- and relative volume-matched. Fasted venous blood samples were collected pre-, post-, and 45min post-exercise to assess KP metabolites. Affect was monitored continuously throughout each session using the Feeling Scale (FS). Three indices reflecting the magnitude and direction of affective responses during exercise were derived: within-session decline (Δ FSmin-pre), within-session peak (Δ FSmax-pre), and post-exercise rebound (Δ FSrebound).

► **Results:** Baseline-adjusted linear mixed models revealed no condition or TimexCondition effects for any KP metabolite or ratio, while large time effects were observed (p's<.022, $\eta^2_p=.07-.39$), with KA exhibiting the strongest modulation. Post-exercise, KA/KYN increased, and QA/KA decreased (p's<.043, $Idl=.51$), reflecting acute upregulation of the neuroprotective branch. Forty-five minutes post-exercise, both ratios reversed direction (p's<.001, $Idl=.95$), likely driven by a post-exercise decline in KA. Greater Δ FSmin-pre was significantly associated with moderate increases in KA/KYN and decreases in QA/KA (p's<.036, $\eta^2_p=.07$).

► **Conclusion:** Despite marked protocol differences, KP responses were similar, suggesting that KP neuroprotective and neurotoxic branches are not differentially modulated by RE intensity alone. Δ FSmin-pre emerged as an intensity-independent marker of acute KP activation, pointing to a role of subjective stress load. The biphasic time course warrants further investigation with concurrent inflammatory markers.

PP-03-08 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 269

Weike L, Reinsberger C

Linking subjective symptom clusters to objective neurocognitive, balance, and vestibulo-ocular outcomes in athletes with sport-related concussion

UNIVERSITÄT PADERBORN, Germany

► **Background:** Sport-related concussion (SRC) is a complex injury that presents with a variety of symptoms in different neurological domains. Clinical clusters or profiles can aid in the evaluation and treatment of athletes with SRC. This study aimed to investigate associations between subjective symptom clusters and objective neurocognitive, balance, and vestibulo-ocular performance in athletes with SRC.

► **Method:** Clinical data of 93 athletes with SRC were analyzed retrospectively (age: 22.6±5.3 years). All patients underwent objective assessment of neurocognitive performance (CNS Vital Signs), balance (Stability-Evaluation-Test), and vestibulo-ocular function (video-head-impulse-test, dynamic visual acuity test). Subjective symptom clusters (headache/migraine, anxiety/mood, fatigue, cognitive, vestibular, ocular) were determined for each patient using the symptom checklist of the Sport Concussion Assessment Tool (SCAT). Objective test performance of patients presenting with and without each symptom cluster was compared using independent t-tests or Mann-Whitney-U-Tests. Additionally, Spearman correlations between test outcomes and cluster-specific symptom severity scores were calculated. Post hoc adjustment for multiple comparisons was performed using Bonferroni correction.

► **Results:** Headache/migraine was the most frequently affected domain (present in n=47), followed by vestibular (n=44). Athletes with symptoms in the fatigue cluster demonstrated lower vestibulo-ocular performance compared to patients without this cluster (video-head-impulse-test: p=0.015, r=0.314). Additionally, balance performance was lower in patients with anxiety/mood, fatigue, cognitive, and vestibular symptoms compared to patients not presenting with the respective cluster (p<0.001-p=0.044, r=0.295-0.486). Balance performance correlated inversely with symptom scores in all domains (p<0.001-p=0.047, r=0.291-0.503). Worse dynamic visual acuity correlated with higher symptoms in headache/migraine, cognitive, and ocular domains (p=0.033-0.049, r=0.234-0.254).

► **Conclusion:** Types and quantity of subjective symptom clusters were variable among SRC patients. Lower balance performance was associated with symptoms across nearly all domains, while decreased vestibulo-ocular performance was present in patients reporting symptoms of the fatigue cluster. Future research could focus on predictors for specific clinical profiles or associations with clinical outcomes.

PP-03-09 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 267

Shushollari M, Schlagheck ML, Mund FK, Bahtijarevic Z, Verhagen E, Reinsberger C

Potential concussive events in European professional football

PADERBORN UNIVERSITY, Germany

- **Background:** Head injuries are a concern in professional football due to the risk of concussion and other traumatic brain injuries. In 2014, the Union of European Football Associations (UEFA) introduced a procedure allowing up to 3 minutes for on-pitch medical assessment to enable prompt concussion detection. However, little is known about the specific match situations in which such assessments are performed.
- **Methods:** A video-based observational study identified potential concussive events requiring on-pitch medical assessment in professional football matches across UEFA competitions during the 2021/2022 to 2024/2025 seasons. For each event, the match situation, field location, player position, minute of play, duration of match interruption, and substitutions were recorded.
- **Results:** A total of 253 game interruptions to assess potential head injuries were identified, occurring in 242 matches and involving 320 players. Video footage was available for 109 events (97 matches). Among player positions, defenders were most frequently affected (43%). Most incidents occurred during tackles (92%), especially aerial challenges (70%), with nearly half (49%) involving a player arriving late to contest the header. In 47% of cases, the ball travelled 20–50 meters before the incident. 49% of all incidents occurred within the penalty area. The median time point of interruption was the 45th minute, with 7% happening during added time. Average stoppage time was 163 seconds (2:43 minutes), with 70% lasting three minutes or less. Overall, 42% of affected players were substituted, either immediately or later in the match.
- **Conclusion:** This is the first comprehensive, video-based analysis of potential concussive events across multiple European professional football competitions and seasons. Consistent with previous literature, head injury situations frequently occurred in high-contact zones such as the penalty area, during aerial challenges, particularly long-distance balls, and often involved defenders. Although most stoppages met the three-minute limit, its sufficiency for thorough concussion assessment remains uncertain.

PP-04-01 POSTER PRESENTATION – AI & DIGA'S NR. 205

Kolokas I, Götz C, Spielbichler P, Lang S, Schäfer O, Brunner S, Vieluf S

Artificial Intelligence–Based Classification of the Athlete's Heart from Resting ECGs: A Multimodel Study

LMU KLINIKUM, München, Germany

- **Background:** Regular intensive endurance training induces characteristic electrical and structural cardiac adaptations known as athlete's heart. Differentiating between athlete subgroups based on ECG characteristics may provide insights into training-related cardiac remodelling. However, the extent to which these differences can be captured using automated machine learning approaches remains underexplored.
- **Method:** In total, 423 male athletes were included (193 professional cyclists and 230 leisure athletes). Standard 12-lead ECGs of 10-second duration were recorded for all participants. Three classification pipelines were evaluated: (1) manual feature extraction combined with an Extreme Gradient Boosting (XGBoost) classifier, (2) a Convolutional Neural Network (CNN) using the filtered ECG time-series as input, and (3) foundation model-based feature extraction using ECG-FM coupled with an XGBoost classifier. Model performance was assessed using internal validation and evaluated by accuracy, sensitivity, specificity, area under the receiver operating characteristic curve (AUROC) and area under the precision–recall curve (AUPRC). Wilcoxon signed-rank test was performed to test for significance of differences between models.
- **Results:** The ECG-FM-based pipeline outperformed other models ($p < 0.05$), achieving an accuracy of 0.96 ± 0.03 , a sensitivity of 0.94 ± 0.05 , a specificity of 0.97 ± 0.03 , an AUROC of 1.0 ± 0.0 and an AUPRC of 1.0 ± 0.0 . The CNN (0.92 ± 0.03 , 0.94 ± 0.04 , 0.91 ± 0.07 , 0.96 ± 0.02 , 0.95 ± 0.03) and the manually extracted feature pipelines (0.92 ± 0.04 , 0.92 ± 0.07 , 0.91 ± 0.04 , 0.97 ± 0.01 , 0.96 ± 0.02) achieved competitive performance but remained inferior to the ECG-FM-based approach.
- **Conclusion:** The results demonstrate that advanced representation learning enables detection of subtle ECG patterns associated with endurance training beyond conventional approaches. These findings support that high-level training leaves a quantifiable electrical fingerprint on the heart and highlight the potential of advanced representation learning to capture subtle physiological differences in ECG signals.

PP-03-10 POSTER PRESENTATION – NEUROLOGY & PSYCHIATRY NR. 168

Kappler T, Gutjahr L, Ott T, Meyer T, Venhorst A

Psychophysiological responses to high-intensity interval training and moderate-intensity continuous exercise in insufficiently active, normal and overweight young adults

SAARLAND UNIVERSITY, Germany

- **Background:** Sport physicians prescribe regular moderate-intensity exercise as preventive measure against non-communicable diseases but evidence for long-term adherence is lacking. High-intensity interval training (HIIT) is an efficacious and time-efficient alternative compared to moderate-intensity continuous exercise (MICE), though its general suitability remains debatable. We therefore applied a three-dimensional framework of sensory, affective and cognitive perceptions to equicaloric HIIT and MICE regimes in insufficiently trained, normal and overweight adults.
- **Methods:** Seventy-four insufficiently active (24 ± 28 min/week endurance training) normal ($n=35$, BMI 22.5 ± 1.7) and overweight ($n=39$, BMI 29.4 ± 2.8) men and women (each $=37$, 27 ± 4 years) completed two equicaloric runs: HIIT (27 ± 0 min with 4×3 minutes at 11.1 ± 2 km/h) vs MICE (36 ± 2 min at 6.5 ± 1 km/h). Heart rate, oxygen consumption relative to fat-free mass and blood lactate concentration as well as perceived strain, affective valence and action crisis were assessed at equicaloric measurement points. Remembered enjoyment and predicted frequency to perform this training were recorded after cool-down.
- **Results:** Multivariate analyses of variance of overall and [peak-and-end-rule] averages showed highly significant differences between trials with very large effect sizes in all parameters. Pairwise comparisons confirmed higher physiological strain (heart rate: 167 ± 11 [177 $\pm$ 9] vs 149 ± 11 bpm, oxygen consumption: 41 ± 4 [46 $\pm$ 4] vs 34 ± 3 ml/min/kg and lactate concentration: 6.9 ± 1.7 [7.2 $\pm$ 1.7] vs 1.6 ± 0.5 mmol/l) and corresponding higher perceived strain (13.3 ± 2.0 [14.9 $\pm$ 1.8] vs 10.1 ± 2.2 A.U.) and action crisis (3.6 ± 1.2 [4.1 $\pm$ 1.3] vs 1.8 ± 0.9 A.U.) during HIIT, whilst affective valence (0.8 ± 1.8 [0.2 $\pm$ 2.0] vs 3.1 ± 1.6 A.U.), remembered enjoyment (-0.6 ± 2.5 vs 3.2 ± 1.8 cm) and predicted training frequency (2 ± 1 vs 3 ± 1 /week) were lower.
- **Conclusion:** HIIT is more time-efficient and likely more efficacious but perceptual responses are more favourable during MICE, which is expected to contribute to better long-term adherence. Given that adherence, not efficacy, is barrier to life-long exercise behaviour, prescribing high-intensity exercise in insufficiently active adults may be efficacious but not effective medicine.

PP-04-02 POSTER PRESENTATION – AI & DIGA'S NR. 276

Dieter V, Weber F, Bahns C, Kopkow C, Peschke D, Krauss I

Comparison of a self-directed m-health versus blended care exercise intervention in patients with knee osteoarthritis

UNIVERSITY HOSPITAL TÜBINGEN, Germany

- **Background:** Digital technologies can address current gaps in healthcare by guiding exercise therapy in patients with knee osteoarthritis (KOA). However, the extent to which these technologies differ in effectiveness depending on the level of interaction with healthcare professionals has not yet been investigated.
- The aim was to evaluate the effectiveness of a self-directed m-health (re.flex) compared to a blended care (SmArt-E) exercise intervention regarding pain reduction and functional improvement in patients with KOA.
- **Method:** An explorative analysis was conducted on datasets derived from two randomized controlled trials (re.flex, SmArt-E) which included patients diagnosed with KOA. In both studies, patients were randomized 1:1 into an intervention group (IG: re.flex: self-directed app-based exercise program [3 sessions/week, week 1–12]; SmArt-E: physiotherapist-guided [1–2 sessions/week, week 1–12] and app-assisted [1–3 sessions/week, week 1–12] exercise program in a blended care approach) or usual care (control group, CG). Outcomes were Knee Osteoarthritis Outcome Score (KOOS) subscales pain and physical function at 12 weeks. The statistical analysis was conducted using baseline-adjusted ANCOVA (complete case) with the interaction term group $\times$ study.
- **Results:** The analysis population includes $n=406$ participants (IG: $n=202$; CG: $n=204$; 62% female; mean age: 63.1 ± 8.2 years; mean BMI: 28.5 ± 5.3 kg/m²). Results demonstrate no statistically significant interaction between group (IG, CG) and study (re.flex, SmArt-E) after 12 weeks for pain reduction ($p=.344$) or improvements in physical function ($p=.474$).
- **Conclusion:** No evidence was found for a difference in effectiveness between the self-directed m-health (re.flex) and blended care (SmArt-E) exercise interventions in terms of pain reduction and improvements in physical function in patients with KOA. Identifying subgroups of people who may benefit most from one or the other exercise delivery format seems necessary and helpful. In this context, the development of selection criteria that allow for accurate allocation of patients to the most suitable exercise intervention would be important.

PP-04-03 POSTER PRESENTATION – AI & DIGA'S

NR. 239

Jakobsmeier R, Reinsch D, Krueger B, Landgraeber E, Libuda L, Buyken A, Reinsberger C

Comparison of chest belt and wearable derived heart rate variability outcomes in resting sitting condition

PADERBORN UNIVERSITY, Germany

- Wearable wrist worn devices measuring blood volume pulse (BVP) allow assessments of heart rate variability (HRV) in resting conditions, but data on reliability of HRV values obtained by different sensors are scarce. We aimed to compare HRV measures of a wearable wrist worn device in comparison to a chest belt (electrocardiogram, ECG), which is the gold standard of HRV measurements.
- 28 subjects (22±4.4years; 22.7±2.7BMI; 17 females) wore a Polar H10 chest belt (Polar Electro Oy, Finland) and a wrist worn EmbracePlus device (Empatica, Milan, Italy) during a resting sitting condition. An identical 5-minute period was segmented within synchronized raw data by visual inspection to ensure sufficient data quality for further analysis. Data were pre-processed and analysed using default settings ("noise detection medium"; "automatic artefact correction") in Kubios HRV Scientific (Kuopio, Finland). Time domain HRV outcomes were heart rate (meanHR), heart cycle (meanRR/inter-beat-intervall (IBI)), root mean square of successive differences (RMSSD) and standard deviation of normal-to-normal (SDNN). Statistical agreement between HRV outcomes was calculated using intraclass correlation coefficient (ICC) with 95% confidence intervals (CI). Outcome differences between devices were calculated using dependent t-test or wilcoxon signed rank test depending on normal distribution.
- Artefact correction rate was significantly higher in BVP than ECG (1.82±1.58% vs. 0.22±0.62%; z=-4.015; p<0.001; r=-0.76). ICC for meanHR was 0.993 (0.946-0.998), for meanRR/IBI 0.995 (0.973-0.999), for RMSSD 0.929 (0.555-0.977) and for SDNN 0.953 (0.898-0.978). Differences of HRV outcomes between devices (ECG vs. BVP) was significant for meanHR (65.05±9.83bpm vs. 63.93±9.65bpm; t=4.882; p<0.001; d=1.239), meanRR/IBI (964.54±165.79ms vs. 961.14±167.79ms; z=-3.873; p<0.001; r=-0.73) and RMSSD (64.50±45.01ms vs. 81.21±44.50ms; z=-4.054; p<0.001; r=-0.77).
- Comparing chest belt and wearable device derived HRV outcomes in a resting sitting condition revealed high statistical agreement, but significant group differences for meanHR, meanRR/IBI and RMSSD. HRV outcomes obtained by different devices may need to be interpreted with caution.

PP-04-04 POSTER PRESENTATION – AI & DIGA'S

NR. 272

Reinsch D, Jakobsmeier R, Hasija T, Kuschel M, Menne H, Dailey S, Loddenkemper T, Reinsberger C

Comparison of heart rate variability derived from different wearable sensors and electrocardiography in rest and movement

SPORTMEDIZINISCHES INSTITUT PADERBORN, Germany

- Wearable devices provide a convenient way to access pulse rate variability (PRV) during daily activity, which is often used to derive measures of heart rate variability (HRV). We aimed to compare the validity of HRV measurements of different wearable devices during resting and moving states to electrocardiography (ECG).
- We recorded data from 3 wearable devices (E4 & EmbracePlus (Empatica, Milan) and the EmotiBit (Connected Future Labs, Reno) simultaneously with ECG in 17 healthy subjects (23.3±3.7 years, 9 females) in resting supine, resting standing, and stepping (stairs) conditions. After segmentation into 450s intervals, we used Kubios HRV Scientific (Kubios, Kuopio) to calculate Root Mean Square of Successive Differences (RMSSD) pairs from the ECG and BVP, provided the BVP quality detected in Kubios was sufficient for each participant, device, and condition.
- To assess agreement between the ECG- and BVP-derived outcomes, we calculated the Intraclass correlation coefficient (ICC) and 95% confidence intervals (CIs) for 17 participants. For RMSSD, ICC [95% CI] values were 0.95 [0.87, 0.98] (supine, n=17), 0.81 [0.24, 0.94] (standing, n=17) and 0.04 [-0.20, 0.77] (stepping, n=4) for the E4 wearable. For the EmotiBit, ICCs were 0.78 [0.38, 0.92] (supine, n=16), 0.65 [0.23, 0.86] (standing, n=16) and 0.30 [-0.12, 0.70] (stepping, n=13). For the EmbracePlus, ICC values were calculated with 0.91 [0.78, 0.97] (supine, n=17) and 0.56 [0.04, 0.84] (standing, n=13) (stepping only resulted in one data pair).
- Our results show that the ICC and the number of RMSSD pairs are high for supine, good for standing, and low for the stepping condition, depending on the sensor. Movement, in particular, may negatively affect the agreement between RMSSD derived from wearables and ECG. Therefore, wearable-derived RMSSD measurements during movement should be interpreted with great caution.

PP-04-05 POSTER PRESENTATION – AI & DIGA'S

NR. 180

Singh G, Nieß AM, Carlsohn A

Effectiveness of commercial mobile apps for physical activity and weight loss in adults with overweight or obesity

HAW-HAMBURG, Germany

- Background:** Overweight and obesity represent a major global public health burden, contributing to cardiovascular disease, type 2 diabetes, and reduced life expectancy. Many commercial smartphone apps offer weight-loss programmes, but their medium-term effectiveness remains unclear. This review assessed whether commercially available smartphone apps lead to greater weight loss and physical activity increase than no app (control) in adults with overweight or obesity.
- Methods:** A systematic review and meta-analysis was conducted with a literature search in PubMed, Web of Science, and the Cochrane Library (2021–June 2025). 11 randomised controlled trials met the inclusion criteria: adults aged ≥18 years with overweight or obesity, a commercial smartphone app as the main intervention, a randomised controlled design, and at least one weight or physical activity outcome. Weight outcomes were reported by 8 studies (759 intervention, 713 control participants); 6 studies (536 participants) reported physical activity outcomes, synthesised narratively due to heterogeneity.
- Results:** App-based-only interventions resulted in significantly greater weight loss (−4.50 ± 6.32 kg) compared to control (−1.96 ± 6.15 kg) (MD −2.10 kg, 95% CI: −2.94 to −1.27; I² = 55%). Subgroup analysis showed greater weight loss with longer interventions (≤12 weeks: −1.31 kg, I² = 0%; >12 weeks–6 months: −1.90 kg, I² = 42%; 12 months: −3.49 kg, I² = 0%; p=0.002). Physical activity outcomes were heterogeneous but generally more favourable in intervention groups, with relative improvements vs. controls ranging from +35% to +685%.
- Conclusions:** Commercial smartphone apps appear to support modest weight loss in adults with overweight or obesity, while effects on physical activity remain inconsistent in magnitude but generally favourable in direction. Given their scalability and accessibility, these apps may serve as a useful component of lifestyle interventions. Standardised measurement and clearer adherence reporting are needed to determine which app features most effectively support sustained behaviour change.

PP-04-06 POSTER PRESENTATION – AI & DIGA'S

NR. 149

Claas J, Natale M, Brockhaus M, Friedmann-Bette B

Effects of an App-based multimodal training program on lung function parameters in patients with post COVID-19 syndrome

UNIVERSITÄTSKLINIKUM HEIDELBERG, Germany

- Background:** Persistent dyspnea is a common complaint in patients with post COVID-19 syndrome (PCS). This study investigated whether ventilation parameters in PCS patients are improved after an 8 weeks App-based training program including endurance and strength training, breathing exercises and progressive muscle relaxation.
- Method:** This retrospective analysis included 37 patients with PCS as a subgroup of a multicenter randomized controlled trial (APILOT). Body plethysmography and cardiopulmonary exercise testing (CPET) were analyzed before and after intervention.
- Patients were stratified into those with dyspnea (Dysp, n = 27, female = 18, male = 9, age 50.30 ± 11.09 years, BMI 26.69 ± 5.09 kg/m², VO₂max 26.02 ± 8.05 ml/min/kg) and without dyspnea (Non-Dysp, n = 10, female = 8, male = 2, age = 49.80 ± 9.62 years, BMI 28.31 ± 6.33 kg/m², VO₂max 25.36 ± 4.08 ml/min/kg). Wilcoxon signed-rank test and Mann-Whitney-U-test were applied. All lung function parameters are presented as % target values.
- Results:** Diffusion parameters were significantly reduced in Dysp compared to Non-Dysp: DLCO: 75.48 ± 10.94 vs. 91.89 ± 7.49, p<0.001 (before) and 74.93 ± 11.46 vs. 92.70 ± 12.76, p=0.002 (after intervention); KCO: 82.22 ± 11.64 vs. 90.56 ± 7.73, p=0.042 (before) and 81.00 ± 10.79 vs. 92.10 ± 12.45, p=0.030 (after). At baseline TLC was also significantly lower in Dysp (97.67 ± 9.60 vs. 107.90 ± 7.78, p=0.006).
- Significant increases were observed in Dysp for FEV₁ (before: 98.44 ± 10.02, after: 99.67 ± 12.91, p=0.042) and TLC (before: 97.67 ± 9.60, after: 99.85 ± 9.12, p=0.041) through intervention, without any changes in diffusion and performance capacity.
- Conclusion:** Apparently, dyspnea in PCS patients is associated with persistent limitations in pulmonary diffusion capacity. After the App-based training intervention, marginal improvement of some lung function parameters were found in Dysp, however, diffusion capacity was not significantly influenced.

PP-04-07 POSTER PRESENTATION – AI & DIGA'S

NR. 178

Steinbacher V, Scharhag J

Evaluation of the validity of VO_2max estimation in athletes using Seismofit®

UNIVERSITY OF VIENNA, Austria

- **Background:** Spiroergometry is considered as the gold standard to measure the maximum oxygen uptake (VO_2max). Seismocardiography (SCG) is a new, non-exercise-based technology for estimating the VO_2max , using heart-induced vibrations on the chest wall with an accelerometer. The aim of this study is to compare the measurement of VO_2max using SCG (Seismofit®) and spiroergometry at different activity levels, as well as to investigate the validity of SCG relative to spiroergometry.
- **Method:** In 70 participants (34 competitive athletes, 22 recreational athletes, 14 sedentary athletes), VO_2max was measured using spiroergometry and estimated using Seismofit®. The validity of the estimation method was assessed using a paired t-test, the intraclass correlation coefficient (ICC), the mean absolute error (MAE and MAPE in %), and a Bland-Altman plot.
- **Results:** The measured VO_2max was significantly higher than the estimated values (50.4 ± 8.9 vs. 48.5 ± 7.6 ml/min/kg; $t(69) = 2.68$, $p = 0.009$; $d = 0.32$), with strong correlation and reliability ($r = 0.77$, $p < 0.001$, $\text{ICC}(3,1) = 0.76$ (CI: 95% [0.64, 0.84]) and moderate agreement (MAE = 4.31 ml/min/kg; MAPE = 8.95%). The underestimation of high VO_2max values by Seismofit® was demonstrated by the linear regression $R^2 = 0.59$ (SEE = 4.92 ml/min/kg) with a slope = 0.66 (<1) and was confirmed by a Bland-Altman analysis (Bias = 1.8 ml/kg/min, LoAs -9.47 – 13.07). The Subgroup analysis showed no significant difference among recreational athletes ($p = 0.883$) and sedentary athletes ($p = 0.489$). In contrast, a significant difference ($p < 0.001$) was found among competitive athletes between the measured and estimated values.
- **Conclusion:** Seismofit® provides acceptable validity for recreational and sedentary athletes, but not for competitive athletes. In the future, these results should be examined in further, larger studies with different target groups to enable a better assessment of the generalizability of the estimation method.

PP-04-09 POSTER PRESENTATION – AI & DIGA'S

NR. 262

Sperber F, Nieß AM, Schneeweiß P, Walter T

Real-Time Calculation of Physiological Performance Metrics on Cycling Computers: Development and Validation of a Data Field

EBERHARD KARLS UNIVERSITÄT TÜBINGEN, Germany

- **Background:** Targeted data analysis is a central component for athletic success in amateur and high-performance sports. While modern cycling computers record a multitude of performance data, in-depth physiological evaluation is usually performed post-hoc or not at all. Therefore, the aim of this study was to develop a data field for Garmin Edge devices that calculates relevant sports physiological parameters, such as the heart rate kinetics time constant (τ), cardiac drift, and heart rate recovery, in real time. Despite severe hardware restrictions, the goal was to achieve an accuracy corresponding to the established gold standard, providing athletes with these metrics directly during the ride without additional analysis tools.
- **Method:** To solve this challenge, resource-efficient procedures, including the LMA solver, EWMA models, and a bucketing approach, were initially implemented in Python, simulatively optimized for device application, and validated. Subsequently, the highest-performing variants were translated into the native Garmin programming language, Monkey C.
- **Results:** The validation revealed that the models provide results nearly identical to the post-hoc reference values. Aerobic decoupling could be determined with a mean deviation of only 0.29% and the time constant τ with a mean absolute error of 1.28 s, without exceeding the critical memory limit of 128 kB.
- **Conclusion:** The successful transfer of these algorithms to the end device enables athletes to directly utilize complex physiological performance data for live training control. Depending on the context, however, a distinction must be made between robust outdoor trend metrics and metrics for standardized indoor test protocols.

PP-04-08 POSTER PRESENTATION – AI & DIGA'S

NR. 187

Maaroufi S, Zeitz F, Brixius K

Instantaneous Effects of an Exergame-Based Training Intervention Using the ICAROS Guardian on Gait in Patients with Parkinson's Disease

GERMAN SPORT UNIVERSITY COLOGNE, Germany

- **Background:** Exergames are digital, movement-based games that can complement gait training in individuals with Parkinson's disease (PD) through multimodal intervention approaches. This study investigates the immediate effects of an exergame-based balance and stability training performed on the ICAROS Guardian on gait characteristics in patients with PD.
- **Methods:** Ten participants (seven men; three women; age: 52-76 years; Hoehn and Yahr stage 2-3) completed a gait analysis (40 m walking test; using step sensors by Portabilis Health Care Technologies GmbH, Erlangen, Germany) before and after a 30-minute resting phase (seated), as well as after a 30-minute exergame training on the ICAROS Guardian (ICAROS, Martinsried, Germany; unstable balance and stability training combined with cognitive gaming tasks).
- **Results:** The 30-minute seated rest period did not result in any changes in gait parameters. Following the 30-minute exergame-based training, a significant decrease was observed in stance time (pre vs. post: 0.698 ± 0.112 s vs. 0.676 ± 0.115 s; $p = 0.009$), swing time (0.392 ± 0.035 s vs. 0.384 ± 0.034 s; $p = 0.036$), and stride time (1.092 ± 0.140 s vs. 1.062 ± 0.142 s; $p = 0.014$). These changes were reflected in gait velocity (1.21 ± 0.21 m/s vs. 1.27 ± 0.21 m/s; $p = 0.053$). Additionally, a significant reduction was found in maximal lateral excursion (7.41 ± 1.78 cm vs. 6.42 ± 1.36 cm; $p = 0.041$). No further significant changes were observed in other gait parameters ($p > 0.06$).
- **Conclusion:** The observed changes in gait parameters suggest that an exergame-based unstable balance and stability training using the ICAROS Guardian leads to an immediate improvement in gait dynamics in individuals with PD. Further research is required to determine the duration of these instantaneous effects as well as the long-term impact of ICAROS Guardian training on gait in PD.

PP-05-01 POSTER PRESENTATION 5– CLINICAL CASES & ORTHOPEDICS NR. 121

Betz T, Natale M, Friedmann-Bette B

Acute chest pain in an elite rugby player: A rare case of polyserositis with cardiac involvement

UNIVERSITY HOSPITAL HEIDELBERG – MEDICAL CLINIC, Germany

- A 22-year-old professional rugby player (no prior internal medicine history) presented in our outpatient clinic with chest pain of two weeks duration, predominantly located at the sternum and the left costal margin. Symptoms initially occurred during exertion but progressed to occur at rest. No general symptoms such as fever or fatigue were reported.
- Physical examination revealed reduced breath sounds at the left lung base, while the examination was otherwise unremarkable with normal cardiac auscultation, heart rate (80/min) and blood pressure (110/70 mmHg). Laboratory testing demonstrated marked systemic inflammation (C-reactive protein level of 237 mg/L, leukocyte count 11.17/nl), hypochromic microcytic anemia (hemoglobin 10.8 g/dl), and mildly elevated high-sensitivity troponin T (21 pg/mL). Transthoracic ultrasound identified a fibrinous left-sided pleural effusion (5 cm) and a mild circumferential pericardial effusion (8 mm enddiastolic posterior to the right ventricle). Cardiac magnetic resonance imaging (CMR) confirmed an acute pericarditis with near-normal left ventricular function (EF 52%) and a mildly dilated left ventricular end-diastolic diameter (56 mm), consistent with an athlete's heart. Rheumatological evaluation established an autoimmune etiology, consistent with a polyserositis secondary to mixed connective tissue disease (ANA 1:80,000, speckled pattern, RNP positive).
- The athlete was hospitalized for five days. Anti-inflammatory therapy (ibuprofen, colchicine) was initiated, resulting in clinical improvement and gradual normalization of laboratory and sonographic imaging findings over a period of 6 weeks. After three months of sports restriction, follow-up CMR demonstrated significant pericardial late gadolinium enhancement but without evidence of active inflammation. A gradual return-to-exercise protocol was implemented. Anti-inflammatory medication was gradually tapered and discontinued after six months. The athlete has since remained clinically stable under regular follow-up and reached the previous performance capacity (VO_2max 46.3 ml/kg/min).
- This case highlights the importance of thorough diagnostic evaluation of chest pain in young athletes. Even severe underlying diseases can manifest with seemingly benign symptoms at initial presentation.

PP-05-02 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 138

Natalie M, Betz T, Friedmann-Bette B

Case Report Hyperthyroidism

HEIDELBERG UNIVERSITY HOSPITAL, Germany

- ▶ A 20-year-old professional female cyclist presented with reduced exercise performance capacity and increased heart rates at rest (65 vs. 50 bpm) and under exertion (up to 200 bpm during light exercise) since two weeks. Her preparticipation screening seven months earlier was unremarkable. Five weeks ago, she experienced an upper respiratory tract infection without relevant systemic symptoms and resumed training after a one-day break without complications. During the European Championships one week ago, she experienced a marked decline in performance and had paused training thereafter.
- ▶ Physical examination (blood pressure 115/60 mmHg, heart rate 68 bpm), routine laboratory testing, and cardiopulmonary diagnostics (ECG, echocardiography) were unremarkable. Exercise capacity remained well developed (234 W, 4.0 W/kg; VO₂max 51.9 ml/min/kg; stepwise increasing spiroergometry), however reduced compared to the previous examination (267 W, 4.3 W/kg, VO₂max 54.5 ml/min/kg). In addition, heart rate at each workload level was consistently 15–19 bpm higher than during the prior assessment.
- ▶ Laboratory results after exercise testing revealed manifest hyperthyroidism with marked TSH suppression (<0.008 mU/L), elevated fT₃ (14.23 ng/L) and fT₄ (35.36 ng/L). An endocrinological evaluation revealed elevated thyrotropin receptor antibodies, thyroid peroxidase antibodies, and thyroglobulin antibodies. Thyroid ultrasound demonstrated a normal thyroid size (11 mL), but inhomogeneous parenchyma and hyperperfusion, consistent with Graves' disease. Antithyroid therapy with thiamazole and propranolol was initiated. Training load was markedly reduced and subsequently paused. Under therapy, thyroid hormone levels and heart rate normalized (TSH 0.92 mU/L, fT₃ 2.74 ng/L, fT₄ 16.73 ng/L, heart rate 46/min). Propranolol was tapered and thiamazole stepwise reduced to a maintenance dose. After restoration of a euthyroid metabolic state, a stepwise return-to-sport protocol was implemented.
- ▶ This case highlights the importance of systematic diagnostic evaluation of nonspecific symptoms such as reduced performance and increased heart rate, even in apparently healthy athletes with objectively high performance capacity.

PP-05-04 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 216

Boyen J, Haufe S, Holzward D, Kueck M, Licker L, Zeidler J, Jänsch M, Koch A, Tegthür U, Johannsen H

Electrically-assisted bicycles and road safety: a prospective comparative observational study

HANNOVER MEDICAL SCHOOL, Germany

- ▶ **Background:** Pedelecs (bicycles equipped with electric pedal assistance up to 25 km/h) have experienced substantial growth in popularity across Europe, with Germany representing the largest share of use. They are considered a climate-friendly mode of transport and facilitate active mobility, particularly among older adults and individuals with comorbidities. However, emerging safety concerns have been reported, primarily attributable to their increased mass and higher operating speeds relative to conventional bicycles.
- ▶ **Methods:** We conducted a prospective observational study to examine the influence of e-biking compared to conventional cycling in terms of accident risk, injury severity, and associated factors in the general population. Incurred traffic accidents were reported by participants, with accompanying information asked and collected thereafter.
- ▶ **Results:** A total of 2,086 participants were recruited across Germany. Participants reported 348 accidents and 795 near-miss incidents. The distribution of the age groups of the participants reveals that riders of pedelecs have higher shares of elderly riders (age groups above 55 years) compared to riders of conventional bicycles. During the observational period 93/600 pedelec users (15.5%) and 201/1486 conventional bikers (13.5%) had at least one cycling accident, resulting in no higher probability for pedelec riders for an event (OR: 1.17, 95%CI 0.90; 1.53; p=0.24) in univariate analysis. The occurrence of accident-related injuries and the severity of injuries was similar between pedelecs and conventional bikes.
- ▶ **Conclusion:** In this large, Germany-wide sample, pedelec use was more prevalent among older adults compared to conventional cycling. Despite concerns regarding increased weight and speed, pedelec riders did not exhibit a significantly higher risk of cycling accidents than conventional cyclists. Moreover, the frequency and severity of accident-related injuries were comparable between both groups. These findings suggest that pedelec use does not confer an increased safety risk relative to conventional bicycles, even in an older population.

PP-05-03 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 156

Miletic K, Risch L, Engel T, Stoll J, Mayer F

Detecting functional improvement with a lifting task after 6-week stabilization training in individuals with low back pain: a non-randomized controlled trial

UNIVERSITY OF POTSDAM, Germany

- ▶ **Background:** Lifting tasks assess functional impairment in patients with low back pain (LBP). However, it remains unclear if a simple lifting assessment in the clinical setting can monitor treatment effects. This study aimed to investigate whether a lifting test battery, performed with and without additional weight, can detect improvements in functional impairment following core stabilization training in LBP patients.
- ▶ **Methods:** In this prospective non-randomized controlled trial, 42 participants with LBP (n=29 female, 39±12 years, 76±17 kg, 175±9 cm) and current pain intensity of ≥3 on a Numeric Rating Scale (NRS) were assigned to an intervention group (IG=22) performing 6-weeks of combined supervised and home-based core stabilization training (3x/week) or a control group (CG=20) continuing usual care. Measurements at baseline (M0) and post-intervention (M1) included acute NRS at rest and under load, and squat and stoop lifting with and without additional weight (20% body weight / 0%). Outcome was time to completion [s] for each lifting task. Additional functional assessments included chair rise test [s] and one-leg stance (centre of pressure, COP path length [mm]). Group differences were analysed using gain scores analysis (M1-M0) with independent t-tests or Mann-Whitney U test.
- ▶ **Results:** At baseline, groups did not significantly differ except for age (p=0.04). Lifting tasks showed statistically significant between-group differences during squat 0% (IG: Δ-0.8±0.8s, CG: Δ-0.4±0.5s, p=0.036), stoop 0% (IG: Δ-1.0±0.9s, CG: Δ-0.5±0.9s, p=0.045) and stoop 20% (IG: Δ-1.0±1.1s, CG: Δ-0.3±0.6s, p=0.021). At M1 pain decreased more in the IG both at rest (IG: Δ-2.6±2.1, CG: Δ-1.2±1.6, p=0.02) and under load (IG: Δ-2.4±2.0, CG: Δ-0.9±1.6, p=0.01). No differences were observed in squat 20%, chair rise test and COP path length (p>0.05).
- ▶ **Conclusion:** Improvements in lifting performance, together with reductions in pain, suggest that simple lifting tasks are responsive to functional change after a core stabilization training in individuals with LBP.

PP-05-05 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 221

Urban T, Barsch F, Krumnau O, Prettin S, Deibert P

Exercise-induced Dyspnea in a 45-Year Old Man – A clinical case report with Implications for Sports Medicine Diagnostics

UNIVERSITÄTSKLINIK FREIBURG, Germany

- ▶ **Background:** A 45-year-old male presented to our sports medicine outpatient clinic with a two-week history of progressive exertional dyspnea and accompanying chest pain.
- ▶ **Methods:** Initial diagnostic evaluation included medical history, clinical examination, blood sampling, electrocardiography (ECG), transthoracic echocardiography (TTE) and exercise testing using bicycle ergometry. Diagnostic workup was escalated to include pulmonary function testing, lung ultrasound and computed tomography (CT) of the chest.
- ▶ **Results:** Apart from gastroesophageal reflux disease and nicotine abuse, the initial medical history was unremarkable. Clinical examination, ECG and TTE showed no abnormal findings. Bicycle ergometry was terminated prematurely at low workload due to subjective exhaustion and an unusual inspiratory stridor noted by the experienced medical staff supervising the test. Consecutive pulmonary function testing showed a normal Tiffeneau index but evidence of restrictive and obstructive ventilatory patterns. Lung ultrasound revealed left-sided diaphragmatic paralysis. The patient then reported a motor vehicle accident with diaphragmatic rupture approximately 20 years earlier. As diaphragmatic paralysis alone did not explain the obstructive component, CT of the chest was performed. This revealed a saccular aneurysm of the descending thoracic aorta measuring 68 mm in diameter, most likely of post-traumatic origin, causing compression of the left main bronchus which could explain the inspiratory stridor during bicycle ergometry. The aortic aneurysm was located in a region non-visualizable via TTE. The patient subsequently underwent surgical aortic replacement, followed by a complicated postoperative course.
- ▶ **Conclusion:** This case highlights the importance of thorough medical history taking and attentive clinical observation by experienced staff during exercise testing in sports medicine diagnostics. It also illustrates the limitations of pre-exercise screening, as even comprehensive assessment cannot completely eliminate the residual risk of potentially life-threatening findings during exercise testing.

PP-05-06 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 121

Sonnenburg D, Engel T, Mayer F

Feasibility and Effects of a Home-Based Eccentric Training on Muscle Strength and Functional Performance in Adults at Risk of Sarcopenia – Prove-of-concept study

UNIVERSITY OF POTSDAM, Germany

- **Introduction:** Middle-aged, overweight, untrained adults often exhibit low muscle strength and functional performance, both associated with an increased risk of sarcopenia. These deficits may reflect neuromuscular impairments that can be improved through eccentric resistance training by providing high mechanical loading and enhancing neuromuscular activation. Poor adherence limits initiation and maintenance of resistance training in this population. Home-based approaches may reduce these barriers, but it remains unclear if eccentric training can be implemented in this setting. This study investigated the feasibility and effects of home-based eccentric resistance training on muscle strength and functional performance in adults at risk of sarcopenia.
- **Methods:** 20 participants (55–65 years, overweight, sedentary, no resistance training) were assigned to either an eccentric (ECC) or concentric (CON) home-based resistance training group (11 weeks, 2–3 sessions/week, high-intensity). Training adherence and adverse events were recorded. Pre- and post-intervention (M1, M2), knee flexion and extension strength (eccentric and concentric) were measured using isokinetic dynamometry. Functional performance was assessed using handgrip dynamometer, Timed-Up-and-Go (TUG) and one-minute Stair-Climb-Test (1min-SCT). Changes from M1 to M2 were analyzed using two-way mixed ANOVA (Time×group; $\alpha \leq 0.05$).
- **Results:** Training adherence was high ($\geq 85\%$) in both groups, with no adverse events reported. From M1 to M2, knee extension strength increased during both contraction types without group differences (-14 – 21% ; $p \leq 0.05$). Time×group interactions were observed for knee flexion strength ($p \leq 0.01$), with larger increases in ECC compared to CON for both concentric (0.22 ± 0.13 vs. 0.02 ± 0.13 Nm/kg) and eccentric contractions (0.28 ± 0.26 vs. 0.00 ± 0.22 Nm/kg). Functional performance increased ($p \leq 0.05$) across tests without group differences (Handgrip strength: $+2.2$ kg ($\sim 6\%$); TUG: -0.4 s ($\sim 6\%$); 1min-SCT: $+12$ steps ($\sim 10\%$)).
- **Conclusion:** Home-based eccentric training is feasible and shows comparable effects to traditional concentric training on muscle strength and functional performance, supporting its suitability as a training strategy for middle-aged adults at risk of sarcopenia.

PP-05-08 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 278

Zhang G, Brink M, Huber L, Szymiski D, Kruttsch W, Alt V, Meyer T, Lemmink K, Hecksteden A

Injury risk after return-to-play from lower-limb injuries in women's football: A time-to-event analysis

INSTITUTE OF SPORTS AND PREVENTIVE MEDICINE, Saarland University, Germany

- **Background:** In elite women's football, lower-limb injuries account for approximately 80% of all injuries. Evidence suggests an increased susceptibility to subsequent injury after returning from an index injury to full availability (return-to-play, RTP) in professional male football. Time loss of index injury, widely used as an indicator of injury severity, may affect subsequent injury risk. However, post-RTP injury risk remains understudied in women's football. This descriptive study aimed to characterise the time course of instantaneous risk (hazard) for non-contact subsequent injury following lower-limb index injuries in professional women's football and explore the role of index injury severity.
- **Method:** Prospectively collected injury data from clubs in 1st and 2nd Frauen-Bundesliga during 2023/24 and 2024/25 seasons were used for time-to-event analysis. Lower-limb index injuries (i.e., injuries from which players returned to play) were classified according to time loss as minor (1–7 days), moderate (8–28 days), and severe (>28 days). Non-contact time-loss subsequent injuries occurring within the same season as RTP were considered the event of interest. Kaplan-Meier survival functions were compared using Cox proportional hazards (PH) models after testing the PH assumptions. Following previously published methodology, cumulative hazard functions were estimated from survival functions and used to derive continuous hazard functions for descriptive interpretation. Statistical inference on survival functions does not necessarily extend to hazard functions.
- **Results:** Survival functions differed significantly between the minor and severe groups (hazard ratio = 0.39 ; 95% CI: 0.20 – 0.75 ; $p = 0.0047$). Descriptive hazard curves showed elevated subsequent injury risk shortly after RTP in all groups, which decreased over the following 50 days. Visual inspection indicated that early post-RTP risk was highest after minor injuries, followed by moderate and severe injuries.
- **Conclusion:** This descriptive study observed higher early post-RTP risk after minor injuries compared to moderate and severe injuries in female football. This pattern may reflect differences in post-RTP player management, such as earlier high match exposure after minor injuries. Future research should examine post-RTP match exposure rather than post-RTP days to provide more direct insights into risk trajectories.

PP-05-07 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 177

Quarmby A, Khajooei M, Kurtz P, Kim MH, Mayer F, Engel T

How Much Change Is Real? Reliability and Measurement Error of Single-Leg Jump Testing

UNIVERSITY OF POTSDAM, Germany

- **Background:** Single-leg jump testing is widely used in sports science and rehabilitation, despite limited information regarding test–retest reliability and measurement error. Such data are essential to distinguish true performance changes from normal variability. This study aimed to provide reliability metrics and minimal detectable change (MDC) values for commonly used single-leg jump tests, alongside limb symmetry indices (LSI).
- **Methods:** Twelve physically active participants ($5f/7m$; 32 ± 6 yrs; 72 ± 13 kg; 176 ± 10 cm) performed single-leg countermovement jumps (CMJ), rebound jumps (RJ), and 20 cm drop jumps (DJ) across two test–retest sessions (three repetitions per jump). Outcome measures included flight time, jump height (estimated from flight time), ground contact time, reactive strength index (RSI), and peak force. LSI was calculated between limbs. Reliability was assessed using intraclass correlation coefficients (ICC[2,1]). Measurement error was quantified using MDC at the 95% confidence level (MDC%), relative to the mean.
- **Results:** Jump heights were highest in CMJ (~ 12 – 13 cm), followed by RJ and DJ (~ 9 – 10 cm). CMJ showed moderate-to-high reliability for flight time (ICC = 0.77 – 0.79) and peak force (ICC = 0.92 – 0.95), but poor reliability for RSI (ICC = 0.26 – 0.34). RJ and DJ showed moderate reliability for RSI (ICC = 0.52 – 0.71), with higher RSI in DJ. Ground contact time reliability was moderate in DJ (ICC = 0.59 – 0.76) but low in RJ (ICC = 0.20 – 0.31). LSI ranged 5 – 14% . MDC% ranged 11 – 41% for CMJ, 19 – 30% for most DJ variables, and 28 – 44% for several RJ metrics.
- **Conclusion:** Single-leg CMJ provides reliable measures of flight time and peak force, whereas RJ and DJ offer more reliable assessment of reactive strength. MDC% values indicate that changes of ~ 11 – 20% (CMJ) and ~ 20 – 35% (RJ/DJ) are required to exceed measurement error. These findings provide reference data for interpreting performance changes, however, results are limited to healthy individuals and may differ in injured populations.

PP-05-09 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 214

Haase R, Oehme V, Richter M, Hammerschmidt S, Nitzsche N

Metabolic efficiency in individuals with impaired lung function during an all-out cycling sprint

TECHNISCHE UNIVERSITÄT CHEMNITZ, Germany

- Impaired lung function affects skeletal muscle metabolism and can lead to changes in aerobic and anaerobic performance. Whilst changes in aerobic performance are well known, the anaerobic performance of muscle metabolism in these individuals has scarcely been investigated. The lactate accumulation rate (vLapeakblood) serves as an indirect marker of glycolytic flux and enables insights into anaerobic metabolic function. The aim of this study was to investigate glycolytic capacity in individuals with impaired lung function (ILF) using vLapeakblood.
- Ten individuals with ILF (50.3 ± 12.3 years; 28.5 ± 7.2 kg·m $^{-2}$) and ten healthy individuals (49.9 ± 16.4 years; 24.4 ± 1.8 kg·m $^{-2}$) performed a 10-second all-out isokinetic cycling sprint (90 rpm) to determine vLapeakblood. Capillary blood samples were collected from the earlobe before and up to 20 minutes after the sprint to determine the lactate concentration (BLa). vLapeakblood was calculated as follows: $(BLa_{max} - BLa_{Pre}) \cdot t_{Sprint} \cdot 1$. Peak power (relPpeak) and mean power (relPmean) were recorded. In addition, glycolytic efficiency (GlyEff) was determined from the ratio of relPmean to vLapeakblood. Group differences were analyzed using the Mann-Whitney U test ($\alpha = 5\%$).
- No significant differences were observed between the groups in vLapeakblood (ILF: 0.30 ± 0.12 mmol·L $^{-1}$ ·s $^{-1}$ vs. healthy: 0.29 ± 0.08 mmol·L $^{-1}$ ·s $^{-1}$; $U = 53$, $p > 0.05$), but there were significant differences in GlyEff (ILF: 18.40 ± 5.95 vs. healthy: 34.50 ± 5.27 ; $U = 1$, $p < 0.001$) as well as relPpeak (ILF: 8.18 ± 2.65 W·kg $^{-1}$ vs. healthy: 10.48 ± 2.083 W·kg $^{-1}$; $U = 23$, $p < 0.05$) and relPmean (ILF: 5.13 ± 2.13 W·kg $^{-1}$ vs. healthy: 9.55 ± 1.88 W·kg $^{-1}$; $U = 6$, $p < 0.001$).
- At comparable vLapeakblood, individuals with ILF exhibited significantly reduced glycolytic efficiency and power output. The results suggest that the conversion of anaerobically supplied energy into mechanical power is impaired in these individuals.

PP-05-10 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 113

Sontheimer V, Burkhardt M, Baumann M, Kellmeyer P, Kubosch EJ

Participation in Physical Activity and Sports after Limb Amputation in Germany

UNIVERSITÄTSKLINIKUM FREIBURG, Germany

- ▶ **Background:** Existing research shows that physical activity (PA) and sports are beneficial for physical and mental health as well as social engagement, all of which are important for patients in rehabilitation after major limb amputation. However, German sports infrastructure seems to lack tailored settings for people with such disabilities. This study assessed the participation of amputees in PA and sports, as well as the offers and barriers they face in Germany.
- ▶ **Methods:** A self-designed 103-item online survey was distributed throughout Germany via self-help groups, medical supply stores, state associations and orthopaedic societies. The questionnaire contained questions on demographics, satisfaction with prosthetic care, information availability and expectations, quality of life, pain, activity level and sports participation. This report focusses on the aspects of PA and sports.
- ▶ **Results:** 152 questionnaires were evaluated, including 134 lower limb amputations (LLA) and 27 upper limb amputations (ULA), with the predominant causes being trauma (45%) and infection (21%). Nearly all LLA respondents (99%) used prostheses, contrasting with ULA respondents (74%). Despite 76% of respondents exercising at least 1-2 times weekly, 43% found PA offers and facilities poorly accessible, and only 18% owned sports prostheses. The majority felt limited in their capacity to engage in sports (45%) or leisure activities (32%), while also perceiving these as highly important for their health and quality of life.
- ▶ **Conclusion:** Despite a cohort reflecting high interest and participation in PA and sports, participants perceived a clear lack of opportunities for PA and sports tailored for disabilities. Over 75% reported exercising 1-2 times weekly yet desiring more support and information. Less than one in five owns a sports prosthesis. Taking into account potential limitations in the representability of the cohort, the results clearly illuminate areas with need for improvement in the care system and societal development.

PP-05-11 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 102

Fesseler L, Heinz V, Pilz N, Bothe T

Physiological monitoring of a 58-year-old athlete during the Race Across America (RAAM): a continuous multimodal toolkit

CHARITÉ - UNIVERSITÄTSMEDIZIN BERLIN, Germany

- ▶ **Objective:** Ultra-endurance cycling offers a natural laboratory for studying physiological responses under sustained extreme load. Continuous in-race monitoring is rarely reported. The aim of this study was to investigate the feasibility of a multimodal framework of physiological parameters including metabolic, cardiovascular, and muscle-mechanical patterns during an ultra-endurance event.
- ▶ **Approach:** This study stress-tests a multimodal framework of physiological parameters of a 58-year-old male athlete during the Race Across America (RAAM) 2024, covering 4933 km in 11 d from Oceanside, California, to Atlantic City, New Jersey. Parameters included energy expenditure, continuous blood glucose levels, heart rate, power output, passive muscle stiffness and resting tone, as well as sleep times.
- ▶ **Main results:** The multimodal monitoring toolkit proved feasible and provided continuous, physiological measurements throughout the RAAM, enabling the observation of the following physiological changes: The athlete lost 2.3 kg of total weight and had an estimated energy deficit of 21 169 kcal. Blood glucose levels decreased over the course of the RAAM (0.92 mg dl⁻¹, $p < 0.001$), with an increased time spent below 100 mg dl⁻¹ ($p < 0.001$). Heart rate during cycling progressively decreased, stabilising at a plateau of 94 bpm. Power output-to-heart rate ratio initially dropped until day 7 before peaking on day 11. Mean passive muscle stiffness and resting tone increased during the race compared to baseline levels, with distinct response patterns observed between two leg muscles and one lower back muscle. The total sleep deficit was 65 h during the RAAM.
- ▶ **Significance:** Continuous, multimodal in-race physiological monitoring during the RAAM proved feasible and operationally useful, enabling real-time adjustments to pacing, fuelling and recovery. This framework offers a field-deployable template for ultra-endurance events. Future research should focus on larger, multi-participant studies and long-term follow-up to characterise the physiological responses to extreme endurance

PP-05-12 POSTER PRESENTATION – CLINICAL CASES & ORTHOPEDICS NR. 211

Oehme V, Haase R, Richter M, Hammerschmidt S, Nitzsche N

The relationship between functional performance tests and lung function parameters in people with chronic lung diseases

TECHNISCHE UNIVERSITÄT CHEMNITZ, Germany

- ▶ Chronic lung diseases are associated with reduced physical performance and decreased exercise tolerance. Cardiopulmonary exercise testing (CPET) is considered the gold standard for assessing integrative physiological capacity. Functional performance tests and patient-reported outcomes represent low-threshold alternatives; however, their validity has not yet been fully clarified. The aim of this study was to investigate the associations between routine diagnostic parameters and functional performance tests.
- ▶ In a prospective cross-sectional study, 165 patients with chronic lung disease (91 men / 74 women; age 65 [IQR 16] years; BMI 27.2 [IQR 7.7] kg·m⁻²) were assessed as part of routine diagnostics using pulmonary function testing (FEV₁, % predicted) and CPET (relative VO_{2peak}, relative peak power output). Additionally, functional performance was evaluated using the 1-minute sit-to-stand test (relative STS power, relPSTS), calculated based on repetitions, body mass, and displacement height, and subjective dyspnea was assessed using the modified Medical Research Council scale (mMRC). Linear regression models adjusted for age, sex, and BMI were used to examine associations.
- ▶ STS power was significantly associated with peak power output ($\beta = 0.667$; $p < 0.001$; $R^2 = 0.477$) and VO_{2peak} ($\beta = 0.218$; $p < 0.001$; $R^2 = 0.361$). FEV₁ was also associated with STS performance ($\beta = 0.193$; $p = 0.011$; $R^2 = 0.228$). The mMRC score was inversely associated with VO_{2peak} ($\beta = -0.433$; $p < 0.001$; $R^2 = 0.250$), peak power output ($\beta = -0.667$; $p < 0.001$; $R^2 = 0.401$), STS power ($\beta = -0.363$; $p < 0.001$; $R^2 = 0.207$), and FEV₁ ($\beta = -0.477$; $p < 0.001$; $R^2 = 0.319$).
- ▶ Functional performance tests such as the 1-minute sit-to-stand test capture limitations relevant to daily life and show stronger associations with CPET parameters than static pulmonary function measures. They represent a practical and cost-effective addition to clinical assessment but cannot replace CPET.

PP-06-01 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 148

Diktanaite D, Sonntag A, von Hösslin T, Wagner J, Konrad CJ, Marggraf M

Cardiac Adaptation to High-Intensity Functional Training: Characterization of the 'CrossFit Heart'

UNIVERSITY OF BASEL, Switzerland

- ▶ **Introduction:** CrossFit combines high-intensity metabolic conditioning, resistance training, Olympic lifting, and gymnastics, creating a unique cardiovascular load that is not fully captured by traditional endurance or strength training models. Whether this results in a distinct pattern of cardiac remodelling remains unclear.
- ▶ **Methods:** In this cross-sectional, single-centre study, 122 healthy adults (68 men, 54 women) underwent comprehensive resting transthoracic echocardiography and were classified as experienced CrossFit athletes (CFA, n=62), CrossFit beginners (CFB, n=29), or non-athletic controls (n=31). Cardiac chamber size, wall thickness, systolic and diastolic function, and valvular findings were assessed using current guideline-based reference values.
- ▶ **Results:** Mean left ventricular (LV) dimensions, LV mass index, and systolic function were similar across groups. In contrast, experienced CrossFit athletes demonstrated a predominance of concentric remodelling features. Relative wall thickness > 0.42 was present in 61% of male and 68% of female CFA athletes, while right ventricular wall thickness ≥ 5 mm occurred in 63% of men and 26% of women. Despite these structural changes, CFA athletes showed enhanced LV relaxation (higher lateral e'), with no evidence of chamber dilatation, elevated filling pressures, right ventricular dysfunction, or clinically relevant valvular disease.
- ▶ **Conclusion:** Recreational CrossFit training is associated with a distinct and apparently physiological cardiac phenotype characterised by biventricular concentric remodelling, preserved chamber size, and enhanced diastolic function. This pattern differs from the classic endurance heart and from conventional HIIT, suggesting that CrossFit may represent a unique pressure-dominant 'athlete's heart' phenotype.

PP-06-02 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 117

Groesser V, Weyh C, Frech T, Sommer N, Eder K, Most A, Sossalla S, Krüger K, Bau

Decline in Cardiorespiratory Fitness and its Association with Vascular Aging and Subclinical Atherosclerosis in Healthy Older Adults: A Three-Year Longitudinal Study

JUSTUS-LIEBIG UNIVERSITÄT GIESSEN, Germany

- **Background:** Aging is associated with progressive deterioration of vascular function and cardiovascular risk. Cardiorespiratory fitness (CRF) is closely associated with cardiovascular health, yet longitudinal data in healthy older adults remain limited.
- **Methods:** This study examined three-year changes in vascular and echocardiographic parameters in older adults and their associations with CRF and muscle strength. Forty-nine participants (mean age 63.8 ± 3.8 years) underwent vascular assessments (brachial/central blood pressure (BP), pulse wave velocity (PWV), augmentation index), echocardiography, CRF testing via spirometry to determine $\dot{V}O_{2peak}$, muscle strength testing, and carotid sonography at baseline and after three years. Participants were grouped by carotid plaque status: no atherosclerosis, existing atherosclerosis, or newly developed atherosclerosis.
- **Results:** Over three years, CRF and muscle strength (grip strength, leg flexion) declined significantly (all $p < 0.005$), while systolic BP ($p = 0.042$), brachial-ankle PWV ($p = 0.006$), and echocardiographic parameters including aortic root diameter and ventricular dimensions increased (all $p < 0.001$). Participants with newly developed atherosclerosis showed the greatest CRF decline ($p = 0.012$). Changes in CRF were inversely associated with changes in systolic, diastolic, and central BP (all $p < 0.01$). Declines in leg flexion strength were also linked to larger BP increases. Participants maintaining >90% of baseline $\dot{V}O_{2peak}$ had significantly smaller BP increases.
- **Conclusion:** These results indicate that vascular aging progresses measurably within a few years in clinically healthy older adults and is associated with declines in CRF and muscle strength. Preservation of CRF is linked to more favorable vascular aging profiles and a lower prevalence of newly developed atherosclerosis.

PP-06-04 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 236

Grams L, Kück M, Lödding P, Tegtbur U

From Prevention to Protection: Impact of a Six-Month Individualized Endurance Program on the Cardiovascular and Metabolic Health of Pre- and Post-menopausal Women

HANNOVER MEDICAL SCHOOL, Germany

- **Background:** The menopausal transition is associated with significant hormonal fluctuations that pose a substantial threat to female health, often leading to an increased risk of cardiovascular diseases, metabolic syndrome, and other chronic conditions. This physiological shift frequently results in adverse changes in blood pressure, lipid profiles, and body composition. To address these risks through non-pharmacological interventions, the REBIRTH active women study at Hannover Medical School (MHH) investigated the impact of a structured exercise regime. In this large-scale trial, 265 healthy, sedentary, middle-aged (45–65 years) women underwent a six-month, individually tailored endurance training program to evaluate its potential in mitigating menopausal health declines and optimizing the cardiovascular risk profile.
- **Methods:** A total of 136 women were randomized into a waitlist control group, while 129 participated in an exercise group completing a six-month, individualized endurance program. From the exercise group, 101 women of pre- and post-menopausal status were included in the final analysis.
- **Results:** Analysis separated by menopausal status (pre-menopausal (PreM, n=45) and post-menopausal (PM, n=56) showed comparable improvements in cardiovascular fitness ($\dot{V}O_{2max}$) after six months. However, post-intervention, the PM group exhibited significantly lower fat-free mass and a more unfavorable blood lipid profile (e.g., cholesterol, LDL, and triglycerides) compared to the PreM cohort. Conversely, the PreM group showed a significantly greater reduction in fat mass post-intervention.
- **Conclusion:** While both cohorts achieved significant improvements in $\dot{V}O_{2max}$, post-menopausal women retained a higher risk profile for cardiovascular and chronic diseases. This is highlighted by persistently lower fat-free (metabolically active) mass and less favorable lipid levels. Since moderate endurance training appears insufficient to fully counteract these specific menopausal shifts, future interventions should integrate strength training and High-Intensity Interval Training (HIIT) to maximize metabolic health and provide essential mechanical loading for osteoporosis prevention.

PP-06-03 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 118

Brockhaus M, Peter R, Natale M, Friedmann-Bette B

Dysfunctional breathing patterns detected by cardiopulmonary exercise testing in post-COVID patients

UNIVERSITÄTSKLINIK HEIDELBERG, Germany

- **Background:** Dysfunctional breathing has been described in individuals with persistent dyspnoea following SARS-CoV-2 infection. However, there is a lack of reliable detection methods for erratic breathing patterns. We wanted to find out if the statistical analysis of the VT/VE-curve during cardiopulmonary exercise testing (CPET) allows the discrimination between patients with persistent post-COVID symptoms (PCS) and fully recovered controls (CON).
- **Method:** In the longitudinal case-control study (part of EPILOC-study), 122 PCS and 91 CON underwent CPET using individualized ramp protocols on a cycle ergometer 6–12 months after a confirmed positive SARS-CoV-2 PCR test (phase 1). Approximately 14 months after phase 1 98 PCS and 61 CON were examined (phase 2). Besides analysis of the Wasserman panel, breath-by-breath CPET-data were analysed to quantify erratic breathing patterns using a non-linear saturation function based on VT/VE values, low coefficient of determination (R^2) indicating erratic breathing. For statistical analysis, a mixed linear model was applied.
- **Results:** In phase 1, estimated marginal means for R^2 did not differ significantly between PCS and CON. In phase 2, PCS had significantly lower R^2 values (0.68 ± 0.02) compared with CON (0.74 ± 0.03). In contrast, the VE/ $\dot{V}O_{2peak}$ slope was significantly higher in PCS (27.6 ± 0.6 vs. 26.4 ± 0.7) only during phase 1. Additionally, individuals with low R^2 (≤ 25 th percentile) showed significantly lower $\dot{V}O_{2max}$ ($\text{mL} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$) at both phases (phase 1: 26.2 ± 1.2 ; phase 2: 26.0 ± 1.2) than those with high R^2 (≥ 75 th percentile; phase 1: 28.4 ± 1.2 ; phase 2: 28.2 ± 1.3). Cognitive performance did not differ between the extreme R^2 groups.
- **Conclusion:** Dysfunctional breathing patterns were indicated in PCS by significantly higher VE/ $\dot{V}O_{2peak}$ slope in phase 1 and significantly lower R^2 for VT/VE in phase 2 than in CON. However, our findings do not allow a robust discrimination between PCS and CON. Higher aerobic performance point to more stable breathing patterns post-SARS-CoV-2 infection.

PP-06-05 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 219

Weber V, Tomaskovic A, Ochmann DT, Zentgraf S, Hillen B, Simon P

Impaired exercise capacity in post-COVID-19 condition is not explained by chronotropic incompetence

JOHANNES GUTENBERG-UNIVERSITY MAINZ, Germany

- **Background:** The pathophysiological mechanisms underlying persistent symptoms and reduced exercise capacity after severe acute respiratory syndrome coronavirus 2 infection (Post-COVID-19 condition: PCC) remain unclear, including the proposed contribution of chronotropic incompetence. The objective of this study was to explore physiological responses during cardiopulmonary exercise testing (CPET) to elucidate mechanisms associated with impaired exercise capacity.
- **Method:** Nineteen PCC patients and 19 matched healthy controls (sex, age, body mass index) completed a maximal symptom-limited CPET on a bicycle ergometer. The external workload was standardized between matched individuals until CPET termination in PCC patients, with healthy controls continuing to volitional exhaustion. Heart rate (HR) and oxygen consumption ($\dot{V}O_2$) were continuously measured. The HR/ $\dot{V}O_2$ slope (beats per minute/metabolic equivalent) was calculated as a measure of cardiovascular efficiency. Chronotropic incompetence was defined using the Wilkoff combined approach: peak HR < 80% HR reserve or metabolic chronotropic relationship slope < 0.80. Paired t-tests or Wilcoxon signed-rank tests were applied after Shapiro-Wilk normality testing; significance at $p < 0.05$.
- **Results:** Resting HR was significantly higher in PCC patients compared to controls (85 ± 13 vs. 74 ± 9 bpm; $p = 0.005$). At individual CPET termination, HR and $\dot{V}O_2$ were significantly lower in PCC patients compared to controls (140 ± 22 vs. 165 ± 15 bpm; 15.2 ± 4.8 vs. 24.7 ± 7.6 mL/min/kg; $p < 0.001$). While chronotropic incompetence criteria were met in 68% of PCC patients, the HR/ $\dot{V}O_2$ slope was significantly higher in PCC patients compared to controls (18.2 ± 5.6 vs. 12.3 ± 3.6 bpm/MET; $p < 0.001$), with a mean difference of 5.9 bpm/MET (95% CI 3.2–8.6; $p < 0.001$; Cohen's $d = 1.07$).
- **Conclusion:** PCC patients with impaired exercise capacity demonstrate disproportionately elevated HR responses across standardized workloads compared to matched healthy controls. This pattern of chronotropic excess – rather than chronotropic incompetence – suggests impaired cardiovascular efficiency as an important mechanism of exercise intolerance in this cohort, with implications for diagnostic classification and rehabilitation.

PP-06-06 POSTER PRESENTATION – SPORTS CARDIOLOGY

NR. 112

Barawi S, Happ K, Behringer M

Influence of Muscle Thickness, Subcutaneous Adipose Tissue, and Sex on Arterial Occlusion Pressure

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- ▶ **Introduction:** In blood flow restriction (BFR) training, cuff pressure is typically determined relative to arterial occlusion pressure (AOP), defined as the minimum pressure required to occlude arterial blood flow. AOP is influenced by factors such as limb circumference and body position. Because externally applied cuff pressure affects not only vascular structures but also surrounding tissues, local tissue characteristics may influence AOP. Therefore, this study investigated the influence of subcutaneous adipose tissue (SAT), muscle thickness of the rectus femoris (RF) and vastus lateralis (VL), and sex on AOP.
- ▶ **Methods:** Eighty-one healthy participants (52 women, 29 men; age 25.2 ± 3.3 years) underwent AOP determination using Delfi's Personalized Tourniquet System (Delfi Medical Innovations, Canada). Participants were seated with the hip flexed to $\sim 90^\circ$, and pneumatic cuffs (width 11.5 cm) were placed proximally on the thigh. The system automatically inflated the cuff until arterial blood flow was occluded.
- ▶ SAT thickness and muscle thickness of RF and VL were assessed using B-mode ultrasound (ACUSON Redwood, Siemens, USA). Measurements were performed at 50% of the distance between anatomical landmarks (RF: spina iliaca anterior inferior–patella; VL: greater trochanter–lateral epicondyle). Three images were obtained and averaged.
- ▶ **Results:** Multiple linear regression showed that the model significantly predicted AOP ($R^2 = 0.24$, $p < .001$). SAT was a significant positive predictor of AOP ($p = .014$), with AOP increasing by ~ 1.95 mmHg per mm increase in SAT. Male sex was associated with a 29.95 mmHg higher AOP ($p = .001$), whereas RF and VL muscle thickness were not significant predictors ($p > .05$).
- ▶ **Conclusion:** SAT thickness and sex are significant predictors of AOP. Increased SAT appears to influence the transmission of externally applied pressure to deeper vascular structures and thereby contributes to interindividual variability in occlusion pressure. These findings highlight the importance of individualized pressure determination in BFR training.

PP-06-07 POSTER PRESENTATION – SPORTS CARDIOLOGY

NR. 145

Müller M, Chaabene H, Donatius J, Müller P, von Salzen L, Königstein K

Preterm Birth and Arterial Stiffness in Children and Adolescents: The Compensatory Potential of Cardiorespiratory Fitness

OTTO-VON-GUERCKE UNIVERSITY MAGDEBURG, Germany

- ▶ **Background:** Preterm birth is associated with a 17-fold increased risk of heart failure, a 2.5-fold increased risk of hypertension, and a 53% increased risk of coronary heart disease later in life. One possible link is early vascular aging (EVA), defined as accelerated structural and functional biological aging of the vascular system. The PrEVAFit Study aims to assess the relationship of preterm-birth with clinical biomarkers of EVA.
- ▶ **Methods:** The study will investigate 60 adolescents (age 11–17) without severe exercise-limiting disease, born either preterm (gestational age 28+0 to 36+6 weeks) or term ($\geq 37+0$ weeks). To ensure adequate distribution of gestational age, at least 5 participants will be recruited per gestational week between 28 and 36 weeks. Cardiovascular risk (CVR) will be assessed using traditional biomarkers: blood pressure, LDL-cholesterol, body-mass-index, triglycerides and HbA1c. Macro- and microcirculatory Arterial Stiffness (AS) will be measured using brachial-ankle pulse wave velocity (baPWV) and static retinal vessel analysis (SVA). Motor fitness will be assessed using handgrip strength (HGS) and the standing long jump (SLJ). Cardiorespiratory fitness will be assessed as VO_{2peak} via spirometry. Multivariate regression models will be used to analyse the association of gestational age with baPWV and SVA parameters, controlling for birth weight, stage of puberty, sex and age. Mediation models will be used to analyse the effect of CVR exposure / VO_{2peak} / HGS / SLJ performance on this association.
- ▶ **Results:** We expect that lower gestational age will be associated with higher AS. We also expect that CVR exposure mediates a relevant proportion of the effect strength of this association.
- ▶ **Conclusion:** We expect that the PrEVAFit Study will provide evidence that preterm birth predisposes individuals to EVA already at a young age and that the reduction of CVR exposure, i.e. via regular physical activity, and a high cardiorespiratory fitness bear important preventive potential.

PP-06-08 POSTER PRESENTATION – SPORTS CARDIOLOGY

NR. 284

Özgün I, Özlevent EI, Balcioglu TH

Raverercise as a Music-Driven Physiological State: Cardiovascular and Autonomic Dynamics in a Single-Case Field Analysis

FENERBAHÇE UNIVERSITY, Turkey

- ▶ Electronic dance music (EDM) environments, characterized by high-tempo rhythms, genre transitions, and sensory stimulation, may induce physiological states in which elevated arousal is sustained over prolonged periods. These responses should be evaluated not only through linear indicators such as heart rate (HR), but also via non-linear metrics reflecting autonomic nervous system dynamics. Detrended fluctuation analysis (DFA- α_1), derived from RR interval time series, represents a key index capturing short-term fractal correlation.
- ▶ The aim of this study is to provide an analysis of cardiovascular and autonomic responses recorded in a live EDM environment. HR and heart rate variability (HRV) were monitored using a chest strap (Polar H10) during a 30-minute performance.
- ▶ Findings indicate a substantial and sustained cardiovascular load, with a mean HR of 157bpm and a peak value of 187bpm. HRV indices demonstrated marked parasympathetic withdrawal (RMSSD= 11 ms) alongside sympathetic predominance. During preprocessing, threshold-based artifact correction (medium filter: 0.25s) was applied, resulting in the correction of 84 beats (1.83% of total).
- ▶ Non-linear analysis revealed an overall DFA- α_1 value of ~ 1.15 , indicating a correlated physiological structure. Genre-specific differences showed slightly lower DFA- α_1 values (~ 1.09 in peak techno; ~ 1.04 in psy-trance), suggesting increased complexity in autonomic regulation.
- ▶ Although these preliminary findings yield DFA- α_1 values substantially above those associated with high-intensity physiological load (~ 0.75) in the literature, the participant's attainment of 100% HRmax and maintenance of an average of 84% HRmax throughout the recording support the conceptualization of a distinct physiological state termed "raverercise" (rave+exercise).
- ▶ Raverercise may be understood not only as sustained exertion but as a dynamic autonomic state modulated by musical structure. This study proposes a novel perspective for investigating the interaction between music, movement, and physiological regulation, and may contribute to a deeper understanding of these interrelated phenomena.

PP-06-09 POSTER PRESENTATION – SPORTS CARDIOLOGY

NR. 225

Krueger B, Landgraeber E, Jakobsmeier R, Reinsch D, Reinsberger C, Libuda L, Buyken A

Relevance of initial peak of blood glucose of low GI beverages for heart rate variability among young students

PADERBORN UNIVERSITY, Germany

- ▶ **Background and objectives:** Glycemic index (GI) measures the area under the curve in postprandial response to foods over 2 hours, ignoring values below baseline. Hence beverages can have a low GI due to a moderate 2h-response (e.g. isomaltulose) or due to a spike followed by a rapid decrease below baseline (e.g. fructose-glucose-saccharose mixtures in fruit juices). Since plasma glucose spikes affect the cardiac autonomic modulation with a decrease of heart rate variability (HRV), our hypothesis is that low GI beverages inducing a high initial peak after 30 minutes reduce time-domain HRV parameters.
- ▶ **Methods:** Data stemmed from $n=29$ students (age 22.7 ± 2.1 y; BMI 22.8 ± 2.7 kg/m², 58% female) participating in the cross-over study GlyCoBrain. On two separate days, after fasting overnight, they consumed 500 ml tap water with either 75g Isomaltulose (ISO) or fructose-glucose-saccharose (FGS). Capillary blood glucose was measured before and 30 minutes after the beverage consumption. Continuous blood glucose measurements (CGM) assessed the overall tissue glucose trends. Chest belt sensors assessed time intervals between two consecutive R-waves (RR) while subjects were in a resting sitting position. Time domain HRV parameters RMSSD (root mean square of successive differences of normal RR), SDNN (standard deviation of normal-to-normal RR) and mean heart rate (mean HR) were calculated from RR-waves 25–30 minutes after the beverage consumption. Effective sample rates > 5 min were measured. HRV responses to FGS compared to ISO were analysed using mixed-effects models.
- ▶ **Results:** Capillary blood glucose at 30 minutes was significantly higher ($p < 0.0001$) after FGS solution compared to the ISO solution. CGM data indicated the initial peak of glucose levels. SDNN, mean RR and mean HR, but not RMSSD were significantly different (all $p < 0.02$).
- ▶ **Conclusion:** Results of our small sample suggest that the low-GI FGS inducing a postprandial spike at 30 minutes may adversely affect HRV activity in young health adults.

PP-06-10 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 209

Lödging P, Beyer S, Kück M, Tegtbur U

Sex-specific differences in cardiorespiratory fitness in patients with chronic heart failure

HANNOVER MEDICAL SCHOOL, Germany

- **Background:** Chronic heart failure (CHF) is commonly caused by cardiovascular and metabolic conditions and is influenced by factors such as age, sex, socioeconomic status, and recurrent decompensations and hospitalizations. This analysis presents baseline data from the multicenter HTS Innovation Fund project investigating telemonitoring-supported exercise training in CHF patients (NYHA I–III; n = 699, 40.5% female, 59.5% male).
- **Methods:** For the present analysis, patients were stratified by sex and assigned to NYHA functional class I (n = 255) or NYHA functional classes II+III (n = 443). Among others, (cardiac-specific) laboratory parameters (NT-proBNP, CRP, γ -GT, Hb, TSH, CRP, GFR) and anthropometric parameters (age, weight, height, BMI) were taken. cardiorespiratory fitness (measured as peak power output in watts [PPO] and peak oxygen uptake [VO₂peak]) were assessed with stepwise cardiopulmonary exercise testing on a bicycle ergometer until objective or subjective maximal exertion. The Kansas City Cardiomyopathy Questionnaire (KCCQ) was used to quantify physical limitations, symptoms, self-efficacy, social interference and health related quality of life.
- **Results:** Expected sex differences in anthropometry were observed in both NYHA I and NYHA II+III. In both NYHA classes NT-proBNP, Hb, and γ -GT values were higher for male participants. There was no sex related difference in the KCCQ overall score in both NYHA classes. While PPO and PPO/KG-Bodyweight as well as VO₂peak were higher in men in both NYHA classes, the percent of predicted VO₂peak as a marker for cardiorespiratory fitness was higher in women in both groups (NYHA I: 73.4±17.6% vs 60.6±14.7%; NYHA II+III: 61.6±14.1% vs 44.4±10.4%).
- **Discussion:** Despite men exhibiting higher performance parameters, women achieved higher levels of cardiorespiratory fitness. This underscores the need for a gender-sensitive assessment of performance and goal-setting in clinical practice as well as a sex-specific evaluation of performance data.

PP-07-01 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 163

von Salzen L, Chaabane H, Donatius J, Müller M, Müller P, Königstein K

Association of prematurity and cardiorespiratory fitness

OTTO-VON-GUERCKE-UNIVERSITÄT, Magdeburg, Germany

- **Background:** Preterm birth is associated with significantly increased cardiovascular disease burden, i.e. an up to 17-fold increased risk of chronic heart failure, and a 2.5-fold increased risk of hypertension. Previous studies indicate that individuals born preterm often present with reduced cardiovascular and motor fitness. The PrEVAFit Study aims to assess the association of prematurity with elevated cardiovascular risk and its moderation by cardiorespiratory and motor fitness in children and adolescents born preterm.
- **Methods:** The study will assess cardiovascular risk, the clinical vascular phenotype, as well as motor and cardiorespiratory fitness in 60 adolescents aged 11 to 17 years without severe exercise-limiting disease who were either born pre-term (<37 weeks of gestation) or term (≥37 weeks of gestation). To ensure adequate distribution across gestational age spectrum we will consecutively recruit at least 5 participants per gestational week between 28 and 36 weeks of gestation. Motor fitness will be assessed using handgrip strength (dominant hand; HGS) and the standing long jump (SLJ). Cardiorespiratory fitness will be assessed as VO₂peak via spiroergometry. Cardiovascular risk will be predicted with traditional biomarkers (e.g. blood pressure, LDL-cholesterol, triglycerides, body-mass-index, and HbA1c). The association of gestational week with cardiovascular risk will be analysed using multiple linear regression models controlling for birth weight, age, pubertal stage and sex. Mediation models will be used to analyse the effect of VO₂peak / HGS / SLJ performance on this association.
- **Results:** We expect that lower gestational age will be associated with higher cardiovascular risk. We also expect that lower cardiorespiratory and motor fitness mediate a relevant proportion of the effect strength of this association.
- **Conclusion:** We expect that the PrEVAFit Study will contribute to the mounting evidence that pre-term birth predisposes individuals to increased cardiovascular risk and that cardiorespiratory and motor fitness are potential targets to mitigate for prevention.

PP-06-11 POSTER PRESENTATION – SPORTS CARDIOLOGY NR. 192

Kühn C, Glowka S, Mayer F, Halle M, Fiorentini C

Efficacy and Limitations of Pharmacological Therapy in Isolated Exercise-Induced Hypertension: A Retrospective Analysis

TECHNISCHE UNIVERSITÄT MÜNCHEN, Germany

- **Background:** Exercise-induced hypertension (EIH) independently predicts future cardiovascular events and sustained hypertension. While guidelines prioritize lifestyle modifications for high-normal blood pressure, the optimal strategy, specifically the efficacy of pharmacological versus lifestyle interventions on peak blood pressure (BP) and recovery hemodynamics, remains poorly defined. Identifying effective treatments is crucial for ensuring safe exercise participation and optimizing cardiovascular risk in active individuals.
- **Methods:** This retrospective study identified 133 patients (mean age 50±13 years; 77.4% male, BMI 25±3 kg/m²) with EIH from a pool of 1,258 records. Inclusion required a baseline and a subsequent clinical follow-up evaluation, each featuring maximal exercise testing. Based on European Society of Cardiology (ESC) criteria, EIH was defined as peak systolic BP (SBP) ≥220 mmHg (men) or ≥200 mmHg (women). Participants were stratified by therapeutic strategy: monotherapy (n=67), combination therapy (n=16), or lifestyle modification (n=50), with a median 11-month follow-up. A significance level of $\alpha = 0.05$ was determined a priori.
- **Results:** Compared to lifestyle modifications, pharmacological interventions significantly reduced peak SBP. Monotherapy showed the most substantial improvement, with peak SBP decreasing from 241.9±20.5 to 221.6±19.9 mmHg (-20.3±20.5, p<0.01). Combination therapy also achieved a significant reduction (-18.1±19.9 mmHg, p=0.01; 244.1±15.6 to 225.9±25.7 mmHg), whereas the lifestyle group showed no significant change (-4.6±27.3 mmHg, p=0.12; 230.4±20.0 to 225.8±27.9 mmHg). Furthermore, monotherapy improved 5-minute recovery (SBP: -6.2±20.7 mmHg, p=0.01; diastolic BP: -4.5±9.3 mmHg, p<0.01), in contrast to combination therapy (all p>0.40).
- **Conclusions:** Pharmacological therapy, particularly monotherapy, significantly improves the hemodynamic response at maximal exercise and in recovery compared to lifestyle modifications. However, mean peak SBP often remained above the 220/200 mmHg ESC threshold, highlighting a persistent clinical challenge. The limited sample size of the combination group warrants caution in comparing efficacy. Further studies are needed to identify optimal therapeutic strategies to ensure safe exercise participation and long-term cardiovascular health.

PP-07-02 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 295

Uldrian H, Greule C, Fahrner M, Brand R, Timme S, Nieß AM, Sudeck G

Children's motor and psychosocial swimming ability – Evaluating „Wundine on Wheels“ using a pre-post design

UNIVERSITY OF TUEBINGEN, Germany

- **Background:** Learning to swim is important for children's physical and psychosocial development, a topic addressed in international aquatic literacy concepts. However, while swimming is mandated in the curricula of many countries, numerous primary school-aged children struggle to swim safely. Insights into conditions for skill development in terms of aquatic literacy are highly relevant.
- **Method:** "Wundine on Wheels" is a mobile teaching pool that enables three-month swimming courses to be held at educational institutions without access to a suitable body of water. The program's effects on children's aquatic literacy were analyzed using the Mobile Activity Lab (MAL) at three locations in Baden-Württemberg. Data collection was conducted using a pre-post design focusing on four outcome criteria: (1) perceived water competence, (2) water affinity, (3) basic aquatic motor skills, and (4) psycho-social aspects of aquatic literacy. In accordance with the study design, selected inferential statistical methods were applied for data analysis.
- **Results:** The sample consists of 75 children aged 4–11 years (27 girls, 48 boys). Significant improvements were observed across all four outcome criteria. Effect sizes were large for basic aquatic motor skills and moderate for both perceived water competence and psychosocial aspects of aquatic literacy. Small effects were found for water affinity.
- **Conclusion:** It can be concluded that the swimming courses offered as part of the "Wundine on Wheels" program contribute to the holistic improvement of children's swimming ability within the framework of aquatic literacy. In particular, the effects regarding the motor domain emphasize the program's high relevance as a supportive measure in the process of developing basic aquatic skills in children.

PP-07-03 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 297

Soffner M, Tomschi F, Hilberg T

Competitive gaming affects pressure pain sensitivity but not muscle stiffness: a randomized controlled crossover trial

UNIVERSITY OF WUPPERTAL, Germany

- ▶ **Background:** Competitive esports involve prolonged static postures combined with cognitively and emotionally demanding tasks. While previous research has focused on cardiovascular and stress-related responses, little is known about acute neuromuscular and pain-related adaptations. Therefore, this study investigated whether a one-hour competitive gaming session induces changes in muscle stiffness and pressure pain sensitivity beyond passive sitting.
- ▶ **Methods:** Sixteen healthy males participated in a counterbalanced randomized crossover trial, completing a 1-hour competitive gaming session in the sports simulation game EA FC and a passive control condition (documentary viewing), both performed seated. Pressure pain thresholds (PPT) were measured at the trapezius, adductor pollicis, and tibialis anterior, and additionally analyzed as a pooled value across all sites. Muscle stiffness was assessed using myotonometry at the same sites with the addition of the sternocleidomastoid. Measurements were conducted at baseline (T0) and immediately post-intervention (T1). Data were analyzed using repeated-measures ANOVA. The study was preregistered (DRKS00034399).
- ▶ **Results:** Significant condition $\times$ time interactions were observed for pooled PPT across all sites ($p = 0.012$), with an increase from 60.8 ± 6.5 N to 66.9 ± 6.7 N in the gaming condition and no substantial change from 60.0 ± 5.5 N to 59.0 ± 4.8 N in the control condition. When analyzed individually, a significant interaction was found for the adductor pollicis ($p = 0.040$), with PPT increasing after gaming (59.1 ± 25.0 N to 63.6 ± 25.5 N) and decreasing in the control condition (59.7 ± 23.1 N to 56.5 ± 18.5 N). Muscle stiffness showed no significant effects.
- ▶ **Conclusion:** A one-hour session of competitive gaming did not affect muscle stiffness but was associated with increased pressure pain thresholds, indicating reduced pain sensitivity compared to passive sitting. These findings suggest that competitive gaming induce short-term alterations in pain sensitivity without affecting muscle stiffness.

PP-07-05 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 248

Daniel L, Mohr E, Räss M, Meyer T

Does a standardized warm-up improve fat oxidation outcomes and test-retest reliability during FatMax testing?

UNIVERSITÄT DES SAARLANDES, Germany

- ▶ Measuring the maximal rate of fat oxidation (MFO) and its corresponding power output (FatMax) is common practice in endurance sports and clinical settings. Most protocols use short warm-ups (<10 min), 3-minute stages, and 4–6 data points (Amaro-Gahete et al., 2019). However, key regulators of fat metabolism — including plasma insulin levels and fat oxidation rates — require 30–60 minutes of exercise to stabilize. Current protocols may therefore not adequately reflect the metabolic state they intend to measure, which may partly explain the moderate test-retest reliability reported in the literature.
- ▶ This study included two pre-tests to determine VO_2max and individual warm-up duration, followed by four FatMax tests: two with and two without a standardized warm-up. Diet was controlled via overnight fast, standardized breakfast, and fixed testing times. Statistical analysis included a 2 $\times$ 2 ANOVA and intraclass correlation coefficients (ICC) as well as coefficient of variation (CV) to assess test-retest reliability.
- ▶ The ANOVA revealed no significant effects of condition, test order, or their interaction on FatMax (all $p > .52$). For MFO, a significant main effect of condition was found ($F(1,18) = 13.59$, $p = .002$, $g_{es} = .10$), with higher values following a warm-up and no test order effect or interaction (both $p > .63$). Test-retest reliability was good for FatMax ($\text{ICC} = 0.82\text{--}0.83$, $\text{CV} = 11.7\text{--}13.8\%$) and moderate for MFO ($\text{ICC} = 0.67\text{--}0.71$, $\text{CV} = 17.3\text{--}24.0\%$), with notably better reliability under the warm-up condition ($\text{CV} = 17.3\%$ vs. 24.0%). The study shows that adding a standardized warm-up significantly increased MFO and improved measurement reliability.

PP-07-04 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 190

Wolff DW, Schneeweß P

Decreasing Intervals Are Not Superior to Other Interval Structures for $\text{VO}_{2\text{max}}$ Utilization: Evidence of Large Inter-Individual Variability

UNIVERSITÄT TÜBINGEN, Germany

- ▶ High-intensity training (HIT) is considered an effective method for eliciting maximal oxygen uptake ($\text{VO}_{2\text{max}}$) and improving endurance performance. The aim of this study was to directly compare three interval structures regarding their effectiveness in maximizing time spent at high percentages of $\text{VO}_{2\text{max}}$.
- ▶ Fifteen trained endurance athletes completed three high-intensity training protocols (Decreasing Intervals [DI], Long Intervals [LI], Short Intervals [SI]) on an SRM ergometer in a randomized crossover design. Exercise intensity was based on each participant's individual five-minute maximal power output. Respiratory gas exchange was measured breath-by-breath.
- ▶ The primary outcome was accumulated time $\geq 90\%$ $\text{VO}_{2\text{max}}$ ($t \geq 90\%$ $\text{VO}_{2\text{max}}$). In addition, ventilatory, cardiovascular, metabolic, and perceptual parameters were assessed. No significant differences in $t \geq 90\%$ $\text{VO}_{2\text{max}}$ were observed between protocols ($F(2,22) = 0.79$; $p = 0.47$). At the group level, the SI protocol yielded the highest values, whereas DI was the most effective protocol for the majority of participants.
- ▶ Significant differences were found in mean VO_2 ($F(2,22) = 5.95$; $p = 0.009$) and relative $\text{VO}_{2\text{max}}$ utilization ($\chi^2(2) = 9.244$; $p = 0.010$), with SI showing higher values than LI. Breathing frequency ($F(2,22) = 10.38$; $p < 0.001$) and heart rate ($F(2,22) = 12.74$; $p = 0.002$) were higher in DI and SI compared to LI. Lactate, blood pH, relative power output, and perceived exertion (RPE) did not differ significantly (all $p > 0.05$). Correlation analyses revealed no consistent associations between $t \geq 90\%$ $\text{VO}_{2\text{max}}$ and the examined variables.
- ▶ Overall, no interval structure proved to be universally superior. Instead, the results highlight pronounced inter-individual differences and emphasize the importance of personalized training approaches, as well as consideration of individual VO_2 kinetics.

PP-07-06 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 210

Gartmann J, Schönbach DMI, Bernewitz L, Beyer S, Braun AC, Scholze P, Haverich A, Haufe S, Tegthür U

Increasing physical activity in adolescents during school: A cluster-randomized controlled trial

MEDIZINISCHE HOCHSCHULE HANNOVER, Germany

- ▶ **Background:** Physical inactivity among adolescents is becoming an increasing issue in current and future health policy. The World Health Organization recommends 60 minutes of moderate- to vigorous-intensity physical activity per day for adolescents. As behaviour in adolescence shapes habits in adulthood, primary prevention should be contextualised within the adolescents' social environment. The aim of the project 'Rebirth Active School – Project Pattensen' was to enhance physical activity behaviour to at least 60 minutes on each school day in grades 7 and 8 without compromising the physical education curriculum.
- ▶ **Method:** This monocentric, prospective, interventional cluster-randomized controlled trial with a waiting-control group design was conducted at a cooperative secondary school in a town near Hannover, Germany ($N = 84$). Physical activity was implemented through short exercise sequences during lessons. Body composition was measured using a bioimpedance scale. Adherence to the intervention was assessed using wearable devices worn throughout the intervention phase, as well as through written records.
- ▶ **Results:** There were no significant changes in the body composition during the intervention period. The written records indicated an average of 49 minutes of physical activity at school per week, corresponding to less than 10 minutes per day. The average number of steps taken during the school day in the intervention group was approximately 35% higher. The energy expenditure measured by the wearable was around 30% higher in the intervention group.
- ▶ **Conclusion:** The intervention did not prove acceptable and was not implemented as intended. Therefore, a need for modifications remains, for example, improvement of teachers' commitment to document and implement exercises during regular school lessons via videos and tracking on a web app.

PP-07-07 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 293

Wochner F, Uldrian H, Schmidt J, Nieß AM

Participation profile, training frequency and sustained exercise participation within a workplace health promotion program

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Background:** Workplace health promotion (WHP) is particularly relevant in hospital settings, where employees face high physical and psychological demands. Structured programs with physical activity can improve fitness, metabolic parameters, back health and stress resilience, while low-threshold, workplace-based programs may increase the amount of physical activity. This study examines health data among participants in a WHP program focusing on health risk factors and physical activity behavior.
- **Methods:** Analyses are based on descriptive data from employees who completed a workplace health promotion program including an initial medical examination with blood testing and performance diagnostics, followed by the offer to participate in a ten-week training intervention in the clinics training center. Recorded variables included health data focusing on metabolic risk factors, back health and exercise frequency.
- **Results:** Actually, data of 712 employees was collected (n=538 females, 44.4 ± 12.6 yrs.; n=174 males, 41.8 ± 11.6 yrs.). After excluding participants with incomplete data, 623 individuals were analyzed. 53.0% showed at least one cardiometabolic risk factor. Hypercholesterolemia was present in 14.9%, systolic hypertension in 25.2% and overweight in 31.5% of participants. Men (n=159) were more frequently affected than women (n=464; 59.1% vs. 50.9% with ≥1 risk factor). In addition, 13.1% of women and 5.7% of men had a BMI ≥ 30 kg/m². Back pain was reported by 15.1% of women and 8.2% of men. Training frequency data was available for the entire population; 49% attended five or fewer sessions over ten weeks in the training center. Follow-up data was available for 576 participants, of whom 110 (19%) continued training at the institution.
- **Discussion:** The findings indicate that the program reaches employees with relevant health needs, but training participation rates were low. Although a subgroup showed willingness to continue training, the results suggest that additional strategies are needed to improve adherence and support the integration of physical activity into everyday life.

PP-07-09 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 286

Schönbach DMI, Bernewitz L, Gartmann J, Homeyer D, Braun C, Holzward D, Kück M, Melk A, von der Born J, Haverich A, Hauße S, Tegbur U

Rebirth active School – Baseline data of a cluster randomized waitlist-controlled trial on primary school students' health in the region of Hanover

HANNOVER MEDICAL SCHOOL, Germany

- **Background:** Fitness is rated poor (D+) in Germany's 2022 Report Card on Physical Activity for Children and Adolescents. Based on the KiGGS Wave 2 (2014-2017), 15.4% of children and adolescents in Germany are overweight and 5.9% obese. The KiGGS Wave 1 (2009-2012) showed that 78.2% of children eat breakfast at home every weekday. A reference value of 79.0 for health-related quality of life based on proxy-reports of children aged 7 to 10 was provided by the KiGGS Baseline study (2003-2006). Rebirth active School is an intervention program aimed at promoting students' health in the long term. To evaluate its effectiveness, a cluster randomized waitlist-controlled trial (pre, post, follow-up) with embedded process evaluation was conducted at 33 primary schools in the region of Hanover (2021-2025). Our baseline data provides more recent knowledge on the aforementioned variables.
- **Method:** The German Motor Test evaluated fitness (excluding balancing backwards), bioimpedance analysis assessed weight status (as classified by the World Health Organization), an item following the KIDMED test revealed breakfast habits, and the KINDL-R questionnaire investigated health-related quality of life based on self-report. Data was analyzed descriptively.
- **Results:** Overall, 1,245 children (51.1% male; 7.9 ± 0.6 years; socioeconomic status: 30.8% low, 48.0% medium and 15.7% high) participated. Mean total Z-score of fitness was 98.4 (excluding stand and reach). In our sample, 14.7% of children were overweight and 4.9% obese. The majority (69.3%) ate breakfast daily. Mean sum score of health-related quality of life was 72.9.
- **Conclusion:** Fitness was considered average. The prevalence of both overweight and obesity have remained comparable. As the habit of eating breakfast daily tended to decline, action is warranted. Health-related quality of life was slightly below the age-specific reference value.

PP-07-08 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 206

Beyer M, Boyen J, Tegbur U, Hauße S

Physically active versus passive commuting characteristics and health-related outcomes of members at Hannover universities (DiNaMo-active): A prospective observational study

HANNOVER MEDICAL SCHOOL, Germany

- **Background:** Motorized vehicles, public transport or active modes of commuting (e.g. walking or cycling) intersect with multiple dimensions of sustainability, including environmental protection, public health, and economic efficiency. Choosing active modes of commuting offers a practical way to incorporate regular physical activity into daily routines, while also contributing to broader sustainability goals by reducing emissions and promoting healthier, more resilient communities.
- **Methods:** DiNaMo-active is a prospective, multicenter, observational trial to assess commuting habits and estimate their impact on health-related and economic issues at four higher educational institutions in Hannover. The outcomes include distance, time and intensity on the way to the university.
- **Results:** Forty-three participants are included for now (age: 44.7 ± 14.7 yrs. BMI: 23.9 ± 3.5 kg/m², 67% women). Cycling is the preferred mode of active commuting (95%), while public transportation (51%) and private car use (49%) are equally common as passive commuting modes. Duration and distance of the commute do not significantly differ between active and passive commuting (active 27.5 [21.9; 45.1] min; 5309 [3249; 9215] m; passive 30.0 [24.8; 38.5] min; 6724 [3430; 9924] m). Heart rate is significantly higher during active commuting compared to passive commuting (active 115 [107; 124] bpm, passive 82 [75; 91] bpm; p<0.01). This corresponds to 64.3 ± 9.6 % of the age-predicted maximum heart rate during active commuting, indicating moderate-intensity physical activity, in contrast to very light intensity during passive commuting (46.8 ± 6.8 %).
- **Discussion:** Sustainability is a critical research topic for future planetary well-being. The integration of sustainable and active commuting, offering both individual health and community benefits, remains rarely researched. Preliminary results show that daily active commuting involving 27.5 minutes of moderate-intensity physical activity nearly meets WHO recommendations, while also reducing CO₂ emissions, highlighting a dual benefit for health and the environment.

PP-07-10 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 273

Erz G, Wensing M, Nieß AM, Enck P, Weimer K

Subjective Perceived Exertion at the Individual Anaerobic Threshold and Its Association with Psychological Parameters – Evidence from the TwinFit Study

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Introduction:** Whether psychological everyday parameters modulate perceived exertion during standardised exercise testing remains poorly understood. Using the twin design of the TwinFit Study – which enables genetic control through within-pair comparisons – we examined associations between the Borg scale rating of RPE (Ratio of Perceived Exertion) at the individual anaerobic threshold (IAT) and psychological health instruments including somatic symptom load, depression, anxiety, stress, and quality of life.
- **Methods:** 49 twin pairs (n=98; 31 monozygotic [MZ], 18 dizygotic [DZ]; 31 female pairs) underwent graded bicycle ergometry with lactate measurements. The Borg rating at the IAT (Dickhuth criterion) was correlated with 14 validated instruments (PHQ-15, PHQ-9, GAD-7, PHQ-S, SF-12, PSQ-20, LOT-R, SMM, MHLC). Partial Spearman correlations were computed and adjusted for relative VO₂-max, percentage of HRmax at IAT, and relative power output (Watt/kg). Subgroup analyses were stratified by zygosity and sex.
- **Results:** At the group level, no significant association was found between Borg rating and psychological parameters (all p>0.05, unadjusted). After physiological adjustment, PHQ-15 (somatic symptom burden) showed a significant inverse partial correlation with the Ratio of Perceived Exertion (RPE) or Borg (r=-0.282, p=0.007). This effect strengthened after adjustment (Δr=-0.094), suggesting fitness-independence. Subgroup analyses confirmed this finding in MZ pairs (r=-0.333, p=0.012) and women (r=-0.359, p=0.006). GAD-7 (anxiety) remained significant in women (r=-0.264, p=0.046). At the within-pair level, PHQ-9 (depression) became significant after adjustment (r=-0.294, p=0.048), indicating that the relatively more depressed co-twin reports higher perceived exertion.
- **Discussion:** PHQ-15 and PHQ-9 show opposing directions, reflecting distinct mechanisms: somatic habituation (blunted perception) versus affective exhaustion (amplified perception). All findings are exploratory; Bonferroni correction retains significance only for PHQ-15 overall (p=0.007).
- **Conclusion:** Somatic symptom load is the most robust, fitness-independent predictor of perceived exertion at the IAT. Psychological parameters modulate exercise perception via distinct, instrument-specific mechanisms.

PP-07-11 POSTER PRESENTATION – FITNESS, TRAINING & HEALTH NR. 153

Nader D, Groher J, Weber I, Hautsch N, Scharhag J

Validity of VO₂max Estimates (Whoop, Polar, Seismofit and Ergonizer lactate software) in Comparison with CPET in Austrian Elite Rowers - Experiences within the AIROW-study

UNIVERSITY OF VIENNA, Austria

- **Purpose:** The purpose of this study was to compare maximal oxygen uptake (VO₂max) values obtained from cardiopulmonary exercise testing (CPET) with estimation methods and to evaluate their validity and applicability in elite athletes.
- **Methods:** Seventeen elite rowers (9 women, 22±4 years; training volume 18±5 h/week) completed CPET and alternative VO₂max estimations (Whoop, Seismofit, Polar and lactate software). Validity was evaluated using paired t-test, intraclass correlation coefficient (ICC), mean absolute percentage error (MAPE), Pearson correlations and Bland–Altman analysis.
- **Results:** Across all athletes, mean cycling CPET-derived VO₂max was 53.6±5.1 mL·kg⁻¹·min⁻¹. Seismofit underestimated VO₂max (50.1±5.1; p = 0.006, ICC = 0.65), whereas lactate-based estimation overestimated VO₂max (66±6.7; p < 0.001, ICC = 0.46). Polar (54.4±7.4; p = 0.640, ICC = 0.71) and Whoop (55.8±5.0; p = 0.028, ICC = 0.82) showed the closest agreement with CPET (MAPE = 8.3% and 6.6%). All methods correlated significantly with CPET-derived VO₂max (r = 0.57–0.85, p ≤ 0.01), with the strongest association for the lactate method (R² = 0.71). Bland–Altman analysis showed that all methods of estimation contain a systematic bias, and that this is most pronounced for the lactate-based estimation and lowest for Whoop. Overall, Whoop and Seismofit demonstrated moderate agreement with CPET, whereas lactate-based and Polar estimates showed greater individual variability.
- **Conclusion:** Long-term wearables, such as Polar and WHOOP, showed more accurate estimations of VO₂max values compared to single time-point methods, but remain insufficient for precise measurements in elite athletes. While they may support trend monitoring, accurate and individualized performance diagnostics require laboratory-based CPET conducted by qualified personnel.

PP-08-01 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 224

Tirekoglu P, Walscheid R, Bothur E, Samel S, Hacker S, Reichel T, Krüger K

Analysis of innovative biomarkers for stress sensitivity and reliability in load management

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN, Germany

- **Background:** Physical exertion elicits a systemic stress response accompanied by the release of blood-based stress markers. Due to their sensitivity to inflammatory, muscular, and cellular stress responses, these biomarkers may enable the characterization of physiological response kinetics and allow for the quantification of exercise load. This test-retest study investigated the exercise-induced response, recovery kinetics, and test-retest reliability of four innovative biomarkers (calprotectin [CP], heart-type fatty acid-binding protein [hFABP], heat shock protein 90 [HSP90], and S100 protein [S100]) following standardized intensive endurance exercise.
- **Methods:** Sixty-one healthy participants (31 males, 30 females; 19–43 years) underwent a performance test to determine endurance capacity. After one week of rest, participants completed two identical 60-minute exercise sessions according to their relative individual anaerobic threshold separated by 4 weeks. Blood samples were collected pre-exercise, immediately post-exercise, and at 3 and 24 hours post-exercise, and quantified using Enzyme-linked Immunosorbent Assay (CP, hFABP, HSP90) or Chemiluminescence-Immunoassay (S100). Data were analyzed using JASP (v0.95.40.0) with two-way repeated-measures ANOVA and Bonferroni-corrected post hoc tests. Reliability was evaluated via intraclass correlation coefficients (ICCs).
- **Results:** All biomarkers revealed significant within-subject effects across four time points, CP: F(3,348)=458.74, p<.001; hFABP: F(3,300)=170.25, p<.001; HSP90: F(3,243)=21.13, p<.001; S100: F(3,309)=140.39, p<.001. A significant interaction between time point and exercise session was found for hFABP: F(3,300)=4.19, p=.006, and S100: F(3,309)=2.77, p=.042. No significant main effect of exercise session was observed (all p>.05). Reliability analyses across all biomarkers and exercise sessions showed ICCs between .68 and .98. Mean ICCs were .94 for hFABP, .88 for S100, .83 for HSP90, and .76 for calprotectin.
- **Conclusion:** These biomarkers demonstrated a sensitive response to exercise stimuli and good-to-excellent test-retest reliability. Notably, hFABP showed the highest stability, whereas calprotectin exhibited the lowest. The absence of significant differences between exercise sessions supports their suitability as reliable load management biomarkers.

PP-08-02 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 277

Yoshikawa A, Iizuka M, Kanamaru M, Ohtaki H, Izumizaki M

Bridging Animal and Human Exercise Physiology: Quantitative Analysis of Age-Related Responses to Incremental Exercise in C57BL/6 Mice

SHOWA MEDICAL UNIVERSITY, Japan

- **Introduction:** Exercise exerts a wide range of beneficial effects, including improvements in physical performance, extension of healthy life expectancy, and psychological well-being. Despite these benefits, many underlying mechanisms remain to be elucidated. To address this, animal models are essential; however, a standardized method for the quantitative evaluation of exercise intensity in models such as mice has not been fully established. This study aimed to quantitatively assess physiological responses to incremental exercise in young and middle-aged C57BL/6 mice.
- **Methods:** Both young (2-month-old) and middle-aged (10-month-old) mice were subjected to an incremental exercise test. Oxygen uptake (VO₂), carbon dioxide production (VCO₂), respiratory rate, tidal volume, and minute ventilation were continuously measured using a metabolic chamber. Additionally, blood lactate levels were assessed to evaluate metabolic responses.
- **Results:** The results revealed distinct patterns of physiological responses corresponding to different exercise intensities. VO₂ and VCO₂ were significantly lower in middle-aged mice than in young mice, whereas ventilatory responses were similar between groups. The ventilatory threshold and lactate threshold differed significantly between young and middle-aged mice.
- **Conclusion:** These findings provide important quantitative parameters for exercise prescription in animal models. By establishing baseline physiological data across age groups, this study may facilitate more accurate translation of experimental findings from animal models to human clinical applications.

PP-08-03 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 195

Köbel L, Haller N, Strepp T, Stögl T

Expectations Meet Reality: Individual differences in physiological responses to endurance training prescriptions based on physical exercise testing

JOHANNES GUTENBERG UNIVERSITY, Mainz, Germany

- **Background:** Exercise intensity prescription based on physiological exercise testing (PET) is widely used in health and performance contexts. However, PET-derived prescriptions, using e.g. percentage of maximal heart rate (HRmax), may fail to elicit the intended physiological re-sponses due to inter-individual variability. This study investigates individual response differences across six training modalities derived from PET.
- **Method:** 104 healthy participants completed PET to determine VO₂max, peak power, HRmax and lactate thresholds (LT1, LT2). Subsequently, six endurance exercise modalities were performed in randomized order: three different high-intensity interval trainings (HIIT: 5x4 min HRmax, 30x30 s, 15x1 min), speed endurance production training (SEPT: 40 s intervals), low-intensity training (LIT) and threshold training (THR). Deviations between observed and expected responses, defined as 90% of VO₂max and HRmax for HIIT and SEPT, LT2 for THR, and LT1 for LIT, were assessed as bias via Bland-Altman analysis. Deviations and time in high-intensity zone (TIZ: >90% of VO₂max or HRmax), were analyzed using linear mixed-effects models with modality, sex, and fitness level as fixed effects.
- **Results:** 87 participants (51 male, 36 female) were included. VO₂-biases were significant for all modalities (-3.8 to 1.3 mL/min/kg; LoA: -9.8 to 6.9 mL/min/kg). HR-biases ranged from -3.9 to 4.7 bpm (LoA: -24.4 to 21.3 bpm) and were significant for 5x4, 15x1, SEPT, and THR. Lactate biases were significant in THR and LIT (2.1 and -0.1 mmol/l). Linear mixed-effects models revealed significant effects for modality on VO₂ and HR deviations and of sex (p<.05). TIZ differed significantly between modalities, ranging from 00:39-05:25min (VO₂) and 02:25-12:28min (HR).
- **Conclusion:** The results demonstrate substantial inter-individual variability in physiological responses, indicating that PET-derived prescriptions do not reliably elicit the intended internal load, further reflected by divergent TIZ between VO₂ and HR. These findings highlight the importance of monitoring responses beyond PET prescription.

PP-08-04 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 244

Duarte Muñoz M, Meyer T, Becker S

Immune response to a competitive football match: Indications for compromised function?

UNIVERSITÄT DES SAARLANDES, Germany

- **Background:** The "open window theory" states that after a bout of strenuous exercise, immune function is transiently impaired, which may temporarily increase susceptibility to upper respiratory tract infections. A reduction in lymphocyte counts has been described after continuous exercise, simulated football matchplay and organized matches. This study aimed to compare the changes in immune parameters occurring after a competitive football match (MATCH) to those occurring after continuous running (RUN). We hypothesized that continuous exercise would elicit a stronger response of the immune system when compared to intermittent exercise during a football match.
- **Methods:** Eleven male semiprofessional outfield football players participated in this study. All participants underwent two trials, namely, a competitive football match (MATCH) and an endurance trial, which consisted of running for 56 minutes on a treadmill at a constant speed of 90% of the individual anaerobic threshold (RUN). Blood samples were collected before (baseline) and 15 minutes (+15 min), 60 minutes (+60 min) and 24 hours (+24 h) after the end of each trial. Leukocytes, neutrophils, lymphocytes, cortisol and interleukin-6 (IL-6) were measured at these timepoints.
- **Results:** Lymphocytes decreased significantly from baseline to +15 min ($p < 0.001$) and +60 min ($p < 0.005$) after MATCH. After RUN, a small but significant increase in lymphocytes occurred at +15 min ($p < 0.007$). Serum cortisol was significantly higher at +15 min both trials ($p < 0.0001$ in MATCH, $p = 0.003$ in RUN). IL-6 showed a similar pattern at +15 min ($p < 0.0001$ in MATCH, $p = 0.001$ in RUN). Both parameters were significantly higher at this same timepoint after MATCH when compared to RUN (cortisol $p = 0.004$, IL-6 $p < 0.0001$).
- **Conclusion:** Competitive football induced a stronger transient lymphocyte decrease than continuous running. Our findings suggest that intermittent loads represent a different immune challenge when compared to continuous loads.

PP-08-06 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 260

Pecher A-C, Widmann M, Preuß B, Nieß AM, Klein R, CoSmo-S consortium

Longitudinal seroprevalence of SARS-CoV-2 in German athletes – Data from the CoSmo-S study

UNIVERSITY HOSPITAL TÜBINGEN, Germany

- The CoSmo Study is a prospective multicenter observational project designed to analyse acute and long-term health effects of SARS CoV 2 in German athletes. Here, we evaluated antibody response before and after infection and vaccination.
- Data from $n = 1426$ ($n = 925$ with, $n = 501$ without infection) participants were obtained from the CoSmo S cohort. Within comprehensive diagnostics serum samples were analysed for antibodies against spike-1 (S1), spike-RBD, and nucleocapsid (N) proteins using an in-house ELISA as described. Antibody frequencies were analysed in relation to infection, vaccination and clinical symptoms.
- Among infected athletes, S1 IgG was positive in 48%, RBD IgG 43% and N IgG 56%; IgA rates were 12–15%. Athletes without known infection demonstrated lower reactivities (S1 IgG 33%, RBD IgG 27%, N-IgG 39%; $p < 0.001$).
- Information on vaccination status was available in 270 athletes. Prior to vaccination, 31% (S1) and 20% (RBD) showed IgG reactivity, while N-IgG was detectable in 57%, with markedly lower IgA frequencies. Following vaccinations, S1- and RBD- IgG increased substantially, reaching 98% after the second dose and remaining above 89% after the third dose, whereas IgA responses rose more modestly. N-specific antibodies fluctuated independently of vaccination status, reflecting previous infections within the cohort. S1/RBD IgG reached 90–100% between 5–12 weeks after the second dose, while IgA frequencies remained consistently lower.
- In athletes, antibody patterns clearly differentiated vaccination-induced spike responses from infection-associated nucleocapsid reactivity, with infected individuals showing markedly higher frequencies across all antigens. Notably, one third of athletes without a known infection, exhibited serological evidence of prior, likely asymptomatic or unrecognized (latent) infection. Vaccination elicited strong and durable spike-specific IgG responses, whereas IgA remained lower reflecting primarily infection-driven mucosal immunity. The delayed IgG peak at 5–12 weeks compared with the commonly reported 2–4 weeks may relate to training-associated modulation of immune kinetics or differences in sampling intervals.

PP-08-05 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 213

Rector N, Weber V, Tomaskovic A, Neuburger E, Ochmann D, Simon P

Iron status and peak power output in post COVID-19 condition: an exploratory analysis

JOHANNES GUTENBERG-UNIVERSITÄT MAINZ, Germany

- **Background:** Post COVID-19 condition (PCC) is associated with reduced exercise capacity and persistent fatigue. Iron plays a central role in oxygen transport and mitochondrial energy production, yet its relationship to objective exercise performance in PCC remains poorly understood. We investigated whether iron status parameters are associated with peak power output during cardiopulmonary exercise testing (CPET) in a PCC cohort.
- **Methods:** 92 patients with PCC (82 female; 50.4 ± 10.1 years) from the PCS-TeR cohort underwent symptom-limited CPET (cycle ergometer). Serum iron (Fe) and transferrin saturation (TSAT) were measured 5 minutes prior to testing. Peak power (W/kg) served as the primary outcome. Spearman correlations and linear regression models adjusted for age and sex were used. An exploratory moderation analysis examined whether age moderates the TSAT $\rightarrow$ peak power relationship.
- **Results:** TSAT ($p = 0.25$, $p = 0.016$) and Fe ($p = 0.29$, $p = 0.006$) were significantly associated with peak power. Both remained significant in regression models adjusted for age and sex. Ferritin showed no significant association ($p = 0.09$, $p = 0.41$). An exploratory moderation analysis revealed a significant interaction between TSAT and age ($p = 0.026$), with older participants showing a stronger association. Stratified analyses in women suggested the effect was driven by older women ($p < 0.05$ across cut-offs 45–52 years) rather than younger women ($p > 0.39$), though menopausal status was not directly assessed. Sensitivity analyses confirmed robustness across cut-offs.
- **Conclusion:** Functional iron markers were associated with peak power in PCC, independent of age and sex. The age-moderated effect suggests that iron availability may be particularly relevant for exercise performance in older women, potentially related to menopausal changes in iron metabolism. Direct assessment of menopausal status and replication in larger samples are needed.

PP-08-07 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 186

Wohlfarth D, John L, Lüders N, Munk M, Wiesing A, Kirsten J, Henze A-S, Schulz SVW, Bizjak DA

Marathon-Induced Changes in Hematological and Inflammatory Biomarkers: A Comparison of Runners Across Performance Levels

UNIVERSITY CLINIC ULM, Germany

- **Background:** Participation in marathon running has increased substantially in recent years, with a growing proportion of novice runners. Marathon running imposes substantial physiological stress, which may vary according to training status and performance level. This study investigated marathon-induced changes in hematological and inflammatory biomarkers across performance groups and evaluated systemic and non-invasive markers of exercise-induced inflammation.
- **Methods:** Of the 62 runners (31 female and 31 male) who participated in the Einstein Marathon 2024 (Ulm, Germany), 52 completed post-race testing. Athletes were stratified by finish time into three groups: highly trained, trained or developmental, and recreationally active. Blood and saliva C-reactive protein samples were collected pre- and post-race. Blood analyses included red blood cells, leukocytes, lactate dehydrogenase, haptoglobin, creatine kinase, interleukin-6, and kynurenine. Pre-race body composition was measured via bioimpedance.
- **Results:** All groups showed significant post-race increases in red blood cells, leukocytes, lactate dehydrogenase, creatine kinase, interleukin-6, and kynurenine, alongside decreased haptoglobin, indicating hemolysis, inflammation, and muscle damage. Creatine kinase differed between groups, with smaller increases in faster runners compared with slower groups. Salivary C-reactive protein did not change. Faster runners tended to be younger and have lower body fat percentages, whereas marathon experience and total training years were not clearly associated with performance level.
- **Discussion:** Marathon running elicits substantial inflammatory and muscle damage responses, largely independent of performance level. These findings emphasize that, in addition to performance, exercise duration should be considered when evaluating physiological load in marathon running. Serum kynurenine showed potential as a responsive marker of exercise-induced inflammation, whereas salivary C-reactive protein did not reflect post-exercise changes. Although limited by sample size, particularly in the fastest group, the study provides real-world field data. Future research should include larger cohorts, in-race sampling, and longitudinal recovery monitoring to better understand the interaction between fitness, exposure time, and systemic stress responses.

PP-08-08 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 136

Bizjak DA, John L, Munk M, Reiter M, Lüders N, Kirsten J, Henze A-S, Schulz SVW

Market(rain)ing? Physiological, Metabolic, and Mitochondrial Adaptations to a One-Week Endurance Training Camp in Rec-reational Athletes: An Observational Study

UNIVERSITÄTSKLINIKUM ULM, Germany

- **Background:** Endurance training camps are an established component of elite endurance training. Recently, one- or two-week training camps for recreational endurance athletes have gained popularity, promising performance improvements, enhanced recovery, and lifestyle benefits. However, scientific evidence supporting these claims is scarce. This study therefore investigated the effects of a one-week endurance training camp on body composition, athletic performance, and blood- and saliva-based markers assessing metabolic and mitochondrial function in recreational endurance athletes.
- **Methods:** Female and male endurance athletes aged ≥ 18 years participating in a one-week training camp focused on running and cycling were examined. Assessments included anthropometry, running performance, sleep quality and stress/regeneration, nutritional intake and energy balance, blood profiling, and markers of mitochondrial biogenesis (Vascular endothelial growth factor [VEGF], Growth differentiation factor 15 [GDF-15], mitochondrial DNA, and PGC1-alpha expression). Plasma markers included creatine kinase, lactate dehydrogenase (LDH), klotho, interferon-gamma, and kynurenine, while saliva markers comprised cortisol, C-reactive protein, and uric acid. Measurements were performed the week before the camp (pre), during the training week (camp), and the week after the camp (post).
- **Results:** Thirty-five participants (18 male/17 female; 46.4 ± 14.0 years) were included. Body mass and body fat decreased from pre-camp to post-camp, accompanied by adaptations in phase angle and the lactate metabolism. At post-camp, LDH, klotho, and vitamin D concentrations increased, while interferon-gamma, kynurenine, cortisol, creatinine, and ferritin decreased compared with pre-camp. VEGF decreased following the camp, whereas plasma mitochondrial and nuclear DNA relative abundance and PGC1-alpha expression increased at post-camp.
- **Conclusions:** A one week endurance training camp in a holiday like setting induces measurable physiological, metabolic, and mitochondrial adaptations in recreational athletes and is associated with reduced systemic and psychological stress. However, the concurrent increase in muscle and cell stress markers indicates a substantial physiological load.

PP-08-10 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 229

Schönfelder M, Schranner D, Kastenmüller G, Wackerhage H

MetaExtreme: Exercise increases plasma levels of N-acetylated amino acids in controls and athletes

TECHNICAL UNIVERSITY OF MUNICH, Germany

- **Background:** N-acetylated amino acids (NAAs) are amino acid-carboxylic acid conjugates whose plasma levels are influenced by amino acid turnover, nitrogen handling, and acetyl CoA availability. N-terminal acetylation is a highly abundant protein modification in eukaryotic cells, influencing protein folding, subcellular targeting, protein complex formation, and protein turnover.
- The aim of this study was to determine how an exercise test to exhaustion alters circulating NAA concentrations in untrained controls and highly trained athletes across different sports.
- **Methods:** The MetaExtreme cohort comprised healthy, trained male athletes representing three distinct training modalities – oxidative endurance athletes ($n=11$), anabolic natural bodybuilders ($n=9$) and glycolytic sprinters ($n=8$) – alongside untrained controls ($n=7$). All participants fulfilled a graded cycle ergometry test to exhaustion. Blood samples before and after exercise were analysed by untargeted metabolomics.
- **Results:** Across all groups, acute exercise increased the plasma levels of most NAAs. We observed the largest mean log₂ fold changes for N-acetyl-leucine (0.93-fold, $p=2.4E-12$), N-acetyl-proline (0.80-fold, $p=7.9E-6$), N-acetyl-glutamine (0.75-fold, $p=1.7E-11$), and N-acetyl-2-aminooctanoate (0.82-fold, $p=6.0E-12$). Many metabolites demonstrated highly significant exercise effects with minimal between-group differences in ANOVA or post hoc testing, indicating that the athletic phenotype had little effect. Furthermore, the plasma levels of a few NAAs, including N-acetyl-glycine (-0.2-fold, $p=4.1E-5$) and N-acetyl-serine (-0.07-fold, $p=3.6E-2$), decreased during exercise.
- **Conclusion:** Data by the Epic-Norfolk study and on N-acetyl-taurine show that N-acetylated amino acids associate with disease and other human phenotypes and might have regulatory functions. In summary, NAAs are exercise-modulated metabolites with possible, underexplored regulatory functions. In future, these metabolic signatures potentially could serve as new load indicators and markers of fatigue or metabolic capacity.

PP-08-09 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 160

Munz B, Dick L, Krauß I, Nieß AM

Metabolomics using dried blood spots in young, healthy, sedentary subjects

UNIVERSITY MEDICINE TÜBINGEN, Germany

- **Background:** The iReAct study was a multidisciplinary approach, aiming at identifying factors contributing to training adaptation in young, healthy, sedentary subjects. Metabolomics analyses are a promising tool in Sports Medicine, both in the fields of basic science and clinical practice. Here, we analyzed metabolite patterns in iReAct subjects and compared them to data previously obtained for participants of the MultiPill-Exercise pilot study, a lifestyle intervention program for people with multimorbidity.
- **Methods:** Participants of the iReAct study trained three times per week on bike ergometers. Before and after 6 and 12 weeks of training, earlobe capillary blood was applied to Guthrie Cards, i.e. sheets of absorbent filter paper, and analyzed using flow-injection analysis-mass spectrometry/mass spectrometry (FIA-MS/MS). MultiPill-Exercise participants were subjected to a more general lifestyle intervention, focusing on enhancing physical activity participation. In this group, metabolomics was analyzed at baseline and after 12 weeks.
- **Results:** Overall, resting concentrations of most metabolites were higher in male ($n=3$) when compared to female ($n=10$) iReAct subjects. Furthermore, we found significant declines of a range of metabolites, specifically methionine (Met) and short- and medium-chain acylcarnitines (SC- and MC-ACs), after 12 weeks of training. Moreover, we observed a significant negative correlation ($r=-0.600$; $p=0.05^*$) between changes in C2-ACs and aerobic fitness in response to regular exercise, as assessed via changes in relative maximum oxygen consumption ($\dot{V}O_{2\max}$). When compared to subjects with multimorbidity ($n=26$), resting concentrations of almost all metabolites analyzed were higher than in iReAct subjects. In addition, concentrations of most metabolites increased in this group.
- **Conclusions:** Our data demonstrate that determination of metabolite patterns using Guthrie Cards might be a convenient tool in Sports Medicine. Preliminary results suggest that gender, age and health status might be important determinators of metabolite patterns and that changes in resting SC-AC concentrations might be relevant indicators of training adaptation.

PP-08-11 POSTER PRESENTATION – STRESS RESPONSE & BIOMARKER NR. 188

Nolte C, Risch L, Beckendorf C, Engel T, Mayer F

Prevalence and time-loss of respiratory illness in adolescent athletes

UNIVERSITÄT POTSDAM, Germany

- **Background:** Acute respiratory illness (ARill) is common in athletes, encompassing upper and lower respiratory tract symptoms, and a major cause of time-loss from training. Longitudinal data on ARill prevalence and training impact in adolescent athletes remain limited. This study investigates annual and seasonal prevalence and time-loss burden of ARill in adolescent athletes.
- **Method:** This prospective cohort study collected data from 1212 adolescents of various sports disciplines aged 12–18 years (grade 8–11), using an online questionnaire completed every 3 months over one year. The questionnaire assessed ARill symptoms, their onset, course, and related time-loss. ARill episodes were defined as ≥ 1 acute respiratory symptom (cough, productive cough, rhinorrhea or sore throat).
- Prevalence was calculated as the total number of episodes per athlete-year (overall and among affected athletes). Illness burden was assessed as median (IQR) annual illness days and training time-loss days among affected athletes. Seasonal occurrence was described as the monthly percentage distribution of ARill episodes.
- **Results:** From 1212 adolescents, 343 athletes with complete data were included. Overall, 258 athletes (75%) reported 516 ARill episodes corresponding to an annual prevalence of 1.5 episodes per athlete-year and 2.0 episodes among affected athletes. The median number of sick days among affected athletes was 12 (IQR 7–21). Training time-loss was reported by 227 athletes (66%), with a median of 9 days (IQR 4–15). ARill episodes were highest in September–November (39.2%; 970 time-loss days) and lowest in June–August (11.2%; 189 days).
- **Conclusion:** ARill represents a substantial burden for adolescent athletes, causing considerable time-loss from training. These findings highlight the importance of illness surveillance to quantify burden and guide prevention strategies during seasonal peaks.

OP-07-01 ORAL PRESENTATION – METABOLISM

NR. 230

Tiedemann S, Stiebler M, Piechowiak C, Kunz N, Al-Zawity S, Hubert P, Lading Y, Arndt P, Medunjanin S, Königstein K, Chaabene H, Mattern H, Chakrabarty S, Rauwolf T, Schreiber S, Braun-Dullaes R, Müller P

Acute Effects of High-Intensity Endurance Training on Klotho Levels in Young and Older Adults, and Potential Modulation by SGLT-2 Inhibitors

UNIVERSITÄTSKLINIKUM MAGDEBURG A.Ö.R., Germany

- **Background:** Physical activity improves cardiovascular health through multiple mechanisms, including the release of exerkines. The anti-aging protein Klotho is increasingly recognized as an exerkine: its serum levels decline with age and are inversely associated with cardiovascular morbidity. There is also evidence that SGLT-2 inhibitors (SGLT-2i) may increase Klotho levels. Whether an acute exercise stimulus and a single dose of an SGLT-2i interact has remained unknown.
- **Methods:** In this prospective interventional study (ethics approval: Otto von Guericke University Magdeburg, No. 117/22; DRKS00038533), 20 young (27.5 ± 3.6 years, 10 female) and 19 older adults (70.2 ± 2.7 years, 10 female) were included. The intervention consisted of an individualized cardiopulmonary exercise test (CPET) to exhaustion on a cycle ergometer. Blood samples were collected before (T1), 30 minutes after (T2), and 24 hours after (T3) exercise. Soluble α -Klotho was measured using ELISA (IBL International); samples were diluted 1:4 and analyzed in duplicate. In a second sub-study (washout period: 14 days), older participants received a single dose of empagliflozin (10 mg) 24 hours before a repeated exercise test. Statistics: two-way repeated measures ANOVA (group $\times$ time), post hoc tests with Bonferroni correction; significance level $p < 0.05$; software: MATLAB 2025b.
- **Results:** Older adults had significantly lower baseline Klotho levels compared to younger adults (729.5 vs. 976.2 pg/mL; $p = 0.014$; Cohen's $d = 0.62$). In both groups, acute exercise led to a significant increase in Klotho levels 30 minutes post-exercise (young adults: +15.6%, $d = 1.2$; older adults: +5.1%, $d = 1.03$; both $p < 0.001$), which returned to baseline after 24 hours. A single dose of empagliflozin did not significantly alter baseline Klotho levels ($p = 0.126$), but accelerated the decline in Klotho levels after exercise in older participants (decrease T2–T3 without vs. with empagliflozin: -2.8% vs. -8.3%; $p = 0.008$).
- **Conclusion:** High-intensity aerobic exercise acutely and significantly increases Klotho levels in both young and older adults. A single dose of empagliflozin modifies post-exercise Klotho dynamics in older individuals. These findings highlight the role of Klotho as an exerkine and suggest novel interactions between exercise and SGLT-2i pharmacology.

OP-07-03 ORAL PRESENTATION – METABOLISM

NR. 203

Bierenstiel A, Schneeweiss P, Veit R, Ester-Nacke T, Ahrens J, Wacker K, Müller C, Sandforth L, Jümpertz-von Schwartzberg R, Birkenfeld AL, Niess AM, Preissl H, Weigert C, Kullmann S

Intensity- and sex-specific modulation of brain insulin response following a single session of aerobic exercise in adults with normal weight

IDM AT THE UNIVERSITY OF TÜBINGEN, Germany

- **Background:** Brain insulin resistance is associated with reduced lifestyle intervention efficacy and is linked to obesity, type 2 diabetes, and dementia. We previously showed that eight weeks of aerobic exercise improves brain insulin action in overweight or obese, alongside beneficial metabolic and cognitive effects. However, the acute effects of exercise remain unclear.
- **Method:** In a randomized, placebo-controlled crossover study, 27 healthy adults with normal weight (13 females; mean age 29 [range: 20–52] years) completed three conditions on separate days: 43 minutes of high-intensity interval training (HIIT), 60 minutes of moderate-intensity continuous training (MICT) on a cycle ergometer, and a 60-minute resting control condition. Multiple blood samples were collected. Cerebral blood flow (CBF) was measured 100 minutes after each condition (pre) and 30 minutes after intranasal insulin administration (post) using functional magnetic resonance imaging to assess insulin-induced changes in CBF following exercise. A flexible factorial model included condition (HIIT, MICT, control), time point (pre, post), and sex, adjusted for global CBF (Bonferroni-corrected $p < 0.0125$).
- **Results:** After both HIIT and MICT, lactate and free fatty acid levels were higher than in the control condition ($p < 0.001$). CBF (pre) in the right hypothalamus was lower after MICT vs. control ($p = 0.003$). Both exercise intensities decreased insulin-induced CBF in the right putamen (HIIT vs. control: $p = 0.001$; MICT vs. control: $p = 0.002$), while only HIIT decreased CBF in the left hippocampus ($p = 0.007$) and inferior frontal gyrus/insula ($p = 0.005$). Females showed higher insulin-induced CBF in the right substantia nigra (vs. control: $p = 0.004$) and left superior frontal gyrus (vs. MICT: $p = 0.004$) compared with males.
- **Conclusion:** A single aerobic exercise session modulates insulin action in cognitive and reward-related brain regions, with effects dependent on exercise intensity and sex. This highlights the relevance of personalized exercise interventions. Future studies should examine whether these acute changes predict long-term cognitive and metabolic benefits after exercise.

OP-07-02 ORAL PRESENTATION – METABOLISM

NR. 127

Hecksteden A, Schwindling S, Meyer T, Kierner AK, Maalouli Schaar J, Meyer MR

Acute exercise responses of N-lactoyl-phenylalanine (Lac-Phe) – a potential mediator of exercise-induced anorexia

UNIVERSITÄT INNSBRUCK, Austria

- **Purpose:** N-lactoyl-phenylalanine (Lac-Phe) has been recently characterized in blood serum as a metabolite, which is induced by physical exercise in a lactate-dependent manner and suppresses appetite. This is in accordance with previous findings that point to lactate as a main mediator of exercise-induced anorexia. Considering the relative novelty of Lac-Phe and its nanomolar concentrations, we aim to scrutinize the replicability of its acute response to intensive exercise.
- **Methods:** Five athletic participants (2 female, 3 male) completed two stepwise tests to exhaustion on a bicycle ergometer. Venous blood samples were collected at baseline as well as 1, 15, 30, 45 and 60 minutes after cessation of exercise, processed immediately, and stored frozen until analysis. Lac-Phe concentration was determined after completion of the in-vivo study by liquid-chromatography-high resolution tandem mass spectrometry.
- **Results:** Lac-Phe concentrations increased about 10-fold from very low resting levels (median 1.8 nmol/l) to a maximum 15 minutes after cessation of exercise (median 19.5 nmol/l) followed by a partial decline until 1 hour (median 12.7 nmol/l). Maximum levels of lactate and Lac-Phe were significantly correlated. Secondary analyses point to a potential instability of Lac-Phe in frozen samples.
- **Conclusion:** We confirmed a robust increase in Lac-Phe concentration after exercise as well as a significant association between maximum concentrations of lactate and Lac-Phe. These findings agree with the previously suggested role of Lac-Phe as a mediator of exercise induced anorexia. The stability of Lac-Phe in frozen samples warrants further scrutiny.

OP-07-04 ORAL PRESENTATION – METABOLISM

NR. 157

Dreher SI, Schöler R, Zorn K, Martin J, Kühnle J, Goy T, Ruoff L, Leffek K, Loskill P, Birkenfeld AL, Peter A, Weigert C

Local TGF- β signaling causes impaired contractility and low-response to exercise in human skeletal muscle

UNIVERSITY HOSPITAL TÜBINGEN, Germany

- **Background:** Transforming growth factor- β 1 (TGF- β 1) impacts skeletal muscle-homeostasis, regeneration, and metabolism. Chronic activation of TGF- β 1 impairs myogenesis and promotes fibrosis contributing to muscle dysfunction in conditions like muscular dystrophy and sarcopenia. Elevated TGF- β signaling has also been implicated in impaired response to exercise training, reducing the improvement in glycemic control and mitochondrial function. Thus, elucidating the role of TGF- β 1 in contracting skeletal muscle is essential for understanding maladaptation and variable exercise responses.
- **Methods:** CD56-enriched primary human myoblasts isolated from vastus lateralis biopsies ($n = 3$ –10 donors) were used to generate 2D or a 3D myobundle models capable of electrical-pulse-stimulated ex vivo exercise by utilizing a serum-free IGF1-based differentiation protocol. Models were treated with TGF- β 1 (1 ng/ml) alone or in combination with the TGF- β signaling-inhibitor SB431542 (10 μ M). Analysis included video-based motion-tracking algorithms, qPCR, WB, glucose- and lactate-measurements, transcriptomics and proteomics. Transcriptomics was performed on tissue from vastus lateralis biopsies ($n = 42$ donors). Statistical significance was determined by ANOVA-Bonferroni ($p < 0.05$).
- **Results:** Our human muscle models showed robust contraction during exercise. Acute exercise induced NR4A3 and PGC1 α expression, AMPK-phosphorylation, elevated glucose utilization and lactate production. Down-regulation of TGF- β signaling is important for myotube development. Longitudinal analysis of contracting myobundles revealed that addition of TGF- β 1, independent from maturity of differentiation, completely blocked contractility within only 24h. Local TGF- β 1 signaling reduced the expression of several genes which are relevant for muscle energy metabolism or translation and were now confirmed by gene silencing to be relevant for contractility. Interestingly, expression of these genes was also found to be reduced in skeletal muscle of humans with low-response to exercise.
- **Conclusion:** We revealed a fast and detrimental effect of local TGF- β signaling, present in low/non-responder individuals, on skeletal muscle function and contractility. Identifying specific mediators, will reveal strategies to overcome low-response to exercise, develop personalized interventions to prevent metabolic disease progression and preserve muscle function.

OP-07-05 ORAL PRESENTATION – METABOLISM

NR. 298

Hoene M, Taschke B, Goj T, Hartwig S, Sbierski-Kind J, Vollmer I, Birkenfeld AL, Peter A, Lehr S, Weigert C

Phosphoproteomic profiling reveals acute hepatic signaling responses to endurance exercise in mice

UNIVERSITY HOSPITAL TÜBINGEN, Germany

- **Background:** Physical exercise is an effective way to prevent obesity, type 2 diabetes and metabolic dysfunction-associated steatotic liver disease (MASLD). Given its central role in maintaining energy homeostasis, the liver is also strongly affected by acute endurance exercise. However, hepatic signaling responses to acute exercise remain poorly characterized, particularly at the phosphoproteomic level.
- **Methods:** Male 13 week-old C57/BL6N mice (n=8/group) were subjected to 60 minutes of moderate-intensity endurance exercise on an electric treadmill. Livers were harvested immediately afterwards for phosphoproteomics and transcriptomics (RNAseq) analysis. Phosphoproteomics and transcriptomics data were analyzed using decoyR, RoKAI, and Ingenuity Pathway Analysis (IPA) to infer kinase, phosphatase, and transcription factor/upstream regulator activities.
- **Results:** The exercise session caused acute energy stress in the liver, as indicated by a broad upregulation of stress- and glucagon-responsive transcripts and reduced glycogen levels. Glycogen synthase kinase-3 beta (GSK3 β) was predicted to be de-activated based on both phosphoproteomics and transcriptomics data, indicating that exercise primes the liver for subsequent glycogen replenishment. Of the >15,000 unique phosphosites detected, a similar number was significantly increased and decreased (20% and 21%, respectively, unadj. p<0.05) after exercise. This suggested that, alongside kinases, phosphatases also play a significant role in reshaping the phosphoproteome during exercise. This observation was consistent with a phosphoproteomics-based predicted activation, induction at the transcriptional level, of different phosphatases.
- **Conclusion:** A single bout of endurance exercise triggers extensive phosphorylation changes in the liver, highlighting the liver as a dynamic responder to acute exercise. Our results indicate that in addition to kinases known for their role in regulating energy metabolism, like GSK3 β , phosphatases play a key role in the acute hepatic response to exercise.

OP-07-06 ORAL PRESENTATION – METABOLISM

NR. 103

Fesseler L, Heinz V, Pilz N, Bothe T

Pre-exercise hyperventilation and repeated-sprint performance during inclined high-intensity sprints

CHARITÉ - UNIVERSITÄTSMEDIZIN BERLIN, Germany

- **Objective:** High-intensity exercise induces systemic acidosis, which contributes to muscular performance decline. Controlled pre-exercise hyperventilation has been proposed as a non-invasive intervention to induce respiratory alkalosis and counteract acidosis-related acute fatigue. In this study, we hypothesized that a real-world-applicable pre-exercise hyperventilation protocol can improve incline sprint performance.
- **Methods:** This randomised, single-centre, controlled crossover study included 36 recreational athletes aged 18 to 40 years. Each participant completed a series of three inclined treadmill interval sprints on two separate days: one with pre-exercise hyperventilation and one without. Respiratory parameters were measured via spirometry, and post-sprint capillary blood gas analysis was performed.
- **Results:** Pre-exercise hyperventilation resulted in higher mean CO₂ elimination during hyperventilation (32.8 ± 5.1 vs. 21.5 ± 2.5 mL/kg, p < 0.0001) and lower mean end-tidal CO₂ partial pressure (17 ± 2.5 mmHg vs. 30 ± 2.7 mmHg, p < 0.0001) compared to control condition. Mean cumulative elevation gain did not differ between pre-exercise hyperventilation (83.2 ± 27.6 m) and control condition (84.3 ± 26.0 m, p = 0.555). Differences in CO₂ elimination did not correlate with differences in performance (p = 0.590). We found no alterations in post-sprint capillary blood lactate and pH between both conditions (p > 0.05 for all sprints cumulative and separately). Participants subjectively assessed the breathing protocol as unpleasant, and felt it negatively influenced their performance.
- **Conclusion:** The easily translatable pre-exercise hyperventilation protocol investigated in this study did not improve performance in repeated high-intensity incline sprint intervals. Therefore, we discourage its application in real-world applications.

OP-08-01 ORAL PRESENTATION – SPORTS NUTRITION

NR. 193

Saremi M, Hoseinpour AN, Shahriari F, Bloch V

Caffeine mouth rinsing as a central ergogenic strategy: a systematic review on performance and cognition

DEUTSCHE SPORHOCHSCHULE KÖLN, Germany

- **Introduction:** Caffeine is a widely used ergogenic aid in sport; however, systemic ingestion may induce adverse effects like gastrointestinal distress, sleep disruption, and cardiovascular strain, which are highly relevant in sports medicine practice. Caffeine mouth rinsing (CMR) has emerged as a non-ingestive strategy that may enhance performance via central nervous system stimulation without systemic exposure. This systematic review aimed to evaluate the effectiveness of CMR on physical and cognitive performance, with particular emphasis on its applicability in sports medicine and athlete management.
- **Methods:** A systematic review was conducted in accordance with PRISMA guidelines and registered on PROSPERO. PubMed, Web of Science, and Google Scholar were searched up to July 2025 for randomized controlled trials investigating CMR in healthy, physically active individuals and athletes. Inclusion criteria followed the PICOS framework. Methodological quality was assessed using the PEDro scale, and only studies with moderate to high quality were included.
- **Results:** Thirty-two randomized controlled trials (n = 484 participants) were included. Considerable heterogeneity existed in caffeine concentration (0.13–3%), rinse duration (5–20 seconds), and frequency. Findings for physical performance were inconsistent: improvements were observed in high-intensity, intermittent, and sport-specific tasks, while endurance performance, maximal strength, and repeated sprint outcomes were largely unaffected. Importantly, physiological markers such as heart rate, lactate, and VO₂max remained unchanged, indicating minimal systemic impact. In contrast, cognitive outcomes consistently demonstrated improvements in reaction time, selective attention, and reduced mental fatigue.
- **Conclusion:** CMR appears to exert its effects primarily through central mechanisms, enhancing cognitive function and potentially improving performance in tasks requiring rapid decision-making and neuromuscular activation. CMR represents a promising, low-risk alternative to caffeine ingestion, particularly for athletes sensitive to its side effects. However, protocol heterogeneity and limited data in female athletes warrant further investigation before clinical recommendations can be fully established.

OP-08-02 ORAL PRESENTATION – SPORTS NUTRITION

NR. 289

Havers T, Martini S, Hillgärtner M, Rana G, Schönfelder M, Witting M, Lutter D, Erdogan G, Baumert P, Geisler S, Drey M, Wackerhage H

Effect of 20 g whey protein on the plasma metabolome in young and sarcopenic participants: a test for digestion speed and anabolic resistance?

IST UNIVERSITY OF APPLIED SCIENCES, Germany

- **Introduction:** Sarcopenia, the age-related loss of muscle mass and function (1), is associated with 'anabolic resistance', a reduced muscle protein synthesis response to an anabolic stimulus, such as protein intake (2). We hypothesize that, analogously to an OGTT for glucose, the metabolome response after protein ingestion is a measure of protein digestion speed and anabolic sensitivity, since a rapid rise in amino acids indicates rapid digestion, while fast clearance suggests high protein synthesis or anabolism. To test this, we compared the metabolome response to 20 g of whey protein in young individuals and in individuals with sarcopenia.
- **Methods:** Twenty-three participants, including young healthy adults (n = 12; 25.4 ± 2.0 years) and (pre-)sarcopenic elderly (n = 11; 82.9 ± 6.2 years), received a 20 g bolus of whey protein after overnight fasting. We collected venous blood at 0, 60, and 120 minutes post-ingestion and analyzed blood plasma using LC/MS untargeted metabolomics with HILIC separation in both positive and negative ionisation modes. Following log₁₀ transformation, median normalisation and ComBat batch correction, we applied a mixed effect ANOVA (time $\times$ group) with Benjamini–Hochberg FDR correction (q < 0.05).
- **Results:** A total of 2,968 metabolites were detected, 201 of which were annotated. Data revealed no significant interaction (time $\times$ group) for any measured annotated metabolite (all > 0.99), indicating that the kinetics of the whey protein response are similar across age groups. We identified significant time effects (q < 0.05) for a broad range of metabolites, including essential amino acids such as leucine (q < 10⁻¹⁰), valine (q = 5.06×10^{-6}), and threonine (q = 6.15×10^{-8}), as well as various fatty acids (e.g., FA 16:1, q = 1.06×10^{-5}). Significant group differences (q < 0.05) independent of protein intake were found in metabolites such as trimethylamine N-oxide (q = 0.019), tryptophan (q = 0.0038), and N(6)-methyladenosine (q = 0.019), highlighting distinct baseline metabolic profiles in (pre)sarcopenic adults. Next, we will perform additional analyses to test whether the metabolome's response to protein ingestion reflects digestion speed and anabolic sensitivity.
- **Conclusion:** Ingestion of whey protein not only causes a transient rise of amino acids but also of other metabolites. Additional analyses will ascertain whether this can be utilized to estimate the anabolic sensitivity of an individual. Furthermore, this data shows that protein ingestion not only affects plasma amino acids but also other metabolites.

OP-08-03 ORAL PRESENTATION – SPORTS NUTRITION

NR. 233

Grebe SM, Lenz C, Krüger K

Supplements Do Not Correct Nutritional Deficits in Elite Athletes: Protein oversupply versus carbohydrate deficit

JUSTUS-LIEBIG UNIVERSITY, Germany

- **Introduction:** Despite evidence-based recommendations support a “food first” approach, the use of dietary supplements is widespread in competitive sports. However, it remains unclear to what extent supplements correct deficiencies in nutrient intake. The aim of this study was to evaluate supplement use in the context of macro- and micronutrient intake, with a particular focus on energy and carbohydrate adequacy.
- **Methods:** In this study, supplement use and nutrient intake (questionnaire: $n = 618$; three-day dietary records: $n = 198$) were assessed among German junior and elite athletes. Nutrient intake was analysed with and without supplements, using reference values from the German Nutrition Society (DGE).
- **Results:** 69.7% of the athletes reported using at least one supplement, most frequently protein or amino acids (48.2%), vitamins (40.5%), and minerals (40.3%).
- Carbohydrate ($65.7 \pm 20.1\%$ of reference values) and fiber intake ($61.1 \pm 25.7\%$) were significantly deficient and unaffected by supplementation, while protein intake already exceeded recommendations from diet alone ($144.1 \pm 48.8\%$), rising further with supplementation ($175.8 \pm 89.6\%$). Vitamin D was the most commonly deficient micronutrient: 99.5% of athletes failed to meet recommendations through their diet alone (mean $17.4 \pm 15.3\%$), yet only 29.4% received supplementation, among those supplemented, 81% achieved adequate levels.
- The number of nutrient deficits did not differ significantly between conditions ($p = 0.546$).
- Overall, 71.6% of supplements were taken without a pre-existing deficiency, while an existing deficiency was successfully remedied in 24.4% of cases.
- **Conclusion:** Supplements do not adequately correct existing nutritional deficiencies in competitive sports. There is a systematic imbalance in nutrient intake, characterized by an excess of protein combined with an insufficient intake of carbohydrates and energy. This imbalance, as well as existing micronutrient deficiencies, is largely not addressed by dietary supplements. The findings underscore the need for targeted, professionally guided nutritional interventions.

OP-08-05 ORAL PRESENTATION – SPORTS NUTRITION

NR. 183

Esser-Seraphin AJ, Nguyen VTM, Muehlbauer T, Paslakis G, Dinse H, Seitz J, Gradl-Dietsch G, Skoda E-M, Teufel M, Bäuerle A

Beyond thinness: Profiles of sport- and performance-driven disordered eating in athletes

LVR-UNIVERSITÄTSKLINIK ESSEN, Germany

- **Background:** Disordered eating in elite athletes is heterogeneous but still mainly framed around thinness and restriction. In weight-sensitive sports such as ballet and bodybuilding, muscularity-oriented ideals, periodised “bulk/cut” cycles, and the relative energy deficit in sport (RED-S) are increasingly relevant. This study aimed to identify sport-specific profiles of disordered eating and training behaviour that extend beyond classical restrictive and bulimic patterns, including RED-S-associated and mass-gain-oriented constellations.
- **Methods:** Elite athletes ($N = 113$) from weight-sensitive (ballet, bodybuilding) and less weight-sensitive sports (soccer, basketball, racket sports) were included in a two-stage cluster analysis (hierarchical Ward's method followed by k-means) on standardised variables: BMI, muscularity- and thinness-oriented body image, dysfunctional training behaviour, fatigue, gastrointestinal distress, and weight cycling frequency. External validation included psychological distress, menstrual status, and contextual factors (sport type, sex, training status).
- **Results:** A four-cluster solution emerged, comprising a restrictive-symptomatic, a low-risk, a mass/weight-gain-oriented, and a training-compulsive profile. Clusters significantly differed in psychological distress, global eating pathology, injury burden, and weight discrepancy measures. Cluster membership was associated with sport type and sex, indicating sport-specific and gendered patterns.
- **Conclusion:** Findings confirm the multidimensional nature of disordered eating in elite sport, highlighting profiles driven by muscularity, training compulsion, and performance-related weight regulation. Screening and prevention strategies should expand beyond thinness and restriction to address these emerging sport-specific risk constellations.

OP-08-04 ORAL PRESENTATION – SPORTS NUTRITION

NR. 232

Lenz C, Grebe SM, Hacker S, Schwarzenbrunner K, Zentgraf K, Krüger K

Customized Workshop on Optimizing Nutrition Knowledge in Youth Competitive Sports

JUSTUS-LIEBIG UNIVERSITY, Germany

- **Background:** Elite junior athletes frequently exhibit suboptimal micronutrient status, altered metabolic hormone profiles, and limitations in the validity of self-reported dietary assessments. This study aimed to develop and evaluate a practical, needs-based workshop designed to improve nutritional knowledge and support individualized, performance-oriented dietary strategies in elite junior athletes.
- **Methods:** Twenty-three male elite junior athletes (U16) from the German Ice Hockey Federation participated in this pre-post intervention study. Baseline assessments included questionnaires on nutritional knowledge and literacy, as well as three-day food diaries, and were collected three weeks prior (food diary) and on the morning of the workshop (questionnaire). The one-day workshop combined interactive theoretical sessions, practical cooking exercises, and individualized feedback based on each athlete's dietary profile. Based on baseline assessments and on analysis of potential improvements, small groups were formed around various key topics to address both general sports nutrition content and athletes' specific nutritional needs. Nutritional knowledge, food literacy and a feedback survey were reassessed immediately after the intervention. Pre- and post-intervention results were analysed using t-tests for paired samples.
- **Results:** Nutritional knowledge improved significantly ($p = 0.03$), as did self-assessed food literacy ($p < 0.001$). The workshop received a mean rating of 1.7 on a 6-point Likert scale (1 = very good, 6 = insufficient). Participants positively evaluated the individualized and practice-oriented format. 81 % expressed great or very great interest in further nutrition workshop offerings.
- **Conclusion:** This study demonstrates that practice-oriented, individualized, and interactive nutrition interventions appear effective in improving nutritional knowledge in elite junior athletes. The combination of theoretical knowledge, practical application, and individualized support enables sustainable development. Competitive sports organizations should therefore prioritize the integration of individualized nutrition workshops into their athlete development programs.

OP-09-01 ORAL PRESENTATION – FITNESS, TRAINING & HEALTH

NR. 172

Ott T, Gutjahr L, Kappler T, Meyer T, Venhorst A

Comparison of psychophysiological responses to self-determined and prescribed moderate running intensities in insufficiently active, normal and overweight young adults

UNIVERSITÄT DES SAARLANDES, Germany

- **Background:** Current prescriptions for inactive populations recommend moderate-intensity continuous exercise (MICE). However, long-term adherence remains low. Self-paced (SELF) exercise at self-selected intensities may be a suitable alternative, as imposed intensities, especially in overweight adults, are frequently perceived as less enjoyable. We compared psychophysiological responses to equalcaloric MICE and SELF running in insufficiently active, normal and overweight adults.
- **Methods:** Seventy-four insufficiently active adults (24 ± 28 min endurance training/week; $M = 27$, $SD = 4$ years, 37 females) were BMI-categorized into normal ($n = 35$, $23.2 \pm 2 \text{ kg/m}^2$) and overweight ($n = 39$, $29.3 \pm 3 \text{ kg/m}^2$) cohorts. Participants performed two equalcaloric treadmill runs: a prescribed run at the first ventilatory threshold, reflecting current recommendations ($36 \pm 2 \text{ min}$, $6.5 \pm 1.0 \text{ km/h}$), and an autonomously varying self-paced run ($31 \pm 2 \text{ min}$, $8.1 \pm 1.4 \text{ km/h}$). Physiological (heart rate, fat-free-mass-adjusted oxygen consumption, blood lactate concentration) and psychological (perceived strain, affective valence (pleasure/displeasure), and action crisis (urge to quit) using single-item scales) parameters were assessed at nine equal-energy intervals. After cool-down, participants reported remembered enjoyment and predicted how often they would perform it weekly.
- **Results:** Repeated-measures MANOVAs revealed significant trial-by-time interactions with large effect sizes globally. On average, physiological strain was higher during SELF vs. MICE: heart rate (163 ± 11 vs. $148 \pm 11 \text{ bpm}$), fat-free-mass-adjusted oxygen consumption (40 ± 5 vs. $33 \pm 4 \text{ mL/min/kg}$) and lactate (2.7 ± 1.1 vs. $1.6 \pm 0.5 \text{ mmol/L}$). Psychological parameters showed corresponding differences: perceived strain (12.2 ± 2.1 vs. $10.1 \pm 2.2 \text{ A.U.}$), affective valence (2.8 ± 1.7 vs. $3.0 \pm 1.6 \text{ A.U.}$) and action crisis (2.1 ± 1.0 vs. $1.8 \pm 0.9 \text{ A.U.}$). While physiological and perceived strain differed initially, differences in affective valence and action crisis only emerged during later stages. Remembered enjoyment and predicted training frequency did not differ significantly.
- **Conclusion:** Given autonomy to vary intensity, insufficiently active adults prefer exercising at moderate-to-vigorous intensity by accepting higher strain and less favourable perceptual responses towards exercise end without impairing remembered enjoyment or predicted training frequency. Preference-based exercise represents an individualized alternative to current prescription-based exercise.

OP-09-02 ORAL PRESENTATION – FITNESS, TRAINING & HEALTH NR. 128

Gutjahr LP, Kappler T, Ott T, Meyer T, Venhorst A

Psychophysiological responses to vigorous and moderate intensity exercise in insufficiently trained normal and overweight young adults

UNIVERSITY OF SAARLAND, Germany

- **Background:** Many young adults do not engage in sufficient exercise to experience health-benefits. A deeper understanding of the complex mechanisms underpinning regulation of and adherence to exercise is needed. We therefore applied a three-dimensional framework of sensory, affective and cognitive perceptions in goal-directed exercise behaviour to examine psychophysiological responses to currently recommended vigorous and moderate intensity exercise regimes in normal and overweight young adults.
- **Methods:** Seventy-four insufficiently trained (24±28 min/week endurance training), normal (n=35, BMI 22.5±1.7) and overweight (n=39, BMI 29.4±2.8) young adults (18-35 years, 37 female) completed two equicaloric running trials in randomized order: vigorous- (VICE) and moderate-intensity continuous exercise (MICE) for 29±2 and 36±2 min at 8.9±1.5 and 6.5±1.0 km/h, respectively. Physiological (heart rate, oxygen consumption relative to fat-free mass and blood lactate concentration) and perceptual parameters (perceived strain, affective valence and action crisis measured with single-item scales) were assessed at nine time-points during exercise. After cool-down, participants reported remembered enjoyment and predicted frequency to perform this training.
- **Results:** Multivariate analyses of variance of averages in physiological and perceptual parameters showed highly significant ($p<.001$) and very large ($n_2p>.29$) main trial effects throughout. Pairwise comparisons revealed expected velocity-dependent greater cardiovascular (172 ± 9 vs 149 ± 11 min; 43 ± 4 vs 33 ± 3 ml/min/kg) and metabolic (4.4 ± 1.4 vs 1.6 ± 0.5 mmol/l) associated with greater perceived strain (14.7 ± 1.8 vs 10.1 ± 2.2 A.U.) and action crisis (3.7 ± 1.3 vs 1.8 ± 0.9 A.U.) and lower affective valence (0.6 ± 2.0 vs 3.1 ± 1.6 A.U.), remembered enjoyment (-0.2 ± 2.6 vs 3.2 ± 1.7 cm) and predicted training frequency (2 ± 1 vs 3 ± 1 /week) in VICE compared with MICE, respectively.
- **Conclusion:** The three-dimensional framework presents comprehensive insights into strain-perception-thinking-action coupling during goal-directed exercise. Given equicaloric training doses with varying exercise intensities in normal and overweight insufficiently trained adults, moderate-intensity exercise elicited more favourable perceptual responses that are more likely to facilitate the intended behavioural change and subsequent adherence to exercise.

OP-09-04 ORAL PRESENTATION – FITNESS, TRAINING & HEALTH NR. 125

Schwendinger F, Schmidt-Trucksäss A

Intensity matters: how physical activity's impact on mortality varies across cardiovascular conditions

UNIVERSITY OF BASEL, Switzerland

- **Background:** More intense physical activity (PA) is inversely associated with cardiovascular mortality. Yet, it is unclear how this relationship varies across different cardiovascular diseases (CVDs). Thus, we investigate the interaction between PA intensity and specific CVDs—congestive heart failure, coronary heart disease, myocardial infarction, and angina pectoris—and how these interactions impact cardiovascular mortality.
- **Methods:** Data from the National Health and Nutrition Examination Survey (NHANES) 2011–2014, including 7,016 adults with an 82-month median follow-up were analysed. Wrist-worn accelerometers measured PA intensity as intensity gradient. Cox proportional hazard regression models evaluated interactions between intensity and CVD subtypes, adjusting for covariates including BMI, age, sex, and health status. Interaction effects are presented as hazard ratios (HRs) on the Z-scale.
- **Results:** The strength of the association of intensity with cardiovascular mortality varied by CVD subtype. There was limited evidence of an interaction for congestive heart failure and angina pectoris, with interaction HRs of 1.14 (95% CI: 0.86–1.51) and 1.00 (95% CI: 0.62–1.61), respectively. Notably, for coronary heart disease, intensity was less effective in reducing mortality risk compared to individuals without the condition (interaction HR: 1.47; 95% CI: 0.94–2.02), though the effect size was uncertain. Similarly, adults with a history of myocardial infarction displayed a reduced mortality benefit from intensity (interaction HR: 1.57; 95% CI: 0.91–2.71). A curvilinear dose-response relationship was observed in a subset of adults with CVD, with cardiovascular mortality plateauing at PA intensity around 2.7 to 2.6. Similar interaction effects were seen for PA duration across conditions.
- **Conclusion:** While PA intensity generally reduces cardiovascular mortality across various CVD subtypes, its effectiveness may be attenuated in individuals with coronary heart disease or a history of myocardial infarction. Such conditions may require more comprehensive prevention strategies due to potential pathophysiological influences on the response to PA.

OP-09-03 ORAL PRESENTATION – FITNESS, TRAINING & HEALTH NR. 275

Mattioli Maturana F, Nieß AM

Optimizing exercise prescription: a meta-analysis examining the dose-response of exercise duration on cardiorespiratory fitness following HIIT and MICT

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Background:** To characterize the dose-response relationship between exercise session duration and cardiorespiratory fitness ($\dot{V}O_{2\max}$) across the full spectrum of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) prescriptions, and to compare their effects on cardiometabolic risk factors.
- **Method:** A dose-response meta-analysis of randomized controlled trials (RCTs) following PRISMA guidelines, registered in PROSPERO (CRD42022335590). One-stage random-effects models with restricted cubic splines characterized dose-response curve shapes. Effect sizes were estimated using random-effects meta-analysis. Data sources included PubMed and Google Scholar. Eligibility criteria was defined as RCTs in humans, published in English, with exercise interventions ≥ 4 weeks comparing HIIT and MICT.
- **Results:** 69 RCTs (2387 participants) were included. HIIT elicited greater $\dot{V}O_{2\max}$ improvements than MICT ($d = 0.38$, 95% CI [0.27; 0.49], $p < 0.001$). HIIT exhibited a non-linear dose-response, producing $\Delta\dot{V}O_{2\max} = 3.45 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ in as little as ~11 min/session with negligible additional gains beyond ~23 min/session, while MICT followed a linear, volume-dependent pattern that continued to yield improvements across the full range of durations studied. Both dose-response profiles were statistically equivalent across the health spectrum, with no significant difference in curve shape between healthy individuals and those with cardiometabolic risk factors (HIIT: $\chi^2 = 1.87$, $p = 0.39$; MICT: $\chi^2 = 3.73$, $p = 0.16$). Despite distinct dose-response patterns for $\dot{V}O_{2\max}$, both modalities produced equivalent improvements in cardiometabolic risk factors, including blood pressure, body composition, and insulin markers.
- **Conclusion:** HIIT achieves near-maximal cardiorespiratory fitness adaptations with short sessions, while MICT offers a linear, scalable response making it effective across a wide range of durations. Both modalities yield equivalent cardiometabolic benefits regardless of health status, affirming that the choice between them or a combination of both can be guided by individual preference, capacity, and time availability rather than expected health outcomes.

OP-09-05 ORAL PRESENTATION – FITNESS, TRAINING & HEALTH NR. 124

Schwendinger F, Schmidt-Trucksäss A

Continuous vs fragmented intense physical activity and mortality risk: a prospective US-based population study

UNIVERSITY OF BASEL, Switzerland

- **Background:** How are the associations of the intensities of the most active 1-60 min of the day and all-cause and cause-specific mortality moderated by the fragmentation of physical activity (PA) in US adults.
- **Methods:** Adults aged >19 years from NHANES 2011-2014 (N=8,426) wore wrist accelerometers for seven days. Intensity was quantified as the most active continuous (MXCONT) and accumulated (MX) 1, 5, 10, 15, 20, and 60 minutes of the day and their ratio (MXRATIO = MXCONT / MX). Outcomes were all-cause (766 events), cardiovascular disease (231 events), and cancer (192 events) mortality over a median follow-up was 81 months. Survey-weighted Cox proportional hazard models were used including restricted interactions between MXCONT and MXRATIO. Hazard ratios (HR) and 95% confidence intervals (CI) are reported for 400 milli-gravitational units (fast walking) relative to 100 milli-gravitational units (slow walking), except for the 60-minute duration, where 200 milli-gravitational units (brisk walking) were used.
- **Results:** Continuous moderate-intensity PA over 10–60 minutes was associated with lower all-cause mortality compared with more fragmented patterns, while fragmentation had little impact for short (<5 min) vigorous PA.
- For cardiovascular mortality, sporadic vigorous-intensity PA for up to 5 minutes showed stronger but less precise associations than continuous PA. For 20-minute (HRcontinuous=0.15, 95% CI:0.04-0.49 vs HRsporadic=0.24, 95% CI:0.04-1.31) and 60-minute durations (HRcontinuous=0.09, 95% CI:0.03-0.27 vs HRsporadic=0.39, 95% CI:0.10-1.59), continuous moderate-intensity PA showed stronger associations than those of sporadic PA.
- For cancer mortality, moderate-to-vigorous-intensity PA accumulated continuously was associated with lower risk than sporadic PA across all durations, e.g. 5 minutes (HRcontinuous=0.06, 95% CI:0.01-0.37 vs HRsporadic=2.43, 95% CI:0.65-9.11) and 20 minutes (HRcontinuous=0.02, 95% CI:0.00-0.24 vs HRsporadic=0.85, 95% CI:0.20-3.62).
- **Conclusion:** Associations between PA intensity and mortality appear to differ by PA fragmentation. Patterns characterised by shorter, vigorous-intensity PA and longer, moderate-intensity PA were associated with more favourable mortality outcomes.

OP-09-06 ORAL PRESENTATION – FITNESS, TRAINING & HEALTH NR. 140

Mazzolari R, Paul S, Liebel P, Hecksteden A

The effects of the exercise intensity reference method on acute responses during continuous exercise in distance runners: a replicated crossover study

MEDICAL UNIVERSITY OF INNSBRUCK, Austria

- **Background:** During prolonged exercise, the relationship between external load and heart rate (HR) is not constant. Previous studies suggest that speed-HR decoupling may be inversely related to performance level, potentially making HR-based and speed-based exercise prescription more interchangeable in endurance athletes. However, interchangeability at the individual level has not been systematically studied.
- **Methods:** In a replicated crossover design, 21 (13 men, 8 women) distance runners completed three cycles of two paired sessions in random order: a constant-HR session (HR-C) and a constant-speed session (SPEED-C), each lasting 30 minutes. Intensity was set at the midpoint between first and second lactate thresholds. HR, speed, oxygen consumption, and rating of perceived exertion were recorded. Data were analyzed using linear mixed models to assess both the average effect and the subject-by-prescription method interaction. Shrinkage-adjusted individual estimates were obtained, and the consistency of individual responses across outcomes was assessed via correlation analysis.
- **Results:** SPEED-C elicited a significantly greater physiological and perceptual response than HR-C for all measured markers (all $p < 0.001$). A significant subject-by-prescription interaction was observed for all outcomes (all $p < 0.001$), and moderate to large correlations were found across outcomes.
- **Conclusion:** The choice of exercise-intensity reference method acutely affects physiological and perceptual responses in distance runners. The significant subject-by-prescription interaction and the consistency of individual responses indicate that the difference between the two prescription methods is highly individual. This finding has important implications for individualizing exercise programs.

PLENARY 5 EXERCISE AND TRAINING IN CARDIO VASCULAR DISEASE NR. 120

Lang CI, Schenke R, Schlüter S, Gäbel R, Lindner T, Jokschi M, Kurth J, Ince H, Meinel FG, Halle M, Lutter C, Krause BJ, Vollmar B, David R

Endurance exercise training before myocardial infarction reduces decline of myocardial function in aged mice

TUM KLINIKUM, TU München, Germany

- **Background:** Regular endurance exercise prior to myocardial infarction (MI) has been shown to attenuate scar formation and adverse remodeling in young rodents. However, evidence in aged animals—more representative of the typical MI population—remains limited.
- **Purpose:** This study investigated whether six weeks of endurance training immediately before acute MI influences infarct size, scar morphology, and left ventricular remodeling in aged mice.
- **Methods:** Twenty-month-old C57BL/6 mice were randomized to endurance training (EX-MI, $n=11$; treadmill running 30 min at 18 cm/s, 5 days/week for 6 weeks) or sedentary control (SED-MI, $n=12$). MI was induced by permanent ligation of the left anterior descending artery. In vivo 2-[18F]F-FDG PET imaging was performed on days 5 and 7 post-MI to assess inflammatory activity. Cardiac MRI at day 28 evaluated morphology and function, followed by histological analyses.
- **Results:** Compared to sedentary controls, EX-MI mice exhibited smaller but thicker infarct scars. Although left ventricular dilation was similar between groups, contractile performance was significantly improved in trained mice, reflected by higher ejection fraction and stroke volume. Global longitudinal and radial strain rates were increased, and scar deformation analysis revealed greater peak circumferential and radial strain. FDG uptake within the scar was significantly elevated at day 7 in EX-MI animals, suggesting altered inflammatory dynamics. In addition, the remote myocardium was thicker and demonstrated enhanced radial deformation in the exercise group.
- **Conclusion:** Short-term endurance training prior to MI mitigates adverse remodeling in aged mice by reducing scar size and thinning while preserving myocardial contractility in both infarcted and remote regions. These findings indicate that pre-infarction exercise enhances compensatory capacity and may represent a protective strategy in the aging heart.

PLENARY 5 EXERCISE AND TRAINING IN CARDIO VASCULAR DISEASE NR. 217

Schoch R, Kröpfl JM, Gasser BA, Infanger D, Hanssen H, Wick R, Precht LM, Dieterle T, Schmidt-Trucksäss A

Determinants of exercise capacity in heart failure with preserved ejection fraction

UNIVERSITY OF BASEL, Switzerland

- **Background:** Exercise intolerance, reflected by reduced peak oxygen uptake ($\dot{V}O_{2peak}$), is a defining feature of heart failure with preserved ejection fraction (HFpEF) and results from impairments across the oxygen transport pathway. However, the relative contributions of central hemodynamics, ventilatory efficiency, oxygen transport, and peripheral muscle function to exercise capacity remain incompletely defined.
- **Methods:** This cross-sectional analysis included baseline data from the HIT-HF trial. $\dot{V}O_{2peak}$ and ventilatory efficiency ($\dot{V}E/\dot{V}O_{2peak}$) were assessed by cardiopulmonary exercise testing. Cardiac output was measured using impedance cardiography, total hemoglobin mass (tHbmass) by carbon monoxide rebreathing, and leg power by counter movement jump testing. Associations with relative $\dot{V}O_{2peak}$ were examined using multivariable linear regression including cardiac output, $\dot{V}E/\dot{V}O_{2peak}$, tHbmass, and leg power, adjusted for age, sex, and BMI. Relative importance of predictors was quantified using the Lindeman-Merenda-Gold (LMG) method.
- **Results:** A total of 32 patients were included (mean age 73 (10) years, BMI 25.6 (4.3) kg/m², 65% female). The model explained 74% of the variance in relative $\dot{V}O_{2peak}$ (adjusted $R^2 = 0.66$, $p < 0.001$). Leg power showed the strongest positive association ($\beta = 0.80$, 95% CI: 0.29 to 1.30, $p = 0.003$) and the largest relative contribution (26%). Cardiac output showed a smaller, non-significant association ($\beta = 0.18$, 95% CI: -0.06 to 0.42, $p = 0.14$; LMG: 12%), while $\dot{V}E/\dot{V}O_{2peak}$ and tHbmass demonstrated trivial contributions ($\beta = -0.10$, 95% CI: -0.38 to 0.17, $p = 0.445$, LMG: 2%, and $\beta = -0.04$, 95% CI: -0.34 to 0.25, $p = 0.767$, LMG: 2%).
- **Conclusion:** In HFpEF, peripheral muscle function, quantified by leg power, showed the strongest association with exercise capacity, exceeding contributions from central hemodynamics, ventilatory efficiency, and oxygen transport. These findings highlight the central role of peripheral mechanisms in exercise intolerance in HFpEF.

PLENARY 6 FEMOROACETABULAR IMPINGEMENT NR. 197

Beringer L, Bachmann D, Schmitz L, Steimer O, Schneider G, Hell D, Komnik I, Meyer T, aus der Fünten K, Potthast W

Real-time visualization and analysis of femoroacetabular impingement in elite badminton players using subject-specific anatomical–kinematic models

SAARLAND UNIVERSITY, Germany

- **Background:** Femoroacetabular impingement (FAI) is a major contributor to hip pain and early joint degeneration in athletes. While morphological diagnosis is well established, the dynamic, sport-specific mechanisms leading to a reduction of distance between the acetabulum and the femoral head-neck junction remain insufficiently understood. This is particularly relevant in badminton, where complex and asymmetric movement patterns place high demands on hip joint mobility. This study aimed to develop and evaluate an in-lab system for real-time visualization and analysis of FAI during sport-specific movements.
- **Methods:** Five male elite badminton players with radiologically confirmed FAI were included. Subject-specific three-dimensional hip models were generated from magnetic resonance imaging (MRI). Badminton-specific movements were recorded using an optoelectronic motion capture system. Anatomical and kinematic models were fused into individualized avatars and validated. The femoroacetabular distance (FAD) between the femoral head-neck junction and the acetabular rim was continuously calculated during dynamic movements. Pain-provoking phases, identified by the athletes during testing, were used to define mechanically critical hip positions.
- **Results:** The combined model enabled movement-specific visualization of femoroacetabular interaction. The system allowed standardized real-time analysis and immediate feedback. Pain-associated patterns primarily occurred during combined hip flexion, adduction, and internal rotation, as well as during hip abduction. A mean critical FAD of 6.4 mm (95% CI: 4.6–8.3 mm) was identified across all pain-provoking trials.
- **Conclusion:** The presented approach enables functional, sport-specific movement assessment of FAI beyond static imaging. It provides a basis for improved screening, prevention, and individualized load management in high-performance athletes.

PLENARY 6 FEMOROACETABULAR IMPINGEMENT

NR. 179

Tejada JJM, Liang C, Brüsche M, Liang C, Günther K-P, Keller G

Ultra-Low-Dose CT Enables Reliable Assessment of Morphological FAI Parameters with significant Radiation Dose Reduction

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Background:** Accurate assessment of morphological parameters is essential for the diagnosis of femoroacetabular impingement (FAI). These measurements are usually performed using conventional radiography and magnetic resonance imaging (MRI). While computed tomography (CT) is limited due to higher radiation exposure, it provides excellent bone visualization. A previously introduced ultra-low-dose CT (ULDCT) protocol can provide reduction of radiation exposure by 96%. Aim of this study was to assess validity and reproducibility of ULDCT for commonly used FAI parameters compared to standard CT (CT).
- **Methods:** 41 patients underwent both ULDCT and CT prospectively after ethical approval. Acetabular version (AV), alpha angle (AA), femoral torsion (FT), anterior and posterior acetabular sector angle (AASA and PASA) were assessed in 58 hips in UldCT and in normal CT by two independent readers with different training. Results were compared by using the Kruskal-Wallis-test between both modalities. Dose-length product (DLP) was quantified for radiation exposure. Interobserver reliability was assessed via Bland-Altman-analysis and intraclass correlation (ICC).
- **Results:** Mean values were obtained in ULDCT (vs CT): AV $18.75^{\circ} \pm 5.29^{\circ}$ ($18.29^{\circ} \pm 5.40^{\circ}$), AA $38.18^{\circ} \pm 7.78^{\circ}$ ($37.65^{\circ} \pm 8.15^{\circ}$), FT $15.06^{\circ} \pm 8.51^{\circ}$ ($19.12^{\circ} \pm 1.98^{\circ}$), AASA $62.59^{\circ} \pm 8.28^{\circ}$ ($63.62^{\circ} \pm 7.63^{\circ}$), and PASA $99.4^{\circ} \pm 10.14^{\circ}$ ($100.6^{\circ} \pm 9.71^{\circ}$). No statistical difference was found between both modalities ($p=0.14-0.94$). ULDCT reduced radiation exposure significantly by expected 97% ($p < 0.05$; mean DLP: CT 490.81 mGy-cm vs. ULDCT 13.58 mGy-cm). Bland-Altman analysis as well as ICC demonstrated higher intra- as well as inter-observer-reliability for acetabular measurements when compared to alpha angle and femoral torsion.
- **Conclusion:** ULDCT is a reliable tool to evaluate FAI parameters and can reduce radiation exposure significantly. It represents a promising addition to radiography and MRI with reliable focus on acetabular parameters. Reproducibility of femoral-based parameters needs further optimization.

OP-10-02 ORAL PRESENTATION – AI & DIGA'S

NR. 134

Lang S, Goelz C, Schlichtiger J, Brunner S, Vieluf S

ECG foundation models for cardiovascular screening in athletic populations

LMU KLINIKUM MÜNCHEN, Germany

- **Background:** AI-driven cardiac screening has the potential to transform sports medicine through improved accuracy, efficiency, and cost-effectiveness. A key success factor in this data-scarce field is the flexibility of advanced foundation models. Since most ECG foundation models are trained primarily on clinical datasets, they may not capture the characteristic cardiac adaptations seen in athletes. Therefore, before deployment in sports medicine, their applicability to athlete populations must be verified.
- **Method:** We fine-tuned three state-of-the-art models (ECG-FM, HuBERT-ECG, ECGFounder) on PhysioNet2021, 88,252 samples, and tested and compared them on a dataset of 43 expert-annotated 10s, 12-lead ECGs of highly trained/national-level football players who underwent a routine sports medicine examination. Statistical significance was assessed via bootstrapping, paired permutation tests between datasets, and Friedman tests with Wilcoxon post-hoc comparisons and FDR correction to assess model differences on the athlete dataset ($\alpha = 0.05$).
- **Results:** The clinical dataset comprised a heterogeneous, predominantly older, mixed-sex population (mean age 59.4 ± 18.1 years; 54.7% male) across multiple international centers, whereas the athlete dataset included young, male athletes (mean age 20.3 ± 4.5 years). Performance metrics were strong on PhysioNet (ECG-FM: AUROC: 0.97, AUPRC: 0.57, Sensitivity: 0.89) but dropped significantly on athletes' data, confirming a domain shift (AUROC, Sensitivity: $p < 0.05$). ECGFounder performed best in AUROC/AUPRC ($p < 0.05$ vs. HuBERT-ECG: AUROC: 0.84, AUPRC: 0.72, Sensitivity: 0.57) and accurately detected sinus bradycardia (AUROC: 0.87) and sinus arrhythmia (AUROC: 0.95).
- **Conclusion:** Even without any athlete-specific fine-tuning, transferability was notable, demonstrating that foundation models can deliver strong results with far less data than would be needed to train from scratch. Moving forward, large, diverse, and open athlete ECG datasets are required to refine these models even further. This work provides a first step toward athlete-focused AI frameworks for reliable, generalizable ECG-based screening for cardiac abnormalities.

OP-10-01 ORAL PRESENTATION – AI & DIGA'S

NR. 141

Wefelnberg MM, Baumann FT, Guthoff H, von Stein P, Zubac D

Diagnostic accuracy of the dynamic retina vessel analyzer: The influence of biological and systemic moderators in healthy individuals

UNIKLINIK KÖLN, Center for Integrative Oncology, Germany

- **Background:** Although the dynamic retinal vessel analyzer (DRVA) was established as a validated surrogate biomarker of vascular function, the literature lacks data on standardized and comprehensive analyses of potential confounders—such as $\dot{V}O_{2peak}$, intraocular pressure (IOP), and eye dominance—limiting our understanding of the device's applicability and interpretability. The aim of our study was to evaluate the intra-ocular symmetry of retinal vascular reactivity measured via DRVA-derived parameter, arterial and venous flicker-induced dilation (aFID, vFID) and arterial constriction (aCON), and to determine if these biomarkers are influenced by eye dominance, or systemic factors.
- **Methods:** In this prospective, methodological study 20 healthy participants (age 30 ± 5 , 55% women) had passed medical clearance and completed two laboratory visits. During the first lab visit, all study participants completed a cardiopulmonary exercise test (CPET) until voluntarily exhaustion, while on the second visit their vascular endothelial function was assessed using the DRVA for both eyes in random order.
- **Results:** No significant inter-ocular differences were found for aFID, vFID, or aCON ($p > 0.05$). Bland-Altman analysis and the linear mixed model analyses confirmed no systematic bias from eye selection ($p > 0.094$) or systemic moderators like the $\dot{V}O_{2peak}$ or IOP ($p > 0.05$, for all dependent variables, respectively). According to reliability analysis, vFID was the most stable biomarker (CV=28.9%, ICC=0.662), while aFID (CV=46.4%, ICC=0.377) showed higher variability. The vFID biomarker demonstrated the highest absolute and relative reliability, followed by aCON, while aFID was identified as the least symmetrical parameter.
- **Conclusion:** Data presented here suggest that the vascular endothelial response of the retina is not moderated by eye dominance, or systemic factors like $\dot{V}O_{2peak}$ and IOP, suggesting that arbitrary eye selection does not introduce systematic bias into data. Still, to enhance diagnostic precision, we recommend assessing both eyes in clinical practice to account for the significant inter-ocular variability observed here.

OP-10-03 ORAL PRESENTATION – AI & DIGA'S

NR. 147

Lee M, Kim HR, Kweon S, Rein R, Krutsch W, Memmert D, Meyer T

Identifying High-Risk Duels in Elite Football Using Machine Learning

SAARLAND UNIVERSITY, Germany

- **Introduction:** In elite football, many injuries occur during player-to-player contact, especially in tackling situations. However, manual screening of match footage is time-consuming, and video-based assessment alone cannot objectively quantify kinematic and spatiotemporal characteristics preceding injury-related re-sponses, especially when contact situations are only partially visible on screen. This study aimed to use electronic performance and tracking systems (EPTS) data and machine learning to identify high-risk tackling situations associated with injury-related responses and to relate player-level risk exposure to injury history, helping distinguish isolated accidents from repeated exposure to risky situations.
- **Methods:** Data from 50 matches of the 2023/24 German Bundesliga season were analyzed. Duels were identified from event data annotated by human labelers and matched with synchronized EPTS tracking data. For each duel, a 4-second window was extracted, centered on the moment of minimum interpersonal distance. Based on predefined criteria, trained labelers assigned positive labels to duels with an observable injury-related response, and kinematic and interaction features were used to train several machine learning and deep learning models for binary classification (positive vs negative).
- **Results:** A total of 6,806 tackling situations were extracted, of which 289 (4.2%) were labelled as positive. long short-term memory (LSTM) showed the highest test performance (ROC-AUC 0.85), followed by XGBoost (ROC-AUC 0.83), indicating good discrimination between injury-related and non-injury situations. Model-derived risk profiles also identified players with repeated exposure to high-risk tackling situations and provided a basis for relating these patterns to individual injury history.
- **Conclusion:** It was shown that machine learning applied to EPTS-derived tackling data can identify high-risk contact situations associated with injury-related responses in elite football. The model also identified players more frequently exposed to high-risk tackling situations, thereby supporting interpretation of injury history in terms of isolated accidents versus recurrent risk exposure and informing more targeted injury analysis and prevention strategies.

OP-10-04 ORAL PRESENTATION – AI & DIGA'S NR. 241

Zentgraf S, Weber V, Wieprecht DA, Schömer E, Simon P, Hillen B, Nägele M

Modelling skin temperature dynamics during incremental running: A generalized additive mixed modelling approach to physiological and mechanical determinants

JGU MAINZ, Germany

- **Background:** Infrared thermography (IRT) is a non invasive method for quantifying skin surface temperature (T_{sk}) and provides detailed insights into cutaneous thermoregulatory processes during exercise. Because the time dependent dynamics of T_{sk} arise from a complex interplay of physiological, mechanical, and anthropometric factors, a modelling framework capable of separating these influences is required to isolate underlying physiological mechanisms.
- **Methods:** T_{sk} of the posterior calf was recorded in twelve endurance trained participants (6 female, 6 male; 24.9 ± 2.21 years) during an incremental cardiopulmonary exercise test using a high resolution 1 Hz thermal time series. Metabolic heat production (MHP), body surface area (BSA), and the stage dependent segmental airflow over the calf (v_{air}) were additionally determined. Non linear temperature trajectories were analysed using a generalized additive mixed model (GAMM). The model included a separate start phase smooth (0–15 s), factor smooth interactions for stage specific time courses, a two dimensional tensor interaction between time and MHP, and additive smooths for v_{air}, BSA, and sex. A random intercept per participant and an AR(1) structure accounted for interindividual variability and temporal autocorrelation. Significance was set at p < 0.05.
- **Results:** The model explained 92 % of the variance in T_{sk} (adjusted R² = 0.919). The time × MHP interaction was the strongest physiological predictor (F = 22.36, p < 0.001), reproducing the intrastage cooling pattern with temperature decreases of approximately 2–3 °C under high metabolic load. Segmental airflow produced a significant convective offset (F = 560.94, p < 0.001) of –1.0 to –1.3 °C between low and high v_{air} values. BSA exerted a strong non linear thermogeometric influence (F = 6506.27, p < 0.001), with individuals of larger surface area exhibiting ~1.5–2 °C lower T_{sk}.
- **Conclusion:** The results demonstrate that sympathetic mediated vasoconstriction is the central mechanism driving distal cooling, with its temporal progression most strongly influenced by MHP. Segmental airflow modifies the absolute temperature level but does not affect the relative temporal dynamics. Incorporating segmental airflow refines the interpretation of IRT data and enhances understanding of true physiological adaptation patterns.

OP-10-06 ORAL PRESENTATION – AI & DIGA'S NR. 222

Wittke T-C, Wegner N, Riester TB, Dopfer-Jablonska A, Haple C, Müller F, Behrens GMN, Vakilan A, Fischer F, Stölting A

A transfer-oriented digital exercise intervention for rheumatic disease: lessons from the development of DiEgO

HANNOVER MEDICAL SCHOOL, Germany

- **Background:** Fatigue, fluctuating symptoms, and limited therapy resources challenge sustained participation in physical activity in people with rheumatic diseases. Digital tools offer potential support, yet often fail to account for symptom variability and individual needs. We previously developed DiEgO, a fatigue-sensitive app-based self-management programme, with primary focus on occupational therapy content. Building on these experiences, the current project, RELIEV, transfers core development principles into a web-based application for people with rheumatic diseases. By combining exercise-focused content with symptom-sensitive support, the application aims to help users maintain participation in everyday life and work.
- **Methods:** This development study used a transfer-oriented approach. User-derived principles from the participatory development of DiEgO were reviewed for applicability to rheumatic disease and adapted to long-term exercise support. Transfer focused on symptom-sensitive exercise delivery, low cognitive burden, pacing options, flexible module use, and integration into daily routines. Clinical insights from rheumatology care on challenges in sustaining exercise therapy informed the disease-specific adaptation of the web-application.
- **Results:** The transfer process resulted in the concept of RELIEV, an exercise-focused web-application that extends the fatigue-sensitive logic of DiEgO to rheumatology care. Key transferable principles included short, clearly structured units, flexible navigation, explicit pacing support, self-monitoring of current capacity, and practical relevance for everyday life. For rheumatology, these principles were further specified toward symptom-adapted guidance, sustained exercise participation, and compatibility with work-related demands. In patients with concomitant fatigue symptoms, RELIEV and DiEgO may interlock as complementary digital components.
- **Conclusion:** RELIEV demonstrates how participatory experiences from one chronic condition can be translated into an exercise-focused digital intervention for another. This transfer-oriented approach may be relevant for sports and exercise medicine, where sustained physical activity and work ability depend on symptom-sensitive, low-threshold support beyond conventional therapy. Modular linkage across related interventions may also reduce the risk of new digital care gaps in patients with overlapping symptom profiles.

OP-10-05 ORAL PRESENTATION – AI & DIGA'S NR. 164

Ritsche P, Sarto F, Santini F, Leitner C, Franchi M, Romney G, Faude O, Finni T, Seynnes O, Cronin N

UMUD: A Web Application for Easy Access to Musculoskeletal Ultrasonography Datasets

UNIVERSITY OF BASEL, Switzerland

- **Background:** Ultrasonography is widely used to assess skeletal muscle and tendon properties, such as architecture, cross-sectional area, and tissue stiffness. Despite its growing application in different scenarios, and the increasing call for open data access and sharing in clinical research, there remains a significant scarcity of public datasets in this field. This lack of accessible and standardized public datasets limits large-scale analysis algorithm studies, trainee training and the development of image analysis algorithms. To address this, we developed the Universal Musculoskeletal Ultrasonography Database (UMUD: <https://universalmuscledatabase.streamlit.app/>), a web application to facilitate access to these datasets and foster standardization and innovation in musculoskeletal ultrasonography imaging research.
- **Methods:** UMUD is an online repository that aggregates and indexes metadata from publicly available musculoskeletal ultrasonography datasets hosted on platforms like the Open Science Framework and Zenodo. The web application is built using a streamlit (v1.35.0) frontend and mongoDB for its database infrastructure. Standardized metadata descriptors, i.e., muscle group, ultrasound device, participant demographics, are implemented using a combination of pydantic models (v1.10.0) and json schemata to ensure reproducibility and ease of usage for contributing data. UMUD provides detailed instructions for community contributions, including tools for data anonymization.
- **Results:** UMUD includes 15 datasets comprising 145,464 images and/or 2,674 videos from 1,901 participants. The platform also provides benchmark datasets for training and validating algorithms. These include multi-expert analyses of muscle architecture and panoramic cross-sectional area images, a dataset with muscle geometry overlays for teaching architecture analysis and labeled datasets for deep learning models. Furthermore, UMUD lists state-of-the-art automated analysis algorithms to support their application.
- **Conclusion:** By offering a centralized and standardized repository of datasets and tools, UMUD addresses key challenges in musculoskeletal ultrasonography research, promotes transparency, and supports reproducible research and advances in automated image analysis. Future developments will expand datasets, improve platform functionalities, and introduce community-driven challenges.

OP-11-01 ORAL PRESENTATION – ORTHOPEDICS NR. 228

Brunon N, Hirt J, Marti D, Schwab JM, Laurençon J

Influence of Femoral Morphology on Radiographic Detection of Cam Deformity

HFR FRIBOURG - HÔPITAL FRIBOURGEOIS, Switzerland

- **Background:** Cam deformity is a common morphological abnormality associated with femoroacetabular impingement. Although radial sequences on magnetic resonance arthrography (MRA) or computed tomography (CT) are considered the reference standard for detecting cam deformities, radiographs remain the first-line imaging modality in clinical practice. However, the sensitivity of radiographs to detect cam deformities is variable and may be influenced by anatomical and projection-related factors. Therefore, the aims of this study were (1) to determine the detection rate of cam deformities on radiographs compared with radial sequences on MRA, and (2) to assess whether femoral morphology influences the radiographic detection of cam deformities.
- **Method:** We retrospectively reviewed MRA of patients presenting to our institution with a cam deformity, defined as an alpha angle >60° measured on radial MRA sequences. Exclusion criteria included prior hip surgery, trauma, Perthes disease, and insufficient image quality. Anteroposterior pelvis radiographs and cross-table lateral views of the hip were reviewed, and alpha angles were measured. In addition, the caput-collum-diaphyseal (CCD) and femoral torsion angles were assessed. Univariable logistic regression analyses were performed to evaluate associations between femoral morphology parameters and radiographic detection of cam deformities. Statistical significance was set at p < 0.05.
- **Results:** Radiographs detected 80% (65 of 81) of cam deformities identified on MRA. A higher CCD angle was associated with a lower likelihood of detecting cam deformities on radiographs (OR 0.85 per degree, 95% CI 0.73–0.97; p = 0.027). In contrast, femoral torsion was not associated with radiographic detection (p = 0.19).
- **Conclusion:** Radiographic evaluation of cam deformities using the alpha angle failed to detect approximately 20% of cases identified on MRA. A higher CCD angle was associated with a reduced likelihood of detection on radiographs, whereas femoral torsion showed no significant influence.

OP-11-02 ORAL PRESENTATION – ORTHOPEDICS

NR. 220

Brunon N, Hirt J, Rossanaly G, Marti D, Schwab JM, Laurençon J

Where is the Cam? A Circumferential Analysis of Cam Topography

HFR FRIBOURG – HÔPITAL FRIBOURGEOIS, Switzerland

- **Background:** Cam deformity is a key morphological abnormality of femoroacetabular impingement. While typically described in the anterosuperior region, posterior cam deformities have also been reported. Precise assessment of cam location and circumferential extent is clinically relevant for surgical decision-making, as incomplete identification may lead to under-resection and persistent symptoms. However, studies systematically evaluating the circumferential distribution of cam deformity remain limited. Therefore, the aims of this study were (1) to determine the topographical localization of cam deformity and (2) to assess sex differences.
- **Method:** This retrospective study reviewed magnetic resonance arthrographies (MRA) of patients presenting with hip pain. Exclusion criteria included prior hip surgery or trauma, Perthes disease, and insufficient image quality. Of 142 hips (104 patients), 120 hips (84 patients) were included. Alpha angles were measured on radial MRA sequences at each clock-face position (12 o'clock superior, 3 o'clock anterior). Cam deformity was defined as an alpha angle >60° in at least two adjacent sectors.
- A linear mixed-effects model was used to analyze alpha angles across sectors. Statistical significance was set at $p < 0.05$.
- **Results:** 59 female hips and 61 male hips were included. Cam deformity was present in 83% of hips (99/120), including 95% of males, and 69% of females ($p < 0.001$). In cam-positive hips, cam involved the superior quadrant (11–1 o'clock) in 74%, the anterior quadrant (2–4 o'clock) in 55%, the posterior quadrant (8–10 o'clock) in 31%, and the inferior quadrant (5–7 o'clock) in 29% ($p < 0.001$). Alpha angle distribution differed between sexes ($p = 0.004$).
- **Conclusion:** The majority of cam deformities were located in the anterosuperior quadrant. However, posterior and inferior extensions were also observed in up to one-third of cam positive hips, representing potentially underrecognized areas of cam involvement. Males showed a higher prevalence and different distribution patterns compared to females.

OP-11-03 ORAL PRESENTATION – ORTHOPEDICS

NR. 263

Lopez-Gomez F, Cassel M, Engel T, Mayer F

Bone Marrow Edema and Pain Characteristics in Adolescent Athletes with Low Back Pain

UNIVERSITY OUTPATIENT CLINIC, Sports Medicine & Sports Orthopedics, University of Potsdam, Germany

- **Background:** Low back pain (LBP) is prevalent among adolescent athletes (AA), but its origin -specific or non-specific-remains unclear. MRI is frequently used to diagnose specific pathologies, where bone marrow edema (BME) is considered an early stage of Bone Stress Injury (BSI). However, even if BME is present, its role as the cause of pain is uncertain. Therefore, this study analyzed if pain intensity and characteristics are related to BME in AA with LBP.
- **Methods:** This retrospective cross-sectional study included $n = 232$ AA (age 12–21 years) who underwent lumbar MRI for LBP diagnostics to rule out BSI. After excluding structural abnormalities, $n = 95$ AA (age 15 ± 1.6 years; 61% male) were categorized into two groups by the presence or absence of BME. Pain intensity (Visual Analog Scale) served as the outcome measure. Training load (sessions/week, minutes/session), age, and sex were considered moderating factors. A subgroup analysis examined pain during running, jumping, throwing, and sport-specific movements. Group differences were analyzed using nonparametric Mann-Whitney-U-test ($\alpha = 0.05$). Multivariable logistic regression assessed pain intensity and movement-related pain, adjusted for age, sex, and training volume.
- **Results:** Of the 95 AA, 41 (43%) had BME. There was no statistically significant group difference in pain intensity (VAS 3.1 ± 2.1 vs. 3.5 ± 2.1 , $p = 0.43$). Training frequency was similar, but athletes with BME had shorter session durations ($p = 0.03$). Age, sex, and training volume showed no influence ($p > 0.05$). In subgroup analysis ($n = 47$), BME was not linked to pain during running, jumping, throwing, or sport-specific movements ($p > 0.05$). Age was inversely associated with pain during running and jumping, with younger athletes reporting more pain.
- **Conclusion:** BME was not associated with pain intensity or movement-specific pain in AA with LBP. Therefore, MRI-detected BME should be interpreted cautiously, as it may not be the source of pain in every case.

OP-11-04 ORAL PRESENTATION – ORTHOPEDICS

NR. 274

Utku B, Braun L, Willwacher S

Could prophylactic ankle taping be a risk factor for patellofemoral pain syndrome?

HACETTEPE UNIVERSITY MEDICAL FACULTY, Turkey (Türkiye)

- Ankle taping (AT) is widely used to reduce recurrent ankle sprains by limiting peak inversion during sport-specific activities. Rearfoot inversion–eversion is mechanically coupled with tibial rotation. Increased knee internal rotation has been linked to overuse injuries in distance runners. Therefore, this study investigated whether taping influences calcaneus–tibia coupling and whether these effects change over time with continued use.
- Twenty-five healthy participants (10 women, 15 men) without current injury were included. Three conditions were tested: barefoot (BF), tape freshly applied (TF), and tape after 15 minutes of sports-specific activity (TU). Participants performed running trials (4.5 ± 0.2 m/s) on a tartan surface, striking a force platform with the right foot. Kinematic data were collected using a 22-camera motion system, and kinetic data were obtained from embedded force platforms. Joint angles were calculated using Cardan methods. Calcaneotibial coupling coefficients (CCs) were derived using linear regression between rearfoot eversion–inversion and tibial rotation. Furthermore, vector coding was applied to assess relative joint contributions as a function of time by calculating vector orientations from angle–angle plots.
- During stance, calcaneal eversion/inversion was coupled with tibial rotation across all conditions (CC: $1.00 - 1.27$). Taping significantly increased CCs compared to BF, with no difference between TF and TU ($p_{\text{Bonf}} = 1.00$). Vector coding angles smaller than 45° ($33.4 - 36.6^\circ$) indicated greater tibial transverse plane motion relative to rearfoot movement. Differences between BF and taping conditions were significant (BF-TF, $p < .001$; BF-TU, $p < .001$), but not between taping conditions. Effect sizes further confirmed stronger coupling with taping (BF-TF $d = -0.730$; BF-TU $d = -0.754$). However, taping also reduced peak rearfoot eversion significantly (BF: -7.2° , TF and TU: -5.6° , $p < .05$ for BF-TF and $< .01$ for BF-TU conditions). Increased CCs and reduced peak rearfoot eversion might have offsetting effects when considering tibial internal rotation in runners using ankle taping.

OP-11-05 ORAL PRESENTATION – ORTHOPEDICS

NR. 237

Menge C, Mai J, Fohrmann D, Dalos D, Rückemann L, Radovanovic G, Lutter C, Schwalm L, Hollander K

Do advanced footwear technology shoes influence running-related injury risk? An exploratory randomized controlled trial

MSH MEDICAL SCHOOL HAMBURG, Germany

- **Background:** Advanced footwear technology (AFT) shoes, featuring compliant and resilient midsoles and stiffening elements such as carbon plates, are known to improve running economy. Whether these performance benefits are accompanied by changes in running-related injury (RRI) risk remains unclear. Therefore, this study aimed to investigate the effect of AFT shoes on the occurrence and distribution of RRIs.
- **Methods:** Competitive runners with a World Athletics score >400 were randomized to an AFT intervention group or a non-AFT control group. During the 12-week intervention, participants were instructed to gradually increase the proportion of training performed in the study shoes from 10% to 30%. The Oslo Sports Trauma Research Center (OSTRC) questionnaire was completed weekly. An RRI was defined as an OSTRC score $\geq 25/100$. Participants meeting this criterion were additionally invited for clinical examination by sports physicians. Injury outcomes were compared using risk ratio (RR), incidence rate ratio (IRR) and Kaplan–Meier analysis with log-rank testing.
- **Results:** A total of 69 participants (AFT $n = 35$; non-AFT $n = 34$) were included in the analysis. In the AFT group, 14 participants (40%) and in the non-AFT group, 6 participants (17.6%) had at least one injury (RR 2.27; 95% CI 0.99–5.21; $p = 0.063$). Injury incidence rates were 8.9 (95% CI 4.88–14.96) and 4.6 (95% CI 1.69–10.01) per 1000 exposure hours in the AFT and non-AFT group (IRR 1.94, 95% CI 0.74–5.06). Kaplan–Meier analysis indicated a higher injury-free survival probability in the non-AFT group, but the difference was not statistically significant (log-rank $p = 0.057$). Foot, ankle and thigh injuries occurred only in the AFT group, while the knee was the most affected anatomical region in both groups.
- **Conclusion:** Injury risk was approximately twofold higher in the AFT group, but between-group differences were not statistically significant. These exploratory findings should be investigated in larger studies with longer follow-up.

OP-11-06 ORAL PRESENTATION – ORTHOPEDICS

NR. 108

Krauß I, Schweda S, Dierkes K, Schmid J, Martus P, Müller G, Munz B, Nieß AM, Sudeck G

Effects of the 24-week multi-component exercise and lifestyle intervention MultiPill-Exercise in physically inactive adults with multimorbidity: follow-up data of a pragmatic randomized controlled trial

UNIVERSITÄTSKLINIKUM TÜBINGEN, Germany

- **Aims:** To determine whether a multi-component lifestyle intervention increases health-enhancing physical activity (HEPA), VO₂peak and BMI compared with standard health care courses in patients with multimorbidity up to 18 months after baseline.
- **Methods:** In this multi-site pragmatic randomized controlled trial, health insurance members with ≥2 chronic conditions (cardiovascular disease, diabetes, obesity, or osteoarthritis) achieving <75% of WHO physical activity recommendations were enrolled. The intervention group (IG) participated in a 24-week program including supervised exercise, dietary counselling, and PA-related health competence training. The control group (CG) attended standard health care courses. Outcomes included HEPA (min/week; EHIS-PAQ), adherence to aerobic and muscle-strengthening recommendations, VO₂peak, and BMI assessed at 6, 12, and 18 months (PA measures only).
- **Results:** A total of 254 participants were analysed (mean age 56.5 years; 62% female). Between-group differences in HEPA were not significant. However, IG showed a significant within-group increase of 104 min/week at 6 months ($p=0.005$), which was not sustained long term. IG had higher short-term odds of meeting aerobic (OR=2.20, $p=0.01$) and muscle-strengthening recommendations (OR=1.93, $p=0.03$), with the latter demonstrating within-group changes in both groups until t18 (all $p<0.05$). Both groups also showed improvements in VO₂peak (IG ± 2.7 ml/kg/min; CG ± 1.6 ml/kg/min) and BMI (IG ± 2.0 kg; CG ± 1.42 kg) at 6–12 months. No serious adverse events occurred.
- **Conclusion:** MultiPill-Exercise did not outperform an active standard care comparator in HEPA but produced clinically relevant within-group improvements and higher adherence to PA recommendations compared to CG. Improvements in VO₂peak and BMI were small but may still confer health benefits in individuals with low cardiovascular fitness and help counteract typical annual weight gain of 0.5–1 kg. Overall, the multi-component intervention designed for patients with multimorbidity appears safe and potentially advantageous compared with unspecific or single-disease-oriented standard care. However, sustained support and careful exercise dosing may be necessary to achieve long-term engagement in health-promoting physical activity and clinically meaningful fitness gains.

OP-12-02 ORAL PRESENTATION – SPORTS NEUROLOGY & PSYCHIATRY

NR. 299

Weike N, Coenen J, Reinsberger C

Functional connectivity in response to submaximal exercise in athletes with sport-related concussion

UNIVERSITÄT PADERBORN, Germany

- **Background:** Sport-related concussion (SRC) is a common and complex injury in sports. Early physical exercise has been shown to be beneficial for the recovery process, yet many athletes experience exercise intolerance after injury. Investigating neurophysiological reactions to exercise may provide insights into underlying mechanisms, but the knowledge about exercise-induced changes in brain network activity in SRC is limited. This study aimed to investigate functional connectivity before and after submaximal exercise in athletes with SRC compared to healthy controls.
- **Method:** Twenty-nine athletes with SRC (23.7±4.4 years) and 29 healthy, matched control athletes (24.0±4.3 years) performed a standardized, submaximal cycling exercise protocol. Resting-state electroencephalography (128 channels) was recorded before and after exercise. Functional connectivity (phase-locking value) was calculated for whole brain, default mode network and central autonomic network. Time x group interactions were tested using mixed ANOVA. Differences between pre- and post-exercise for both groups were investigated using dependent t-tests or Wilcoxon tests.
- **Results:** No interaction or group effects were found in the ANOVA. Significant time effects were observed for functional connectivity in whole brain ($p=0.004$) and central autonomic network ($p<0.001$). Within-group analyses showed differences between pre- and post-exercise for functional connectivity in whole brain ($p=0.006$, $r=0.512$) and central autonomic network ($p=0.011$, $r=0.472$) in the control group, with an increase in connectivity from pre- to post-exercise. In the SRC group, functional connectivity also increased, but the change was not significant.
- **Conclusion:** Changes in connectivity from pre- to post-exercise did not differ between SRC and control group. However, within-group analyses showed an increase in whole brain and central autonomic connectivity only in controls, which may indicate a blunted or more variable response to exercise in SRC patients. Since exercise-induced change seems to be heterogeneous in the SRC group, future studies should investigate whether changes correlate with symptom severity, exercise tolerance or individual recovery trajectories.

OP-12-01 ORAL PRESENTATION – SPORTS NEUROLOGY & PSYCHIATRY

NR. 283

van den Bongard F, Nuernberg M, Reinsberger C

High vs. Low Density: Assessing the Impact on Phase Locking Value in EEG

PADERBORN UNIVERSITY, Germany

- **Background:** Spatially co-registered Electroencephalography (EEG) derived data may allow to assess functional brain networks. Several data analysis algorithms provide access to functional brain connectivity measures that can for example be used to study effects of sports and exercise. Usually, high-density EEG setups are needed to obtain the appropriate source localization of the electric signal and reduce volume conduction artifacts, but those arrays require extensive preparation time and are often impractical in sports settings.
- **Methods:** This study systematically evaluated the influence of different electrode densities (128, 96, 64, 32 electrodes) in EEG recordings on Phase Locking Value (PLV) across resting-state EEG data from healthy individuals and epilepsy patients ($n=50$, 37.96 ± 11.99 years, female $n=26$, male $n=24$), assessed before and after exhaustive exercise. Friedman test, followed by pairwise post-hoc comparisons, was calculated on z-transformed normalized data. Besides whole brain connectivity, PLV was determined in the Default Mode Network (DMN, 13 regions of interest (ROI), Central Autonomic Network (CAN, 24 ROI) and Visual Network (VIS, 7 ROI).
- **Results:** Whole-brain PLV showed no significant differences across different densities (68 ROIs). In contrast, PLV in the DMN ($p<0.008$), CAN ($p<0.008$), and VIS ($p<0.008$) were significantly different across arrays. A significant PLV difference of pre-post exercise delta values was only observed for DMN PLV between 96 and 128 electrodes ($p<0.008$).
- **Conclusion:** Despite normalization and z-transformation, connectivity differed between electrode densities before and after exercise, indicating spatial sampling effects. While global metrics remained relatively robust, lower-density setups may distort network-level connectivity, possibly due to signal-to-noise ratio and volume conduction. A significant difference between 96 and 128 electrodes on pre and post exercise differences suggests that these effects may also be relevant in longitudinal analyses.

OP-12-03 ORAL PRESENTATION – SPORTS NEUROLOGY & PSYCHIATRY

NR. 269

Rißmayer M, Möller S, Jelic S, Jung-Botho M, Demir S, Buller S, Bloch W, Lichtenstein T, Javelle F

Biomarkers and Affective Responses to Exercise in Depression: The Role of Individual Preferences

DEUTSCHE SPORHOCHSCHULE KÖLN, Germany

- **Background:** Aerobic exercise is a well-established treatment for Major Depressive Disorder (MDD). However, poor adherence remains a major barrier, limiting its clinical effectiveness. Research indicates that affect experienced during exercise is a key driver of adherence. Yet, most studies assess affect only after exercise, when improvements may reflect relief-like effects rather than the actual in-task experience. For future participation, negative affect during the session likely represents the main burden. While high-intensity training (HIT) may induce strong biological effects on immune and metabolic markers relevant to depression, individual differences in tolerance and preference for exercise intensity may adversely affect in-task affect, particularly at higher intensities. Therefore, we compared the routine blood picture and kynurenine metabolites, alongside acute affective responses, during HIT and self-paced exercise, and examined the influence of individual preferences for exercise intensity on both outcomes.
- **Methods:** In a randomised crossover design, 24 patients with MDD completed one HIT session and one self-paced cycling session. Affective responses during exercise were assessed using the Feeling Scale. Fasting blood samples were collected pre-exercise, immediately post-, and 30 minutes post-exercise. Individual preference and tolerance for exercise intensity were assessed via questionnaire as potential moderators.
- **Results:** A significant time x condition interaction indicated more positive affect during self-paced compared to HIT ($p<0.01$, $\eta^2=.16$). Thereby, the decline in affect during exercise was moderated by individual preference for exercise intensity ($p=0.008$, $\eta^2=.13$). No significant differences between conditions were observed for Systemic Inflammation Index or Kynurenine metabolites ($p>.050$).
- **Discussion:** HIT did not produce different effects on inflammation or kynurenine metabolism compared to self-paced exercise. However, affective responses between exercise conditions differed substantially depending on individual preferences. Given the importance of positive affect for adherence, these findings underscore the need to integrate individual intensity preferences when balancing biological and psychological factors in personalised exercise prescriptions for depression.

OP-12-04 ORAL PRESENTATION – SPORTS NEUROLOGY & PSYCHIATRY NR. 264

Schlagheck ML, Berger K, Meyer T, Wellmann J, Reinsberger C

Depression and anxiety disorder in former professional football players - SocHealth (NAKO)

PADERBORN UNIVERSITY, Germany

- **Background:** Professional football players face high physical demands during their careers. Among potential long-term effects, neuropsychiatric disorders, including depression and anxiety, have gained considerable attention. However, empirical data on long-term mental health in this population remain scarce.
- **Method:** SocHealth is a satellite project of the German National Cohort (NAKO) investigating the health status of former professional football players compared with the general population. Lifetime depression and anxiety disorders were assessed using self-reported physician diagnoses, and current symptoms using the Patient Health Questionnaire-9 (PHQ-9) and the Generalized Anxiety Disorder Scale (GAD-7). Logistic regressions were performed separately for men and women and for depression and anxiety outcomes, with cohort (former athletes vs. control) as the main predictor. Models were adjusted for age, years of education, and self-reported physical activity level. Models for PHQ-9 and GAD-7 outcomes were additionally adjusted for German language proficiency.
- **Results:** This analysis included 268 male and 47 female former professional football players aged 35–72 years and 71,892 male and 59,812 female NAKO participants within the same age range. Compared with controls, former athletes had lower odds of depression (men: 6% vs 11%, OR= 0.55; 95%-CI [0.32;0.86]; women: 6% vs. 20%, OR= 0.30; 95%-CI [0.07;0.82]) and anxiety (men: 3% vs. 6%, OR= 0.50; 95%-CI [0.23;0.94]; women: 4% vs. 11%, OR= 0.41; 95%-CI [0.07;1.32]) based on self-reported diagnoses. Similar patterns were observed for moderate-severe depressive (PHQ-9 ≥ 10 , men: 2% vs. 6%, OR= 0.26; 95%-CI [0.08;0.61]; women: 6% vs. 9%, OR= 0.72; 95%-CI [0.17;1.97]) and anxiety symptoms (GAD-7 ≥ 10 , men: 2% vs. 3%, OR= 0.57; 95%-CI [0.20;1.23]; women: 6% vs. 7%, OR= 1.04; 95%-CI [0.25;2.85]).
- **Conclusion:** Former professionals showed lower lifetime prevalences and current symptom burden for depression and anxiety. This may indicate beneficial long-term effects of professional football participation or higher resilience to mental health problems among individuals reaching professional levels in football.

OP-12-06 ORAL PRESENTATION – SPORTS NEUROLOGY & PSYCHIATRY NR. 175

Wences-Chirino T, Proschinger S, Trebing S, Hoenen L, Linnig M, Sperling A, Kupjetz M, Joisten N, Zimmer P

Twelve Weeks of High-Intensity Interval Training Improves Quality of Life and depressive symptoms in Persons with Multiple Sclerosis: Results From a Single-blind Randomized Controlled Trial

TECHNISCHE UNIVERSITÄT DORTMUND, Germany

- **Background:** Multiple sclerosis is a chronic neurological disease leading to progressive physical and mental disability. Fatigue and depressive symptoms are prevalent MS symptoms and risk factors for a lower quality of life (QoL) in persons with relapsing-remitting MS (pwRRMS). These factors may improve by high-intensity interval training (HIIT). This study aimed to assess the effects of a 12-week HIIT program on patient-reported outcome measures (PROMs) in pwRRMS, and to evaluate whether these changes are related to training-related variables.
- **Methods:** Seventy-five pwRRMS with mild-to-moderate disability (Expanded Disability Status Scale (EDSS) score ≤ 4) were randomized to the 12-week HIIT program (3x/week) or a passive waitlist control group. Participants conducted cardiopulmonary exercise testing and PROMs assessing fatigue (Fatigue Scale for Motor and Cognitive Functions (FSMC)), mood symptoms (Hospital Anxiety and Depression Scale (HADS)) and QoL (Multiple Sclerosis International QoL (MusiQoL)) at baseline, post-intervention, and after a 4-week follow-up. The effects of HIIT were evaluated using linear mixed-effects models fitted separately for each variable outcome and Bonferroni-corrected pairwise comparisons. Pearson correlations were calculated between changes in PROMs, cardiorespiratory fitness, attendance [%], and interval intensity [W/kg], and time since diagnosis within the HIIT group.
- **Results:** HIIT significantly improved depressive symptoms of pwRRMS ($p = 0.001, \eta^2 p = 0.153$) and the total HADS ($p = 0.003, \eta^2 p = 0.079$) while not affecting FSMC scores compared to the control group. QoL also improved ($p = 0.043, \eta^2 p = 0.047$), mainly resulting from improvements in 'symptom burden' ($p = 0.038, \eta^2 p = 0.048$) and 'relationship with friends' ($p = 0.037, \eta^2 p = 0.047$) subdomains. Changes in PROMs were not correlated with each other nor with changes in training-related variables or time since diagnosis. However, greater improvements in cardiorespiratory fitness were correlated with higher attendance ($p < 0.001, r = 0.606$) and greater interval intensity increase ($p < 0.001, r = 0.610$).
- **Conclusion:** Twelve weeks of HIIT improves QoL and depressive symptoms in pwRRMS. The observed improvements were independent of disease duration, training attendance, and changes in fitness and interval intensity.

OP-12-05 ORAL PRESENTATION – SPORTS NEUROLOGY & PSYCHIATRY NR. 170

Fiedler DV, Rosenstiel S, Peters S, Zwanzleitner L, Flagmeier AL, Ramos-Murguialday A, Sundmacher L, Wolf S, Ehring T, Sudeck G

Process evaluation of an exercise intervention (ImPuls) promoting physical activity for patients with mental disorders

INSTITUTE OF SPORTS SCIENCE, Tübingen, Germany

- **Background:** Physical activity is an effective adjunctive treatment for mental disorders, yet its implementation into routine care remains challenging. A manualized group exercise intervention including behavior-change techniques ("ImPuls") was developed to promote physical activity among people with mental disorders within the outpatient mental health care setting in Germany. This contribution examines the implementation of the program, including reach, dose, fidelity, as well as barriers and facilitators.
- **Methods:** A process evaluation with a mixed-methods design was applied alongside a pragmatic randomized controlled trial. Quantitative data included recruitment metrics, attendance rates, and fidelity ratings based on video-recorded group sessions. Qualitative data were collected through semi-structured interviews with 20 exercise therapists and one focus group interview with 5 managers. Data were analyzed using descriptive statistics and qualitative content analysis, and integrated to provide a comprehensive understanding of implementation processes.
- **Results:** Recruitment was successful with $n = 400$ patients included, but varied across sites and referral pathways, indicating the importance of adaptive, context-sensitive strategies. Attendance rates suggested good adherence and a low dropout rate of 19%. Fidelity analyses showed generally high adherence to core intervention components (87%). However, key elements such as goal setting and barrier management were perceived as both particularly important and also very challenging to implement. Qualitative findings highlighted the importance of structured training of therapists, practical experience, and challenges related to time constraints and integration into daily routines.
- **Conclusion:** The findings underline the feasibility of implementing manualized exercise intervention including behavior-change techniques for people with mental disorders in outpatient mental health care. Adaptive recruitment strategies, comprehensive training formats for therapists, and flexible delivery options appear crucial for successful implementation. Future research should investigate optimal strategies for sustainable integration into routine care and their impact on intervention effectiveness.

PLENARY 7 EXERCISE IS MEDICINE IN NEUROLOGICAL DISORDERS NR. 109

Kupjetz M, Langeskov-Christensen M, Riemenschneider M, Inerle S, Ligges U, Patt N, Bansi J, Gonzenbach RR, McCann A, Ueland PM, Wences Chirino TY, Joisten N, Hvid LG, Dalgas U, Zimmer P

Exercise-induced kynurenine pathway modulation in multiple sclerosis: multinational evidence from four randomized controlled trials

TU DORTMUND UNIVERSITY, Germany

- **Background:** The kynurenine pathway of tryptophan metabolism is an important neuroimmune hub that is imbalanced in multiple sclerosis (MS). In people with MS, kynurenine pathway metabolites (kynurenines) appear to cluster into either a predominantly inflammation-associated, likely neurotoxic pattern (NeuroTox) or a predominantly neuroprotective pattern (NeuroPro). Acute endurance exercise (EE) induces a transient, neuroprotective shift in individual concentrations of kynurenines. This study employed a pattern-based approach to assess (1) the acute effects of strength-focused exercise (SFE) and (2) the effects of regular SFE and EE on NeuroTox and NeuroPro.
- **Methods:** Serum concentrations of kynurenines were analyzed using targeted metabolomics (LC-MS/MS). The robustness of NeuroTox and NeuroPro was examined by repeating the baseline exploratory factor analysis (EFA) in a pooled follow-up cohort of 269 people with MS who participated in four randomized controlled exercise trials conducted in Denmark (NCT03322761, NCT02661555), Germany (DRKS00017091), and Switzerland (NCT04356248). Linear mixed-effects models were used to assess the acute effects of SFE and the effects of regular SFE (10 weeks) and EE (3 or 24 weeks).
- **Results:** Loadings of kynurenines on NeuroTox and NeuroPro were reproduced in repeated EFA. Acute SFE significantly increased NeuroPro from baseline to the end of the session (model estimate = 0.421, 95% CI [0.216, 0.626], $p < 0.001$). EE significantly reduced NeuroTox from baseline to the 24-week assessment in one of the examined cohorts (NCT02661555) (model estimate = -0.432, 95% CI [-0.786, -0.080], $p = 0.019$).
- **Conclusion:** NeuroTox and NeuroPro are temporally robust. Acute strength-focused exercise boosts NeuroPro. 24-week endurance exercise appears to diminish NeuroTox, with divergent results obtained across studies. Future studies examining the determinants of changes in both patterns, as well as their clinical implications for alleviating MS pathophysiology or symptom burden, are warranted.

PLENARY 7 EXERCISE IS MEDICINE IN NEUROLOGICAL DISORDERS NR. 246

Javelle F, Clare E, Cleef S, Cyriax M, Dreisigacker F, Drost L, Görg D, Kambeitz J, Krombholz S, Lichtenstein T, Meißenburg J, Ringleb M, Rißmayer M, Schulz C, Thevis M, Zimmer P, Bloch W

From Acute Inflammatory Responses to Long-Term Clinical Adaptations: High-Intensity Interval Training vs. Stretching Effects on Depressive Symptoms and the Kynurenine Pathway in Major Depressive Disorder

GERMAN SPORT UNIVERSITY COLOGNE, Germany

- ▶ **Background:** Major depressive disorder (MDD) is a leading cause of disability worldwide, with chronic inflammation playing a key role in its pathophysiology. It is associated with alterations in the kynurenine pathway (KP), promoting the synthesis of neurotoxic metabolites. High-Intensity Interval Training (HIIT) has demonstrated anti-inflammatory effects, suggesting it may balance KP alterations and reduce depressive symptoms. This randomised controlled trial examined whether HIIT, compared with an active control condition, can concordantly regulate inflammatory-mediated changes in the KP and depressive symptoms in outpatients with MDD. Acute effects were also tested to better understand the mechanisms underlying behavioural changes.
- ▶ **Methods:** Outpatients diagnosed with mild to moderate MDD, unmedicated or on stable medication, were allocated to either HIIT (4x4min [85 to 95% HRmax]) or stretching. Participants trained three times per week for 10 weeks under supervision. A comprehensive test battery, including clinical interviews and questionnaires, blood sampling, and cardiopulmonary exercise testing, was conducted at baseline, after 5, and after 10 training weeks. In addition, an acute exercise session was assessed after three weeks (pre-, post-, and 45 minutes post-exercise) to evaluate transient inflammatory responses in both groups.
- ▶ **Results:** A total of 55 outpatients (4 still ongoing; age=35.6±8.2y; 56.4% female) were allocated to HIIT (n=27) or stretching (n=28). HIIT improved aerobic fitness, while no changes occurred in stretching (VO_{2peak}: p<.001; η^2 =0.290). Both intention-to-treat (ITT), and per-protocol analyses revealed significant decreases in depressive symptoms, with greater effects for HIIT (ITT: IDS-C30: p<.001; η^2 =0.160). Preliminary kynurenine analysis indicated that HIIT reduced the neurotoxic branch activity (ITT: Quinolinic Acid/Kynurenine: p=.016, η^2 =0.150). These long-term adaptations may be associated with acute inflammatory responses induced by HIIT but not by stretching (e.g., Leukocytes: p<.001; η^2 =0.470, Systemic Immune Inflammation index: p<.001; η^2 =0.130).
- ▶ **Conclusion:** HIIT appears as a promising (add-on) treatment for MDD, potentially through acute inflammatory effects influencing chronic KP alterations.