

前言

本刊主要收录Web of Science核心合集数据库有关体教融合、体医融合、奥林匹克教育、冰雪运动、体育工程、反兴奋剂、文化与新闻传播领域的最新研究成果。

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本刊旨在利用Web of Science核心合集平台为广大师生提供有关目前热点的最新研究内容。检索出的数据采用书目共现分析系统(Bicomb V2021)对文献信息进行提取,包括期刊、关键词、标题、发文年份等,相同含义的字段去重且批量合并,同时去除没有实质意义的字段,对所提取的字段进行频次统计,形成高频矩阵,并使用社会网络分析软件Vosviewer绘制成知识图谱,进行共词聚类分析。

本期选录体教融合方面的文献12篇,体医融合方面的文献18篇,冰雪运动方面的文献12篇,体育工程方面的文献19篇,反兴奋剂方面的文献19篇。

目 录

体教融合

Alignment of physical education curricula with physical literacy across europe: An observational mapping study with country-level predictors	2
Multimodal algorithmic fusion model for physical education assessment: Spatiotemporal comparison of inertial measurement units and traditional scales	3
"I didn't want physical education days to come": Emotional experiences in physical education of prospective primary education teachers	4
Integrating stem education within strength & conditioning-based physical education classes	5
Factors influencing high school physical education teachers' content selection	5
What's right with pe: Exploring positive narratives in physical education	6
Effects of applying gamified exercise in health education classes on physical activity levels in school-aged children: A randomized controlled pilot study	6
Effect of an integrated physical activity and nutrition education program delivered by physical educators	7
Physical education as a tool for emotional growth: Insights from a multidimensional approach in early childhood education	8
Socio-emotional skills and physical activity in primary and secondary education students ..	8
Gendered grouping practices in secondary physical education in england: Listening to student voice	9
Comparative effects of physical education interventions on motor ability and executive function in junior high school students and their interrelationships	10

体医融合

Comparative efficacy of various exercise types on psychophysiological outcomes in colorectal cancer survivors: A network meta-analysis	12
Heart rate variability-guided exercise training compared with standard exercise training in patients with coronary artery disease: A randomized clinical trial	12
Kinesiophobia and physical activity in patients after percutaneous coronary intervention: The mediating role of self-efficacy and the moderating role of type d personality	13
Exercise as a therapeutic intervention for long-lasting and chronic diseases	14
Anatomy of a failure: A retrospective evaluation of a cognitive bias modification intervention to promote physical activity in cardiac rehabilitation	14

Freen n, lönn a, carrol s, et al. Association of physical activity and sitting time trajectories with mortality risk in 9430 australian adults with coronary heart disease	15
Effectiveness of postoperative progressive relaxation exercises on pain, anxiety, and physiological parameters after emergency abdominal surgery: A randomized controlled trial	16
Sex differences in physical activity, psychosocial determinants, and symptom outcomes in knee osteoarthritis: A cross-sectional analysis of a hispanic/latino-predominant cohort	17
Effects of hybrid-type multicomponent exercise training on cardiopulmonary capacity, resting metabolic rate, and muscle strength following bariatric surgery	18
A cardiac-rehab home-based mhealth program to improve physical activity in patients with coronary artery disease: A randomized controlled trial	19
Assessing the synergy between a mediterranean diet and physical activity on cardiometabolic risk: A 2x2 factorial randomized controlled study	19
Air pollution and incident cardiovascular disease: Modification by genetic susceptibility and the mitigating role of physical activity	20
Exercise during chemotherapy treatment as an adjuvant programme in patients with lymphoma (edonola): Study protocol for a randomised controlled trial	21
Effects of exercise on multiple health outcomes in children and adolescents with overweight or obesity: A meta-analysis of 176 randomized controlled trials and its implications for global obesity prevention	22
Sustaining physical activity in chronic obstructive pulmonary disease: A qualitative study of perspectives on a personalized community-based physical activity program	23
Exercise training for the management of dyslipidaemia. A position statement from exercise and sports science australia (essa)	24
Differential responsiveness to exercise and cognitive remediation in physical health in people with schizophrenia: Results from the cortex-sp study	24
Perceptions and experiences of self-initiated discontinuation of home-based exercise rehabilitation in people with coronary artery disease	25

冰雪运动

Designing inclusive mountain landscapes for social sustainability: A flow-chain framework and toolkit for alpine ski areas	27
From first ski day to olympic gold: A mixed-methods case study of long-term ski-specific training and fitness development in one of the most successful alpine skiers in history	27
Skiing through climate change: How tourist specialization shapes adaptation preferences and willingness to pay	28
On the edge: Lumbar spine health and injury risk in high-level competitive figure skaters	29

Integration of a state-space floor thermal model with dest for annual load simulation of indoor ice rinks and ski resorts	29
Dental occlusion and athletic performance: The impact of customized occlusal splints on postural control in professional figure skaters	30
The experiential dynamics of winter sports: Interrelationships of perceived experiences, norms, behavioural control and behavioural intentions	31
Visual behavior in inline speed skating: An eye-tracking evaluation for performance analysis	31
Go big or spin fast? Biomechanical deterministic models for snowboard halfpipe tricks performed at the beijing 2022 olympic winter games men's final.	32
Oxidative stress and antioxidant enzyme activities in elite female turkish cross-country skiers.....	33
Backcountry skiing in Norway: Between global lifestyle sport and national tradition.	34
From snow to screens: Resident support for olympic esports games in a former winter olympic games host city.....	34
Combined action observation and motor imagery elicits superior frontoparietal activation in elite ski jumpers: An fnirs study	35
Can winter sport nostalgia stimulate tourists' motivation during the off-season? A two-wave longitudinal study.....	34

体育工程

Attention-based multimodal framework for athlete-performance analysis and rehabilitation monitoring using vision and wearable sensors	38
Revolutionizing wearable sensor data analysis with an automated decision-making model for enhanced human activity detection	39
Prevalence and factors associated with adolescent idiopathic scoliosis in shanghai, china: An artificial intelligence-assisted screening approach	39
Msba-lstm: A multi-scale bidirectional attention long short-term memory network for early risk prediction from multimodal wearable sensor time-series data in sports	40
Wearable sports vision training may improve selected visuomotor outcomes and hitting precision in collegiate badminton athletes: A randomized controlled trial	41
Behaviordiff: A vae-diffusion framework for ai-generated synthetic behavioral data in procrastination prediction for sports instruction	42
Artificial intelligence in padel performance assessment: A comparative study of result-based and computer vision-derived rankings	42
From passive filling to active energy dissipation: Evolution, mechanisms, and application prospects of impact absorption and damping coatings in modern sports protective gear	43

Sweat-based electrochemical wearable biosensors for sports performance and fatigue monitoring: From laboratory prototypes to field deployment	44
The role of artificial intelligence in structuring youth athletic training: Implications for personality and motivational development	44
Ai-driven adaptive vibration control in smart plate systems: A sustainable approach for next-generation sports engineering	45
Exploring the role of artificial intelligence in anterior cruciate ligament injuries in high-performing & elite athletes	46
Artificial intelligence in sport management education: A students' perspective	46
Innovation in 3d printing and applications in orthopaedic sports medicine	47
Artificial intelligence in sports medicine: A decision-centered framework for the future sports physician	47
Rethinking ethical governance of generative AI in sport pedagogy research: A discipline-sensitive perspective	48
Multimodal human action recognition and personalized sports health promotion: A deep learning framework integrating wearable sensor fusion.....	49
Impact of the artificial intelligence robot applications in the mega-sport event on destination loyalty formation process: The case of hangzhou asian games 2022	50
From AI coaching to athletic engagement: The mediating roles of cognitive adaptability and growth mindset in sports students	51

反兴奋剂

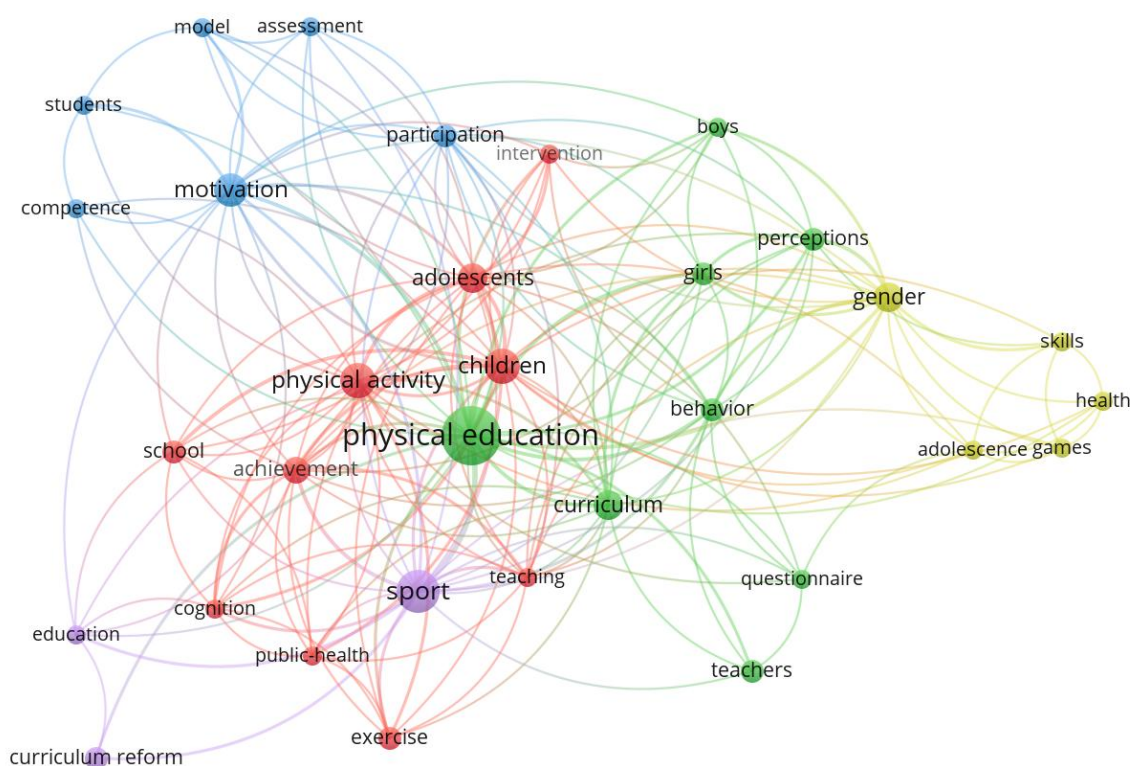
Comparison of dried blood spot sampling methods for rna-based biomarker measurement in anti-doping.....	53
Comprehensive profiling of 6 α -chloro-testosterone metabolism in human urine using gas chromatography-mass spectrometry.....	53
Revisited pharmacokinetic profiles of methylprednisolone in plasma and urine after single and multiple oral administrations: Relevance in sports drug testing	54
Doping in recreational sports	55
Comparing the stability and detectability of testosterone esters in capillary serum, sodium fluoride-containing plasma, and dried blood spots after testosterone ester administration ..	56
Characterization of novel metabolites of the hif stabilizer jnj-42041935 in rats using lc-hrms for doping control purposes: A pilot study	56
Comprehensive metabolic characterization of gbt1118 in humans using a combined approach via uhplc-hrms for doping control	57
Analysis and characterization of kisspeptin and its analogues in serum and urine samples by liquid chromatography-high-resolution mass spectrometry for doping control purposes	58

Psychoactive drug use among athletes: Motives and risk factors beyond sports performance - a scoping review	58
Metabolic profiles of mk-3984 (sarm) in zebrafish using ultra high performance liquid chromatography q extractive hf hybrid quadrupole orbitrap mass spectrometry (uplc-qe-hf-ms) for doping control	59
Towards a comprehensive screening approach for detecting gene doping in racehorses and sport horses by targeting common and intrinsic plasmid sequences	60
Rapid analysis of urinary aicar by liquid chromatography-isotope ratio mass spectrometry .	60
Detection capabilities of a single dried blood spot for recombinant erythropoietin micro-dose testing in sport	61
From lip service to leader: A forgotten scandal and canada's emergence as a trailblazer in the global anti-doping movement	62
Enhancing the athlete biological passport with blockchain: A secure and transparent anti-doping approach	62
A comparison of three analytical procedures for oxandrolone long-term metabolite determination in urine samples	63
Legal and societal aspects of doping in sport.....	63
Institutional initiatives of the international olympic committee's anti-doping policies: Historical and contemporary perspectives	64
Direct lc-hrms/ms characterisation and rt-qpcr detection for potential mrna-based doping agent	64

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体教融合

本期体教融合学术研究共检索到英文相关文献1027篇，研究热点主要围绕体育课程改革、学校体育教育、青少年学生群体等方面展开。检索结果如下：1) 关键词共词分析。提取关键词191个，经过数据清洗后关键词为182个，词频 ≥ 2 (含2) 的关键词有19个，累计百分比为39.27%，高频关键词有体育教育、体育活动、动机、体育、性别等，生成可视化知识图谱（见下图）。2) 来源期刊分析。涉及期刊31种，其中载文4篇及以上的期刊有4种，所载文献累计百分比为54.29%，刊载体教融合第一位的期刊分别为：*Sport Education and Society*（JCR学科分区Q1、Q2）。3) 学科交叉分析。引用文献总计2035篇，最多的频次为6次，该文献为：*Fun and enjoyment in physical education: young people's attitudes*。4) 学术关注度分析。文献级别用量最多的是36次，排名前三位的文献分别为：*From kindergarten to primary school - Physical education as a support for students' transition*、*Valuable yet costly: Exploring students' perceived costs in physical education*、*Integrating Artificial Intelligence (AI) Literacy into Physical Education Teacher Education: A Call to Action*。



CARL J, SALIN K, BARNETT L, et al. Alignment of physical education curricula with physical literacy across Europe: an observational mapping study with country-level predictors [J]. LANCET REGIONAL HEALTH-EUROPE, 2026, 65.

ABSTRACT

Background: Physical literacy (PL) is recognised by UNESCO and WHO for fostering lifelong physical activity. Although PL stands on the global agenda of health and education policies, analyses of the adoption by European education are scant. This study aimed to map the alignment of physical education with PL in Europe, explore potential predictors at country level, and identify country 'alignment laggards'. Methods: Experts from 40 European countries assessed the alignment of national physical education curricula with PL using a pre-validated 15-indicator survey ($\alpha = 0.86$). Country-level PL alignment scores were calculated and mapped. Regression models investigated whether these scores were predicted by educational attainment (PISA), human development (Human Development Index), relative economic strength (Gross Domestic Product/Capita), societal liberty (Human Freedom Index), and innovation spirit (Global Innovation Index). Residual errors were computed to identify association-adjusted "laggards" in curricular PL alignment. Findings: Significant heterogeneity in PL alignment existed across Europe. Estonia, Wales, Finland, and Norway showed the highest, and Romania, Croatia, Cyprus, and England the lowest PL alignment. Countries' educational attainment ($\beta = 0.43$ [CI95 0.13, 0.65], $p = 0.0062$), human development ($\beta = 0.32$ [CI95 0.011, 0.58], $p = 0.043$), and innovation spirit ($\beta = 0.32$ [CI95 0.0071, 0.58], $p = 0.046$) were significantly associated with curricular PL alignment but not relative economic strength and liberty. A total of 17 European countries were consistent 'laggards' in curricular PL alignment across all significant predictors. Interpretation PL policies follow educational, developmental, and innovative gradients. Stakeholders should integrate PL as a strategic lever to transform physical education, guiding curricula and programmes to foster health through lifelong physical activity.

CHEN L, SHEN B, YIN Z, et al. Valuable yet costly: Exploring students' perceived costs in physical education [J]. EUROPEAN PHYSICAL EDUCATION REVIEW, 2026, 32(2): 366-82.

ABSTRACT

Although physical education (PE) potentially fosters holistic development across physical, cognitive, affective, and social domains, its unique physical and social demands can render it valuable yet costly. These costs, however, remain underexplored, limiting our understanding of their effects on motivation and impeding efforts to design effective curricula and teaching strategies. Grounded in situated expectancy-value theory, this study investigates perceived costs, their causes, and implications for middle school PE curriculum and instructional practices. Qualitative data were collected from 30 students (aged

12-14 years, $M = 13$, $SD = 0.61$, 50% male, 50% female) in three middle schools in China through focus groups and individual interviews. Thematic analysis of the transcripts led to the construction of four themes that capture students' perceived costs in PE, encompassing physical and physiological, psychological, opportunity, and social cost. These findings indicate that students' perceived costs are potentially driven by the predominant emphasis on the physical domain in the PE curriculum. This highlights the need to reform high school PE entrance examinations, restructure the curriculum using a constructivist approach, and implement models-based practice to help mitigate perceived costs by emphasizing the long-overlooked affective and social domains. Given the significance of cost in PE, recognizing it as a distinct motivational factor can inform the creation of more inclusive and engaging PE experiences, thereby potentially fostering sustained participation and holistic growth.

CHENG J, LI Z. Multimodal algorithmic fusion model for physical education assessment: spatiotemporal comparison of inertial measurement units and traditional scales [J]. BMC SPORTS SCIENCE MEDICINE AND REHABILITATION, 2026, 18(1).

ABSTRACT

Background: Conventional physical education assessment depends on subjective teacher observation and simple rating scales, often resulting in subjective bias, low evaluation efficiency, and delayed instructional feedback. Methods: This study constructed a hierarchical multimodal fusion framework integrating inertial measurement unit (IMU) data and expert rubric scores for standardized PE skill evaluation. The framework adopts Dynamic Time Warping for spatiotemporal alignment to resolve asynchrony between continuous sensor signals and discrete manual scoring, and applies adaptive gated fusion to balance modality weights according to data quality. A total of 3,920 skill samples from 245 middle-school students across three schools and four sports were independently annotated by three calibrated PE teachers, achieving high inter-rater reliability ($ICC(2,k) = 0.87$, 95% CI [0.84, 0.90]). All experiments were conducted with participant-wise data splitting and ten repeated random-seed trials to ensure result stability. Results: The proposed multimodal model achieved an overall accuracy of $91.3 \pm 0.4\%$, significantly surpassing single-modality baselines ($p < 1 \times 10^{-8}$). Spatiotemporal alignment effectively eliminated temporal mismatch, and the model maintained stable performance under simulated data missingness and sensor failure. The 43.2 ms single-sample inference speed meets real-time classroom assessment demands. Ablation experiments verified the essential role of cross-modal attention in multimodal learning. Leave-one-school-out and cross-stratum evaluations confirmed stable performance across different schools, genders, age groups and skill levels. The current multi-validation results support reliable within-population model performance, while external validation with independent cohorts is still required for broader generalizability. Model interpretability analysis further validated the biomechanical rationality of the

learned assessment patterns. Conclusions: This study provides a feasible multimodal digital assessment pipeline for standardized and formative physical education evaluation. The system intelligently reproduces expert-level teacher scoring rather than objective biomechanical measurement, which makes it a powerful auxiliary tool for classroom teaching rather than a substitute for professional teacher judgment. This work offers a practical digital transformation pathway for PE assessment, with standardized curriculum alignment and staged teacher professional development supporting reliable real-world educational deployment.

FLORES-AGUILAR G, RiOS-SISó X, MUÑOZ-LLERENA A. "I didn't want physical education days to come": Emotional experiences in physical education of prospective primary education teachers [J]. LEARNING AND INSTRUCTION, 2026, 104.

ABSTRACT

Background: Physical Education (PE), despite its potential for holistic development, often faces low educational and social status. Traditional pedagogical approaches can generate negative emotional experiences that influence attitudes toward physical activity in adulthood, particularly among females. Aims: To describe and compare the primary emotions that prospective primary education teachers experienced during their PE classes throughout compulsory primary (CPE) and secondary (CSE) education, and to analyze the underlying factors associated with these emotions. Sample: Fifty-six female students (aged 19-27 years) enrolled in the "Fundamentals and Curriculum of Physical Education" course at a public university in southern Spain during 2023/2024 academic year. Methods: A qualitative phenomenological design was employed using written autobiographical narratives. Participants reflected on positive and negative PE experiences across CPE and CSE, identifying causes and associated emotional states. Data were analyzed using Qualitative Content Analysis, specifically Theme Analysis, with NVivo 14 software. Results: Joy was the predominant emotion in CPE, linked to diverse content, cooperative activities, and cathartic release. In CSE, anger and fear predominated, primarily due to physical fitness testing, grading pressures, and "exposed body" experiences. Key negative themes included the captain technique for group formation, soccer dominance during free sport, content repetition, traditional assessment methods, and discriminatory teacher attitudes (sexism, fat-phobia). Conclusion: Participants' narratives revealed gender inequalities and traditional pedagogical approaches in PE that generated negative emotional experiences, particularly in CSE. These experiences may influence future teaching practices, emphasizing the urgent need to revise pre-service teacher training to address gender equity, combat discrimination, and implement innovative methodologies.

FULLERTON S, CHAPMAN I. Integrating stem education within strength & conditioning-based physical education classes [J]. STRENGTH AND CONDITIONING JOURNAL, 2026, 48(2): 191-200.

ABSTRACT

Science, technology, engineering, and math taken together as STEM Education, can be integrated into strength and conditioning (S&C)-based physical education (PE) classes to enhance learning experiences while also developing skills inherent of exercise science practitioners in the 21st century. Situating inquiry learning (IL) through project-based learning (PBL) can effectively incorporate STEM Education in S&C-based PE classes, providing contextualized and meaningful learning experiences for students. With more S&C coaches transitioning to teaching roles responsible for delivering educational programs and assigning grades, adequate pedagogical and curricular guidance is warranted. The purpose of this article is to provide a framework for integrating STEM Education into S&C-based PE courses. IL follows the 4 steps of: (a) problem clarification, (b) creating a hypothesis, (c) hypothesis testing, and (d) conclusion and validation. Delivered through PBL, inquiry projects speak to personal concerns and students have "voice and choice" in their building of knowledge and skills. We recommend incremental changes when implementing STEM Education, starting with a model-based approach of inquiry through PBL within a needs-supportive learning environment. More research is needed in the United States to evaluate STEM Education interventions in S&C-based PE courses and their effect on knowledge, skills, and dispositions of students.

GILLISPIE O, TSUDA E, ELLIOTT E. Factors Influencing High School Physical Education Teachers' Content Selection [J]. JOURNAL OF TEACHING IN PHYSICAL EDUCATION, 2026.

ABSTRACT

Purpose: This study explored the factors influencing high school physical education (HS-PE) teachers' content selection and the facilitators and barriers to teaching the content outlined in the National Standards. **Methods:** This study employed an explanatory sequential mixed-methods design. Ninety-five and nine HS-PE teachers completed the survey and the interview, respectively. Data were analyzed using three sequential steps: a quantitative data analysis, a qualitative data analysis, and an integrated analysis of both sets of data. **Results:** Most teachers focused on games and sports or fitness activity categories. Five themes identified in the interview data include beliefs about the purpose of HS-PE, content knowledge and instructional confidence, perceptions of student needs, challenges of large class sizes and limited resources, and collaboration opportunities and challenges among colleagues. **Discussion/Conclusion:** Improving teacher expertise through targeted professional development, smaller class sizes, and better facilities is crucial for aligning the intended and taught curriculum in HS-PE.

GRAY S, LAMBERT K, YOUNG L. What's right with PE: Exploring positive narratives in physical education [J]. EUROPEAN PHYSICAL EDUCATION REVIEW, 2026, 32(2): 257-73.

ABSTRACT

For decades, physical education (PE) scholars have called for a change to how PE is conceptualised and enacted, highlighting that its current (and persistent) form and focus - organised around physical activities and sports - are not fit for purpose. Much of this change-oriented discourse highlights what is wrong with PE, leading to suggestions about how PE should change in and for the future, for example, by adopting critical approaches and connecting more to the lives of young people. While we do not disagree with these perspectives and ideas, it is important to note that, in general, they have had little impact on PE curricula or pedagogy. In this paper, we suggest an alternative, strengths-based approach. Drawing from discussions with a range of professionals from the PE community (teachers, undergraduate and postgraduate pre-service teachers and teacher educators) across five national contexts - Canada, England, Ireland, Norway and Scotland - we generated narratives about 'what's right with PE'. The narratives highlighted that PE can be 'fit for purpose' when it connects to the wider school and community, when everyone has a shared understanding of its purpose, and when PE teachers enact a broad, holistic and inclusive curriculum. We present the narratives as a reflective tool, encouraging all professionals within the PE community to consider how they align with (or against) their current experiences. We hope that these reflections facilitate critical thinking and problem solving to ensure that the subject is (and remains) fit for purpose now and in the future.

HSIAO L, WANG C, YANG Y, et al. Effects of Applying Gamified Exercise in Health Education Classes on Physical Activity Levels in School-Aged Children: A Randomized Controlled Pilot Study [J]. JOURNAL OF NURSING RESEARCH, 2026, 34(3).

ABSTRACT

Background:Declining physical activity (PA) among schoolchildren is a global issue. Schools play a crucial role in children's PA, as they spend most of their waking hours at school. Therefore, developing an easy-to-implement school-based physical activity program is important.**Purpose:**This study was designed to evaluate the effectiveness of using gamified exercise in health education classes to enhance PA levels among schoolchildren.**Methods:**A randomized controlled pilot design was applied. Two elementary schools were randomly assigned, respectively, to an experimental group (EG; n = 47) that received a gamified fitness program with reciprocal physical education and a control group (CG; n = 44) that received reciprocal physical education only. The gamified fitness program, developed and validated by a multidisciplinary team, was delivered during health education classes. PA levels were measured using

AI-wireless wrist sensors worn during schooltime at three points, including the first week (T1), sixth week (T2), and 12th week (T3) of the program. Program feasibility was assessed using participant satisfaction and analyzed using Generalized Estimating Equations (GEE). Results: PA levels at the three time points (T3-T1) were significantly different between the two groups. The results of GEE analysis revealed that daily steps (mean difference $\pm$ SE: 4,068.4 $\pm$ 1,144.1 steps), total PA (84.4 $\pm$ 16.0 min), light PA (LPA; 72.6 $\pm$ 15.3 min), and moderate to vigorous PA (MVPA; 12.1 $\pm$ 2.9 min) increased significantly more over time in the EG than the CG. Moreover, approximately 85% of the EG identified the PA program as being satisfactory and feasible. Conclusions/Implications for Practice: The results of the pilot trial conducted in this study demonstrate the feasibility of integrating gamified exercise into school health education classes and the potential of this program to increase physical activity levels in schoolchildren significantly. The success of the developed program is attributable to its multidisciplinary approach, engaging design, and focus on core strength and cardiorespiratory endurance. Gamified fitness in health education may be used to promote activity, support inclusive policies, and reduce disparities among school-age students.

LAROSE D, PARADIS A, PANAHI S, et al. Effect of an Integrated Physical Activity and Nutrition Education Program Delivered by Physical Educators [J]. JOURNAL OF SCHOOL HEALTH, 2026, 96(6).

ABSTRACT

Background: Few school-based interventions integrate nutrition with physical activity (PA), especially within physical education classes. This study evaluated the effect of a nutrition education program designed for physical educators (PEs) that combined nutrition education with PA. Methods: In this cluster-randomized study, classes were assigned (class level) to a control ($n = 11$; 140 students) or an intervention group ($n = 8$; 143 students) over 4 months. PEs ($n = 7$) and students ($n = 283$) completed questionnaires pre- and post-intervention. Primary outcomes included students' nutrition knowledge, attitudes, environments, behaviors, and dietary intake. Additionally, PEs' appreciation, relevance, and use of the program and self-reported and measured compliance were evaluated. Mixed-effects models were used for analysis. Results: Students in the intervention group showed a greater improvement in nutrition knowledge than those in the control group (adjusted mean change: +3.6 versus +1.3 points, respectively; $p < 0.001$). No significant changes were observed for other outcomes. Implications for School Health Policy, Practice, and Equity Providing PEs with tailored resources enables them to effectively integrate health promotion into physical education classes. Conclusions: A nutrition education program for PEs has the potential to improve students' nutrition knowledge and offers a feasible approach to incorporate nutrition education into the physical education curriculum.

MIRA C, GARCÍA-TAIBO O, MACHÍN R, et al. Physical Education as a Tool for Emotional Growth: Insights from a Multidimensional Approach in Early Childhood Education [J]. EARLY CHILDHOOD EDUCATION JOURNAL, 2026, 54(6): 4945-56.

ABSTRACT

Physical Education (PE) provides a privileged context for fostering emotional competence in early childhood, yet empirical research with younger students remains scarce. This study aimed to analyse the effects of a PE-based program on children's emotional competence and to explore possible gender differences in program outcomes. A quasi-experimental, mixed-methods design was applied with 97 students aged 7-8 years from a public primary school in Alicante (Spain), allocated to experimental ($n = 41$) and control ($n = 56$) groups. The intervention consisted of eight 45-minute sessions combining cooperative games, yoga-based relaxation, and motor activities. Data was collected through the Children's Emotional Adjustment Scale (CEAS), systematic teacher observations using the HSC-EF system, and student-generated pictograms. The experimental group demonstrated significant improvements in mood repair and anxiety control ($p < .001$), while no significant changes were observed in temperament control or social assertiveness. Observations revealed frequent prosocial behaviours such as dialogue, kindness, and cooperation, though conflict-resolution skills appeared less consistently. Pictograms predominantly expressed joy and illustrated strong associations between sessions and emotional experiences. No significant gender differences emerged. The findings highlight PE as an effective setting for socio-emotional learning in early primary education. Short-term programs can enhance regulation of negative emotions, while more stable traits may require longer interventions. Integrating cooperative and reflective practices into PE strengthens children's emotional growth in inclusive ways.

MORCILLO-MARTÍNEZ A, GÓMEZ-BARRETO I, INFANTES-PANIAGUA A, et al. Socio-Emotional Skills and Physical Activity in Primary and Secondary Education Students [J]. JOURNAL OF SCHOOL HEALTH, 2026, 96(5).

ABSTRACT

Background: Socio-emotional skills (SES) are essential for students' wellbeing and academic adjustment, and physical activity (PA) has been shown to contribute positively to emotional, social, and cognitive development. Understanding their relationship within school populations becomes highly relevant for educational and health promotion practices.
Method: A cross-sectional study was conducted with 874 students aged 10-16 years. SES were assessed according to the OECD framework using the Social and Emotional Skills Survey. PA levels were measured through the physical activity questionnaire for children (PAQ-C) and adolescents (PAQ-A), classifying students as active or non-active.
Results: PA showed positive and significant correlations with all SES domains, with varying intensity across domains. Active

students obtained higher SES scores across domains, although small differences by gender and educational level were also observed. Differences were more pronounced at lower educational levels and decreased progressively in higher grades. Implications for School Health Policy, Practice, and Equity Findings support integrating PA as a strategic component of social-emotional learning initiatives. Schools can play a key role in promoting students' health and wellbeing by incorporating appropriate PA opportunities that strengthen socio-emotional learning (SEL) and contribute to a positive school climate. Conclusions: PA is consistently associated with more favorable socio-emotional profiles. Promoting structured and meaningful PA in school settings may support students' holistic development and enhance their overall wellbeing.

WILKINSON S, STRIDE A, PENNEY D. Gendered grouping practices in secondary physical education in England: Listening to student voice [J]. EUROPEAN PHYSICAL EDUCATION REVIEW, 2026, 32(2): 220-38.

ABSTRACT

There is substantial international literature on single- and mixed-sex grouping in physical education (PE), much of which focuses on the relative impact on students' physical activity levels, perceived self-confidence and/or interactions with teachers and peers. A smaller body of research has explored students' perspectives on single- and/or mixed-sex grouping in PE. However, much of this research is dated, limited in scope to a relatively small number of students from a small number of schools and/or dominated by binary thinking, with little recognition that students may express preferences for a combination of grouping approaches. This study was designed to extend previous research by generating large-scale data relating to cisgender students' preferences for single-sex grouping, mixed-sex grouping or a combination of these approaches in secondary school PE. The study used an online survey to generate data from 2073 boys and 2161 girls ($n = 4234$) from 47 co-educational secondary schools located throughout England. Analysis of responses revealed that, overall, most boys and girls preferred single- (52.7%, $n = 2231$) to mixed-sex grouping (23.1%, $n = 979$) or combined arrangements in PE (24.2%, $n = 1024$). Further exploration of preferences showed variations by demographic and situational factors, including gender, ability, cultural background, familiarity with a particular approach and/or the nature of the learning situation. Discussion pursues the potential benefits and challenges that schools may face in adopting flexible, situation-specific, gendered grouping practices in PE. The paper affirms the importance of student voice in decisions that powerfully shape learning opportunities and experiences and in potentially assisting in advancing gender equity in PE.

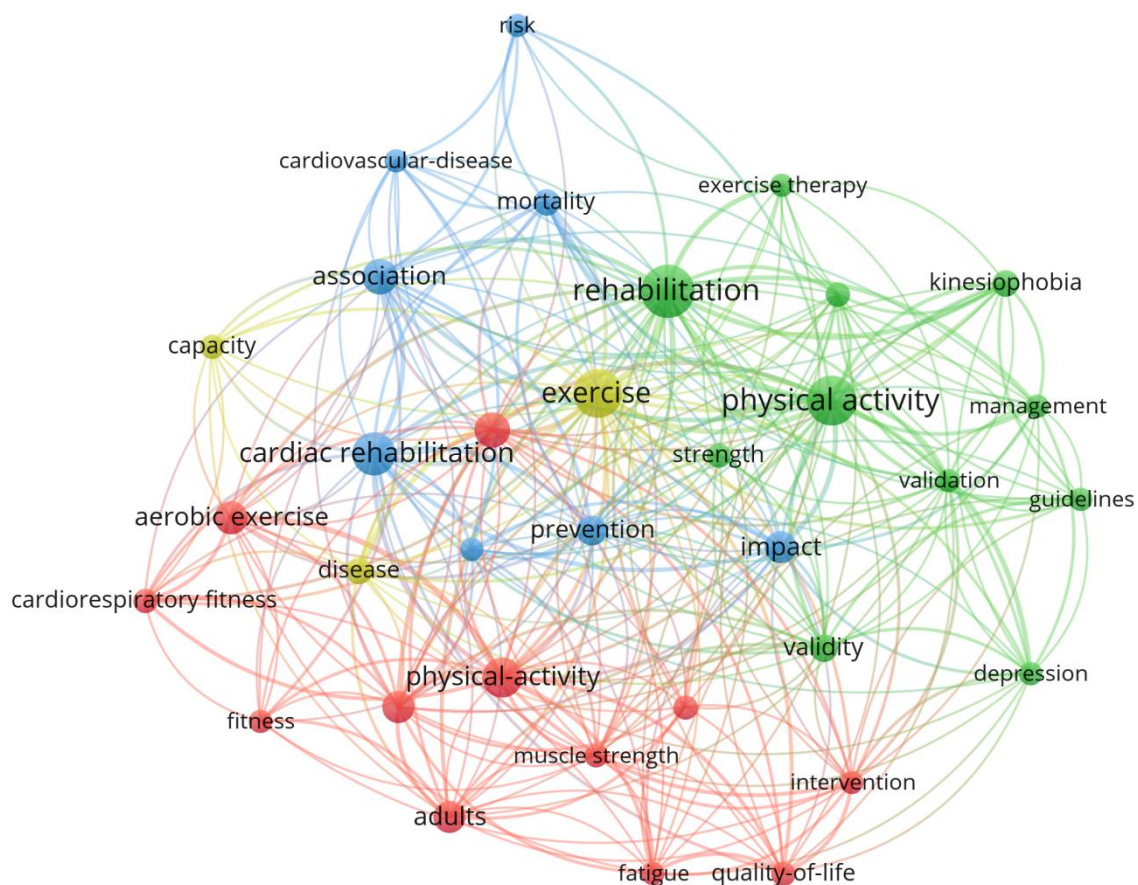
ZHANG X, FAN R, HAN X, et al. Comparative effects of physical education interventions on motor ability and executive function in junior high school students and their interrelationships [J]. FRONTIERS IN PUBLIC HEALTH, 2026, 14.

ABSTRACT

Background: Previous research has demonstrated that physical exercise enhances motor ability (MA) and that participation in physical activity effectively improves executive function (EF). Physical education (PE), as a core element of students' daily activities, plays a crucial role in facilitating these benefits. PE also improves the quality of education. Currently, PE are mainly divided into three types. Understanding differences and associations between MA and EF following various PE may improve educational quality, promote physical and mental health. This study aims to: (1) compare the effects of three PE interventions on MA and EF in junior high school students; (2) examine the relationships between MA and EF. **Methods:** A cluster randomized controlled trial with a pre-post design was employed. Participants were assigned to Fitness Group (FG; $n = 21$), Sports skill Group (SG; $n = 20$), and Interdisciplinary Group (IG; $n = 21$; sports activities with interdisciplinary knowledge), which calculated value using G*Power. Over 12-week, each group completed twice-weekly interventions. Using BMI, waist-circumference, 20-m-shuttle-run, 30-s-sit-ups, grip-strength, standing-long-jump, 50-m-sprint, sit-and-reach, and 20-s-repeated-crossovers assessed physical fitness (PF). Using questionnaires assessed motor cognition (MC), skill and competition assessed motor skill (MS). MA was evaluated by calculating Z-scores for each component based on age-specific data. EF assessed using the Stroop, 2-back, and More-odd shifting. Paired t-tests/Wilcoxon tests, ANOVA/Welch's ANOVA with post hoc comparisons, and Spearman correlations were used for analysis. **Results:** MA improved significantly across all groups. ANOVA showed that the specialized sports intervention produced greater improvements in MA, PF, and MC than other groups, with no significant difference in MS. In EF, inhibitory control (IC) and cognitive flexibility (CF) improved significantly, with greater CF gains in the interdisciplinary group ($p < 0.05$). PF was positively correlated with working memory (WM), whereas MC showed a negative association, possibly due to which may reflect the substantial cognitive resources required for complex coordination and motor tasks. **Conclusion:** Different PE interventions have distinct effects on adolescents' MA and EF. The observed associations between MA components and EF domains highlight the close link between physical and cognitive development. These suggest that PE and health promotion policies should integrate structured physical, sports skill, and cognitively engaging interdisciplinary activities to support adolescents' physical and cognitive development.

体医融合

本期体医融合学术研究共检索到英文相关文献155篇，研究热点主要集中在各类人群的运动康复、运动干预对慢性病的改善作用等方面。检索结果如下：1) 关键词共词分析。提取关键词453个，经过数据清洗后关键词有432个，词频 ≥ 3 (含3) 的关键词的关键词有23个，累计百分比为24.90%，高频关键词为运动、康复、身体活动、心脏康复等，生成可视化知识图谱（见下图）。2) 来源期刊分析。涉及期刊109种，其中载文3篇及以上的期刊有7种，累计百分比为23.85%，刊载体医融合前三的期刊为：Journal of Science and Medicine in Sport (JCR学科分区Q1)、Frontiers in Public Health (JCR学科分区Q1)、Frontiers in Cardiovascular Medicine (JCR学科分区Q2)、BMJ Open (JCR学科分区Q2)。3) 交叉学科分析。引用文献总计5448篇，最多的频次为9次，排名第一的文献是：*World Health Organization 2020 guidelines on physical activity and sedentary behavior*。4) 学术关注度分析。文献级别用量最多的是17次，排名前三位的文献分别为：*Exercise as a therapeutic intervention for long-lasting and chronic diseases*、*Can sports consumption cities reduce residents' medical expenditures? Evidence from China*、*Comparative Efficacy of Various Exercise Types on Psychophysiological Outcomes in Colorectal Cancer Survivors: A Network Meta-Analysis*。



BATRAKOULIS A, PERIVOLIOTIS K, COURNEYA K, et al. Comparative Efficacy of Various Exercise Types on Psychophysiological Outcomes in Colorectal Cancer Survivors: A Network Meta-Analysis [J]. MEDICINE & SCIENCE IN SPORTS & EXERCISE, 2026, 58(4): 670-82.

ABSTRACT

Purpose:This network meta-analysis aimed to evaluate and rank the comparative efficacy of aerobic training (AT), resistance training (RT), combined AT and RT (CT), and high-intensity interval training (HIIT) primarily on body weight and secondarily on body mass index (BMI), fat-free mass, fasting glucose, fasting insulin, handgrip strength, physical activity, cardiorespiratory fitness, fatigue, quality of life, anxiety, depression, and exercise adherence in colorectal cancer (CRC) survivors.**Methods:**MEDLINE/PubMed, Scopus, Web of Science, CENTRAL, and MedRxiv were searched for randomized controlled trials (RCTs) from inception up to July 1, 2025. RCTs published in English comparing exercise to controls (CON) or to another exercise type in CRC patients after colon resection surgery were qualified.**Results:**Thirty-two studies involving 2001 CRC survivors (51.3/48.7 male-female ratio; mean +/- standard deviation: age, 58.0 +/- 10.2 years; BMI, 27.1 +/- 3.9 kg & centerdot;m-2) were included. HIIT and CT were more effective than CON in improving cardiorespiratory fitness and fasting insulin, respectively. No exercise type was identified as being more efficacious than CON in improving any other outcome measures. Nevertheless, HIIT had the highest probability of being the best exercise intervention for improving body weight, physical activity, cardiorespiratory fitness, and quality of life. AT had the highest likelihood of reducing BMI, fasting glucose, and anxiety. CT had the highest probability of improving fasting insulin, fatigue, depression, and exercise adherence, while RT showed the highest probability of being the most effective exercise type in increasing handgrip strength and fat-free mass.**Conclusions:**The current evidence indicates few confirmed benefits of exercise in CRC survivors, suggesting which types of exercise are most promising for a given psychophysiological outcome and may inform further large-scale RCTs of high methodological quality.

BESNIER F, GAYDA M, MAGNAN P, et al. Heart Rate Variability-Guided Exercise Training Compared With Standard Exercise Training in Patients With Coronary Artery Disease: A RANDOMIZED CLINICAL TRIAL [J]. JOURNAL OF CARDIOPULMONARY REHABILITATION AND PREVENTION, 2026, 46(3): 211-8.

ABSTRACT

Purpose: This study aimed to compare heart rate variability-guided (HRV-G) exercise training versus standard exercise training (SET) on peak oxygen uptake (VO₂peak) in patients experiencing an acute coronary syndrome event. **Methods:** This randomized controlled trial included 48 patients randomized to

HRV-G or SET. Both groups consisted of 3 aerobic exercise sessions per week for 3 months. For the HRV-G group, daily exercise was based on a 5-minute morning heart rate recording and the root mean square of successive differences between normal heartbeats (RMSSD). If RMSSD was within ± 0.5 SD from baseline, a high-intensity interval training session was performed; if beyond ± 0.5 SD, an active recovery session was prescribed. The SET group did 2 sessions of moderate-intensity continuous exercise and 1 session of high-intensity interval training per week, irrespective of HRV status. Results: The VO_2peak increased significantly in both groups ($+1.9 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, $P = .002$ for SET and $+2.1 \text{ mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, $P < .001$ for HRV-G) with no significant group-by-time interaction ($P = .794$). Fifty percent of patients were considered responders (Delta VO_2peak change post-pre $>5\%$) in the SET group versus 75% in the HRV-G group ($P = .111$). There was a significant time-by-group interaction for VO_2 at the first ventilatory threshold, adjusted for lean body mass, showing greater improvement in the HRV-G group compared with the SET group ($P = .043$). The training load was significantly lower in HRV-G. Conclusions: In patients with coronary artery disease, HRV-G exercise training led to similar VO_2peak improvements and prevalence of responders but a larger improvement in VO_2 at the first ventilatory threshold adjusted for lean body mass compared with SET, despite a lower training load.

CHEN Y, XIE M, XIA R, et al. Kinesiophobia and Physical Activity in Patients After Percutaneous Coronary Intervention: The Mediating role of Self-Efficacy and the Moderating Role of Type D Personality [J]. ASIAN NURSING RESEARCH, 2026, 20(2): 151-9.

ABSTRACT

Purpose: To investigate the interconnections among kinesiophobia, self-efficacy, Type D personality, and physical activity (PA) among patients with coronary heart disease (CHD) after percutaneous coronary intervention (PCI). The explicit objective was to investigate whether self-efficacy mediated and Type D personality moderated the relationship between kinesiophobia and PA in this population. **Methods:** Between November 2021 and October 2022, 328 patients who had undergone PCI were enrolled from cardiac wards at three different hospitals. The participants were instructed to finalize the International Physical Activity Questionnaire, the Tampa Scale of Kinesiophobia for Heart, the Cardiac Exercise Self-Efficacy Instrument, and the Type D Personality Scale. We used SPSS 22.0 (IBM Corp., Armonk, NY, USA) and the PROCESS macro for SPSS (developed by Andrew F. Hayes, The Ohio State University, Columbus, OH, USA) for the statistical analysis. **Results:** (1) Mediation analysis revealed that self-efficacy partially mediated this relationship. (2) This study demonstrated that kinesiophobia was significantly associated with PA with Type D personality moderating the association between kinesiophobia and self-efficacy as well as the direct link between kinesiophobia and PA. However, kinesiophobia was associated with PA both directly and

indirectly through self-efficacy. The simple slope graph revealed that patients with Type D personality exhibited substantially lower levels of PA than those with non-Type D personality as kinesiophobia increased. Patients with Type D personality had weaker self-efficacy than those without Type D personality when it came to strong kinesiophobia. Conclusion: Self-efficacy and Type D personality play important roles in the relationship between kinesiophobia and PA. Interventions after PCI should focus on reducing kinesiophobia and enhancing self-efficacy to improve PA. Personality assessment allows tailored strategies, with Type D patients requiring targeted approaches for fear and emotion regulation, while non-Type D patients may benefit more from self-efficacy enhancement.

FEBBRAIO M, PEDERSEN B. Exercise as a therapeutic intervention for long-lasting and chronic diseases [J]. CELL METABOLISM, 2026, 38(5): 844-62.

ABSTRACT

In a little over 100 years, global life expectancy has increased by similar to 60%. Paradoxically, it has been estimated that we now exercise five times less than we did 100 years ago. Despite a marked increase in life expectancy, the prevalence of non-contagious diseases (NCDs), otherwise known as "chronic lifestyle diseases," such as cardiovascular disease, type 2 diabetes, cognitive diseases, and cancer, has increased. Here, we discuss the concept of "exercise as medicine" for the treatment of NCD and provide evidence for the direct mechanisms by which regular physical activity can either prevent the onset or slow the progression of these diseases.

FESSLER L, MALTAGLIATI S, MEYER P, et al. Anatomy of a failure: a retrospective evaluation of a cognitive bias modification intervention to promote physical activity in cardiac rehabilitation [J]. BMJ OPEN, 2026, 16(4).

ABSTRACT

Objectives: Promoting regular physical activity (PA) is essential in cardiac rehabilitation; yet many patients exhibit low levels of PA. In January 2022, the Improving Physical Activity (IMPACT) trial, a randomised controlled trial at the University Hospital of Geneva, was launched to promote PA in cardiac patients by targeting automatic approach tendencies towards exercise-related stimuli through a cognitive bias modification (CBM) intervention. This article examines the limited acceptance of this intervention, identifies potential barriers and proposes strategies to improve future implementations. Design: Retrospective evaluation of a preregistered clinical trial. Setting The intervention was conducted in a cardiac rehabilitation centre in Switzerland. Participants 68 cardiac rehabilitation patients (Mage= 57.76, SD = 10.76 years, 87% male). Intervention Patients received 12 CBM sessions over six weeks, designed to target

approach-avoidance tendencies to exercise-related stimuli and improve PA levels. Primary and secondary outcome measures Acceptance was assessed using behavioural (e.g., enrolment and engagement rates), cognitive (e.g., perceived effectiveness) and emotional (e.g., affective evaluation) indicators. The cognitive and emotional indicators were derived from verbal feedback documented by the research assistants based on patients' reactions during the intervention period. These observations do not constitute qualitative research as defined by methodological standards; they were informal notes provided by research assistants during intervention delivery and were not collected or analysed using qualitative research methods. Results: Of the 352 patients initially required, only 68 (19%) were enrolled. Among these 68, 63% completed the minimum number of CBM sessions and 25% completed accelerometer-based PA measures during the week following discharge. These behavioural indicators of low acceptance were associated with cognitive (e.g., scepticism about the task relevance and perceived effectiveness of the intervention) and emotional (e.g., feelings of boredom and disinterest) barriers. Conclusions: The low engagement and acceptance observed in the IMPACT trial highlight several key barriers, such as perceived task irrelevance, task monotony and task boredom that undermine the acceptance and feasibility of this digital CBM intervention in cardiac rehabilitation. These findings emphasise the importance of designing patient-centred interventions, ensuring their seamless integration into clinical contexts and conducting qualitative research prior to implementation to anticipate potential barriers.

FREEN N, LÖNN A, CARROL S, et al. Association of physical activity and sitting time trajectories with mortality risk in 9430 Australian adults with coronary heart disease [J]. JOURNAL OF SCIENCE AND MEDICINE IN SPORT, 2026, 29(5): 529-34.

ABSTRACT

Objectives: To examine the dose-response relationship between moderate-to-vigorous physical activity (MVPA) and sitting time trajectories with cardiac and all-cause mortality in a cohort of middle-aged and older-adults after a diagnosis of coronary heart disease (CHD). Design: This prospective cohort study comprised Australian participants aged ≥ 45 -years with CHD (2006-2020) who had self-reported MVPA (min/wk) and sitting time (hr/day) data from at least two survey waves. Methods: MVPA and sitting time trajectories were categorised as remaining high, decreasing, increasing, and remaining low. Cardiac and all-cause mortality were the main outcomes. Associations were explored using Cox regression models. Results: The cohort included 9430 participants (mean (SD) age, 70 (10) years; 3557 females (38 %)). During a median follow-up of 4.4 (IQR, 6.1) years, 540 cardiac and 2843 all-cause deaths were recorded. Compared with individuals that remained inactive, remaining active was associated with a 36 % and 49 % lower risk of cardiac and all-cause death, respectively. Decreasing or increasing MVPA over time was associated with a 20-33 % lower risk of all-cause death. Compared with high sitting time, individuals that

maintained low sitting time or decreased their sitting time over time reduced the associated risk of cardiac and all-cause death by 33-38 %. Conclusions: Regardless of pre-CHD diagnosis movement behaviours, individuals' post-CHD diagnosis can reduce their risk of cardiac and all-cause mortality by achieving the physical activity thresholds at any time and reducing their sitting time over-time. Further research is needed to confirm the physical activity and sitting time thresholds to receive these benefits.

GöKMEN V, AYOGLU T. Effectiveness of postoperative progressive relaxation exercises on pain, anxiety, and physiological parameters after emergency abdominal surgery: a randomized controlled trial [J]. IRISH JOURNAL OF MEDICAL SCIENCE, 2026, 195(3): 1731-43.

ABSTRACT

Background: Emergency abdominal surgery is associated with pronounced physiological stress, severe postoperative pain, heightened anxiety, and early autonomic dysregulation. Evidence-based non-pharmacological interventions delivered exclusively during the postoperative period remain limited in emergency surgical settings. Aims To evaluate whether postoperative Progressive Relaxation Exercises (PRE) reduce pain and anxiety and improve physiological parameters following emergency abdominal surgery, independent of analgesic consumption. Methods: This parallel-group randomized controlled trial included 70 adults undergoing emergency abdominal surgery. Participants were randomized to receive PRE plus standard postoperative care or standard care alone. PRE was delivered individually at the bedside in three 30-min sessions during the early postoperative period. Pain, anxiety, and physiological parameters were assessed using validated instruments. Analyses were performed using analysis of covariance adjusted for baseline variables, in accordance with CONSORT 2010 guidelines. Results: By postoperative day 2, the PRE group demonstrated significantly lower total pain scores compared with controls (mean difference -7.67, 95% CI -10.35 to -4.99; $p < 0.001$), with large effect sizes (Cohen's d up to 1.51). State and trait anxiety were also significantly reduced (mean differences -7.78 and -7.52, respectively; both $p = 0.004$). At postoperative hour 6, PRE participants showed lower heart rate (-2.03 bpm), lower respiratory rate (-3.03 breaths/min), and higher oxygen saturation (+ 1.57%), indicating early autonomic stabilization. These physiological differences were transient and resolved by postoperative day 2. Analgesic consumption did not differ between groups. Conclusion: Postoperative Progressive Relaxation Exercises are a feasible, nurse-delivered intervention that significantly reduce pain and anxiety and support early physiological stabilization after emergency abdominal surgery.

JAHN J, RIZK R, TRAVIS L, et al. Sex differences in physical activity, psychosocial determinants, and symptom outcomes in knee osteoarthritis: a cross-sectional analysis of a Hispanic/Latino-predominant cohort [J]. RHEUMATOLOGY INTERNATIONAL, 2026, 46(6).

ABSTRACT

Knee osteoarthritis (KOA) is a chronic disease that often leads to persistent pain, functional limitations, and diminished quality of life. Physical activity can be an effective countermeasure but its adherence typically relies on behavioral determinants. Currently, there is limited work investigating how clinical symptoms among patients with KOA affect behavioral determinants, and there is a need for further insight into why females engage in less physical activity. The purpose of this study was to investigate these questions in a sample of patients with KOA. Patients (n=736; mean age 56.4 years) with symptomatic KOA (Kellgren-Lawrence grades 0-4) were evaluated at a tertiary sports medicine clinic and completed validated measures of physical activity behavior and behavioral determinants (attitudes, exercise self-efficacy, social support, barriers), in addition to pain and symptoms. Physical activity score was inversely associated with pain intensity (VAS; $\beta=-0.037$, $p=.004$), pain catastrophizing (PCS; $\beta=-0.124$, $p=.004$), and functional limitation (WOMAC; $\beta=-0.364$, $p<.001$). Greater social support was associated with lower WOMAC ($\beta=-.30$, $p<.001$), lower VAS ($\beta=-.14$, $p=.021$), and lower PCS scores ($\beta=-.18$, $p=.002$). Higher exercise self-efficacy was independently associated with reduced pain catastrophizing (PCS; $\beta=-.061$, $p=.017$) and functional limitation (WOMAC; $\beta=-.267$, $p<.001$). Worsening functional status (WOMAC) was significantly associated with more negative affective attitudes ($\beta=.19$, $p=.001$), lower exercise self-efficacy ($\beta=.34$, $p<.001$), and greater perceived barriers ($\beta=.16$, $p=.002$). Exercise intention was a significant predictor of physical activity ($\beta=.36$, $p<.001$), and was itself predicted by affective attitude, social support, self-efficacy, and perceived barriers. Sex comparisons revealed that males scored significantly higher than females in physical activity ($p=.015$), exercise intention ($p=.031$), exercise self-efficacy ($p=.007$), and social support ($p=.038$), with no significant differences in affective attitude or perceived barriers. Males also reported lower symptom severity than females across VAS ($p=.006$), PCS ($p=.007$), and WOMAC ($p<.001$); however, sex differences in VAS were no longer significant after covariate adjustment. Conclusions: Higher physical activity levels were associated with lower pain and improved functionality in patients with KOA. Sex-based discrepancies in exercise self-efficacy, social support, and exercise intention could help explain why females with KOA participate in less physical activity compared with their male counterparts.

KOKSALAN B, BAHAR A, GUNAL O, et al. Effects of Hybrid-Type Multicomponent Exercise Training on Cardiopulmonary Capacity, Resting Metabolic Rate, and Muscle Strength Following Bariatric Surgery [J]. OBESITY SURGERY, 2026, 36(6): 2722-42.

ABSTRACT

Background: The aim is to investigate the effects of a hybrid-type multicomponent exercise program on muscle strength, resting metabolic rate (RMR), cardiopulmonary capacity (VO₂peak), and body composition after bariatric surgery. **Methods:** Twenty adults (5 males, 15 females; BMI>30 kg/m²) who underwent sleeve gastrectomy were evenly assigned to a hybrid-type multicomponent exercise group (HEG) or a Control Group (CG). Three months after the surgery, the HEG commenced a hybrid exercise program, which was undertaken three days per week for a period of four months. A range of health and fitness metrics were measured at the beginning of the study and after the intervention, including muscular strength, body composition, skeletal muscle index (SMI), VO₂max, and RMR. Exercise effects were analysed using two-way repeated-measures ANOVA, with sex included as a covariate to account for any differences between the groups. **Results:** Significant time effects were observed for all anthropometric and body composition variables in both groups ($p<0.001$), reflecting the dominant effect of surgery. Reductions in body weight and BMI and regional adiposity were greater in the HEG ($p<0.01$), whereas lean body mass, SMI and RMR decreased similarly in both groups ($p>0.05$). In contrast, significant time × group interactions with large effect sizes were found for all upper- and lower-extremity strength measures ($p<0.001$), favoring the HEG, with the greatest gains in the lower extremities ($p<0.001$). Handgrip strength and relative VO₂ peak increased significantly only in the HEG ($p<0.001$). Physical activity levels increased markedly in the HEG ($p=0.003$), with all participants classified as highly active post-intervention, while the CG largely remained in low or moderate categories ($p<0.001$). **Conclusion:** Although the hybrid-type multicomponent exercise program does not prevent early postoperative reductions in RMR and lean body mass after bariatric surgery, it provides associated with functional and metabolic benefits by improving muscle strength, cardiorespiratory fitness, physical activity levels, and adiposity-related outcomes, thereby supporting functional capacity. **Key points:** The hybrid-type multicomponent exercise program implemented after bariatric surgery significantly enhanced cardio-pulmonary capacity and muscle strength, thereby supporting functional recovery. Resting metabolic rate and fat-free mass did not increase in either group after surgery, and the hybrid exercise intervention was unable to prevent these physiological declines. Improvements in body weight, body fat percentage, and other anthropometric parameters were observed in both groups, with more pronounced gains in the hybrid exercise group.

KROESEN S, VONK T, NUIJTEN M, et al. A cardiac-rehab home-based mHealth program to improve physical activity in patients with coronary artery disease: a randomized controlled trial [J]. NETHERLANDS HEART JOURNAL, 2026, 34(5): 189-96.

ABSTRACT

Purpose:Contemporary cardiac rehabilitation (CR) has a moderate effect on physical activity (PA), whereas novel technologies offer promise for enhancing PA levels. Therefore, we assessed the effect of a home-based smartphone training program in addition to center-based CR on PA levels in patients with coronary artery disease (CAD).**Methods:**CAD patients participating in CR were included in this randomized controlled trial (1:1, stratified for index diagnosis). The control group received usual care CR, whereas the intervention group additionally received a 6-week remote smartphone program. The primary outcome was the change in accelerometer-derived moderate-to-vigorous PA (MVPA) from baseline to post-CR. Secondary outcomes included changes in light intensity PA, step count, sedentary time, functional parameters, quality of life, and cardiac anxiety. A baseline-adjusted linear mixed model was used.**Results:**Participants (16% female, intervention n = 44, control n = 49) were 63 [56-69] years old and had a baseline MVPA of 1.0 (95% Confidence interval (CI): 0.9; 1.1) h/day. Changes in MVPA did not differ between the intervention (0.1 (95% CI: -0.0; 0.2) h/day) and control group post-CR (0.1 (95% CI: -0.0; 0.2) h/day, p-interaction=0.75). Also, no differences between the groups were observed for light intensity PA (0.5 (95% CI: 0.2; 0.8) versus 0.4 (95% CI: 0.1; 0.8) h/day, p-interaction = 0.79). Similarly, changes in other secondary outcomes did not differ among groups.**Conclusions:**A smartphone training program on top of the usual CR did not yield additional benefits. A more elaborate mHealth intervention seems needed to change PA during CR in active patients with CAD.

Lê-BRASSARD M, GIGLEUX I, NEYRON A, et al. Assessing the synergy between a mediterranean diet and physical activity on cardiometabolic risk: a 2x2 factorial randomized controlled study [J]. NUTRITION METABOLISM AND CARDIOVASCULAR DISEASES, 2026, 36(5).

ABSTRACT

Background and aims: No randomized clinical trial (RCT) using a factorial design has yet tested the hypothesis that a healthy diet and regular physical activity (PA) have synergistic effects on cardiometabolic risk. **Objective:** to assess the synergy between a Mediterranean diet (MedDiet) and regular PA on postprandial triglyceridemia (TG) and other lipid risk factors. **Methods and results:** In this 2x2 factorial 16-week RCT, two hundred men and women with abdominal obesity and moderate hypertriglyceridemia (TG≥1.5 mmol/L) were randomly assigned to one of four groups: 1-control, 2-MedDiet only, 3-PA only and 4-MedDiet + PA. MedDiet groups were counseled to adhere to a MedDiet and received key MedDiet

foods. The PA intervention targeted 150 min/week of moderate intensity exercise (65 % of measured VO₂peak). Controls were asked to maintain their usual dietary and PA habits. Postprandial serum TG was measured 4h after consumption of 35.1g fat/m² of body surface area. The dropout rate among participants (mean [SD] age, 53.8 [10.6] years; 75.5 % women) was 2.5 %. There was a small synergistic effect of the MedDiet and PA on 4h postprandial TG (Pinteraction=0.025), the MedDiet + PA group exhibiting the lowest postintervention 4h TG concentrations of all groups. There was also evidence of a small synergistic effect between treatments in reducing apolipoprotein B concentrations (Pinteraction=0.077) measured on the last day of intervention, which was no longer observed when measured 48 h after the end of intervention. Conclusion: The combination of a MedDiet and regular PA may have small, short-lived synergistic effects on postprandial TG concentrations and other cardiometabolic risk factors.

LIU W, YU L, YANG M, et al. Air Pollution and Incident Cardiovascular Disease: Modification by Genetic Susceptibility and the Mitigating Role of Physical Activity [J]. JOURNAL OF THE AMERICAN HEART ASSOCIATION, 2026, 15(7).

ABSTRACT

Background: The interplay and joint effects of air pollution, genetic predisposition, and physical activity (PA) on incident cardiovascular disease (CVD) remain poorly understood. This study aimed to examine the associations between various air pollutants and CVD and assessed potential modification by genetic susceptibility and PA. Methods: This prospective cohort study included 330 481 UK Biobank participants without baseline CVD. Annual average concentrations of particulate matter <2.5 μm (PM_{2.5}), PM₁₀, PM_{2.5-10}, nitrogen oxides, and nitrogen dioxide were estimated using land-use regression models. Cox proportional hazards models were exploited to estimate hazard ratio (HR) and 95% CI for CVD associated with air pollution. Multiplicative and additive interactions between air pollution, genetic risk, and PA were assessed. Results: During a median follow-up of 11.8 years, 45 565 incident CVD events occurred. Individual pollutants and a composite air pollution score were positively associated with CVD. Each 5 mg/m³ increase in PM_{2.5} (HR, 1.118 [95% CI, 1.070-1.169]), PM₁₀ (HR, 1.090 [95% CI, 1.063-1.118]), nitrogen oxides (HR, 1.009 [95% CI, 1.006-1.012]), or nitrogen dioxide (HR, 1.027 [95% CI, 1.022-1.033]) was linked to higher CVD risk. Participants jointly exposed to high air pollution and high genetic risk had the highest CVD incidence (HR, 1.666 [95% CI, 1.590-1.746]) (P interaction <0.001), whereas moderate or vigorous PA was protective mainly among those with low pollution and low genetic risk. Conclusions: Long-term exposure to ambient air pollutants was associated with higher CVD risk, particularly among those with high genetic susceptibility. Although PA was protective overall, its benefit was attenuated under higher air-pollution and genetic burdens, underscoring the importance of integrating environmental control with individualized prevention strategies.

MALDONADO-MARTIN S, ZEBERIO-ETXETXIPIA I, DE RITUERTO-ZEBERIO M, et al. Exercise During Chemotherapy Treatment as an Adjuvant Programme in Patients With Lymphoma (EDONOLA): Study Protocol for a Randomised Controlled Trial [J]. CANCER CONTROL, 2026, 33.

ABSTRACT

Introduction: Lymphomas are a heterogeneous group of haematological malignancies commonly treated with chemotherapy. Hodgkin lymphoma predominantly affects younger adults, while Non-Hodgkin lymphoma is more prevalent among older adults. Although survival outcomes have improved, treatment-related cardiovascular, musculoskeletal, and functional adverse effects contributing to fatigue, reduced cardiorespiratory fitness (CRF), diminished quality of life (QoL), and increased frailty risk, remain, particularly among older adults. Reduced CRF, measured by peak oxygen uptake (VO₂peak), is an independent predictor of all-cause and cancer-specific mortality, and chemotherapy tolerance, making its preservation a clinically meaningful target. Evidence supporting exercise during active chemotherapy remains limited. This study aims to evaluate the effect of a 20-week combined exercise (EX) intervention on CRF in people with lymphoma receiving chemotherapy, compared with a treatment-as-usual (TAU) group. **Methods** EDONOLA is a randomised (1:1), multicentre, parallel-group, open-label controlled clinical trial involving adults aged >18 years (n=180, EX, n=90; TAU, n=90). The exercise intervention comprises supervised sessions (two days/week) of low-to high-intensity resistance and aerobic interval training, plus two days/week of unsupervised exercise. The TAU group will receive standard clinical care and physical activity advice. Assessments will be conducted at baseline, 10 weeks, and 20 weeks. The primary outcome will be CRF, measured as VO₂peak. Secondary outcomes will include muscular strength, frailty, body composition, physical activity, sedentary behaviour, QoL, fatigue, sleep, and biochemical profile, including immune biomarkers. Older participants (≥ 70 years) will additionally undergo a comprehensive geriatric assessment, and EX participants will be invited to a voluntary semi-structured qualitative interview. **Discussion:** This multidisciplinary project integrates structured exercise into standard oncology care, aligned with Sustainable Development Goal 3. The intervention aims to mitigate treatment-related side effects, preserve CRF and muscular strength, improve QoL, and reduce frailty risk in people with lymphoma undergoing chemotherapy, while potentially decreasing long-term healthcare burden.

MEN J, WANG P, WANG J, et al. Effects of exercise on multiple health outcomes in children and adolescents with overweight or obesity: a meta-analysis of 176 randomized controlled trials and its implications for global obesity prevention [J]. INTERNATIONAL JOURNAL OF BEHAVIORAL NUTRITION AND PHYSICAL ACTIVITY, 2026, 23(1).

ABSTRACT

Background: The continuing rise in overweight and obesity among children and adolescents portends a life-course public-health crisis. Although evidence has been accumulating that exercise interventions improve health in those with overweight or obesity, few studies have integrated multidimensional health outcomes within a unified analytical framework. To systematically evaluate the effects of exercise interventions on multidimensional health outcomes-including anthropometric, cardiometabolic, cardiorespiratory, and mental health indicators-among children and adolescents with overweight or obesity, and to explore implications for global obesity prevention and control. **Methods:** Six databases (PubMed, Embase, Cochrane Library, Web of Science, CNKI, and Wanfang Data) were searched from inception to January 10, 2025, for randomized controlled trials of exercise interventions in children and adolescents with overweight or obesity. Data were pooled using random- or fixed-effects models, as appropriate. Risk of bias was assessed using the Cochrane Risk of Bias Tool (RoB 2.0), and the certainty of evidence was rated with the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach. **Results:** A total of 176 trials (11,696 participants from 32 countries) were analyzed. Exercise interventions significantly reduced body mass index (MD: -1.25 kg m(-2), 95% CI: -1.51 to -0.98), waist circumference (MD: -2.86 cm, 95% CI: -3.52 to -2.20), and body fat percentage (MD: -2.39, 95% CI: -2.81 to -1.96); improved cardiorespiratory fitness (maximal oxygen consumption MD: 2.83 mL kg(-1) min(-1), 95% CI: 2.17 to 3.50; peak oxygen uptake MD: 2.56 mL kg(-1) min(-1), 95% CI: 1.86 to 3.27); and lowered resting heart rate (MD: -2.89 bpm, 95% CI: -3.82 to -1.97). Cardiometabolic indicators also improved, with reductions in systolic blood pressure (MD: -3.90 mmHg, 95% CI: -5.34 to -2.46) and diastolic blood pressure (MD: -1.70 mmHg, 95% CI: -2.68 to -0.71); total cholesterol (MD: -0.35 mmol/l, 95% CI: -0.43 to -0.27), triglycerides (MD: -0.23 mmol/l, 95% CI: -0.28 to -0.17), and low-density lipoprotein cholesterol (MD: -0.28 mmol/l, 95% CI: -0.35 to -0.20) decreased, accompanied by an increase in high-density lipoprotein cholesterol (MD: 0.08 mmol/l, 95% CI: 0.05 to 0.10). Fasting glucose (MD: -0.20 mmol/l, 95% CI: -0.26 to -0.13) and fasting insulin (MD: -3.93 & micro;U/mL, 95% CI: -4.80 to -3.06) also declined. Regarding mental health, exercise improved self-esteem (SMD: 0.18, 95% CI: 0.04 to 0.33) and self-worth (SMD: 0.25, 95% CI: 0.10 to 0.39), although the evidence for effects on depression and anxiety was limited. The observed effects varied across prespecified subgroups defined by exercise dose and type, region, country income level, sex, and obesity or metabolic phenotypes. **Conclusions:** Exercise interventions consistently improved multidimensional health outcomes in children and adolescents

with overweight or obesity, showing dose- and type-dependent effects with greater benefits in higher-risk groups. These findings underscore the value of exercise as a key strategy to address obesity, while recognizing that political and economic barriers may hinder policy translation. Future research should refine intervention approaches and strengthen pathways from evidence to policy implementation.

REBELO P, BROOKS D, MARQUES A. Sustaining physical activity in chronic obstructive pulmonary disease: a qualitative study of perspectives on a personalized community-based physical activity program [J]. PHYSICAL THERAPY, 2026, 106(6).

ABSTRACT

Importance: Sustaining pulmonary rehabilitation (PR) benefits in community-dwelling individuals with chronic obstructive pulmonary disease (COPD) is challenging. **Objective** The objective of this study was to explore the experiences of individuals with COPD participating in a Personalized Community-based Physical Activities program (PICK UP) and to identify which behavioral change techniques (BCTs) supported sustained physical activity (PA). **Design:** This was a qualitative pre-post intervention study. **Setting** The study was conducted in a community setting. **Participants** This study recruited individuals with COPD assigned to the PICK UP intervention. **Intervention** Participants enrolled in a 6-month, post-PR, community-based program comprising gym, senior exercise classes, pool exercise classes, or Chi Kung. **Main Outcome and Measures** Participants' perspectives on impacts of the PICK UP program, motivators, facilitators, and barriers to adherence were collected through pre-post focus groups. Data were analyzed using deductive and inductive reflexive thematic analysis. The "capability, opportunity, motivation, behavior" framework was used to identify BCTs. **Results** Fifteen individuals with COPD participated (14 male, 70 [8] years, FEV1 57.1% [18.1%] predicted). Five main themes emerged, focusing on PA choice, barriers, facilitators, effects, and suggestions: (1) one size doesn't fit all; (2) organizational factors and system-level support enabling adherence; (3) it doesn't come easy; (4) a positive feedback cycle sustained physical, psychological, and social benefits; and (5) the more, the merrier. The PICK UP intervention supported PA through 13 BCTs, across 5 intervention types (education, persuasion, training, environmental restructuring, and enablement), collectively addressing all 6 components influencing behavior. **Conclusions:** Individuals with COPD reported lasting PR benefits after the PICK UP and were willing to remain physically active. Participants emphasized the importance of diverse PA options and support from peers, health, and fitness professionals. **Relevance** To sustain PA beyond PR, interventions should prioritize intersectoral partnerships and embed ongoing social support. These findings underscore PICK UP's effectiveness, positioning it as a promising and replicable model for promoting long-term PA in individuals with COPD.

SMART N, WOOD G, PEARSON M, et al. Exercise training for the management of dyslipidaemia. A position statement from Exercise and Sports Science Australia (ESSA) [J]. JOURNAL OF SCIENCE AND MEDICINE IN SPORT, 2026, 29(4): 335-41.

ABSTRACT

Objectives: This position stand will aim to summarise the effect of different lipid markers on cardiovascular disease (CVD) progression; determine the exercise prescription (ExRx) to optimise favourable lipid profile changes; ascertain if an optimal exercise prescription exists for different types of dyslipidaemias; and provide recommendations for ExRx for dyslipidaemia. Methods: Synthesis of published literature on exercise training and lipid profiles. Results: Total cholesterol (TC), high density lipoprotein (HDL-C), low density lipoprotein (LDL-C), triglycerides (TG) and very low density lipoprotein (VLDL-C) respond favourably to exercise training, but the effect sizes are moderate compared to lipid lowering medication (LLM). Apolipoproteins respond favourably to exercise training, but less evidence currently exists. A combination (CT) of aerobic (AT) and resistance (RT) training is optimal to improve lipid profile. For dyslipidaemia and hyperlipidaemia, one should consider greater emphasis on AT, whilst for hypoalphalipoproteinemia RT may be prioritised. Lipid changes observed with exercise are modest but offer a valuable complement to dietary therapy and may delay onset or reduce initial dose of dyslipidaemia medication in people treated for primary CVD prevention. Each extra week of exercise training appears to induce a 0.5 mg/dl reduction in TC. Session time, exercise intensity and frequency should be increased in this order for programme progression. Conclusions: Lipids and apolipoproteins respond favourably to exercise training and the effect size is moderate. Both AT and CT improved all lipids, only HDL was improved with RT, so CT appears optimal. It appears that greater exercise programme volume, defined primarily by longer session (minutes) and programme (weeks) times, and hence cardiorespiratory fitness, seems to lead to further improvements in lipid profile.

TOUS-ESPELOSIN M, IRIARTE-YOLLER N, SAMPEDRO A, et al. Differential Responsiveness to Exercise and Cognitive Remediation in Physical Health in People With Schizophrenia: Results From the CORTEX-SP Study [J]. EUROPEAN JOURNAL OF SPORT SCIENCE, 2026, 26(6).

ABSTRACT

Non-pharmacological interventions, such as exercise and cognitive remediation, have been widely investigated in people with schizophrenia (SZ), showing beneficial effects and supporting their role as complementary approaches to pharmacological treatment. Moving towards precision medicine, it is important to consider variability in individual responses. Thus, this study aimed to analyse the prevalence of responders regarding body composition, cardiorespiratory fitness (CRF), and sleep quality in people with

SZ following exercise or cognitive remediation programmes. A total of 159 participants with SZ (41 +/- 10 years) were randomly assigned to the treatment-as-usual (TAU, n = 53), exercise (EX, n = 59), or cognitive remediation programme (REHACOP, n = 47) groups. Anthropometric outcomes, CRF, and sleep efficiency were assessed pre- and post-intervention using standardised methodologies. The typical error (TE) was calculated to identify responders. The EX group showed the highest prevalence of responders in body mass index (21.2%) and fat mass percentage (20%). There were significant improvements in CRF in the EX group (Delta = 21.0%, $p < 0.001$), with a significantly higher prevalence of responders compared with the REHACOP and TAU groups ($p < 0.001$). Sleep efficiency also improved significantly in the EX group (Delta = 1.75%, $p = 0.004$), again with the highest prevalence of responders (27.7%) in this group. These findings suggest that exercise is a particularly effective strategy for enhancing physical health outcomes in people with SZ. However, cognitive remediation may still play a complementary role by supporting the cognitive resources required to maintain exercise engagement and healthy lifestyle changes.

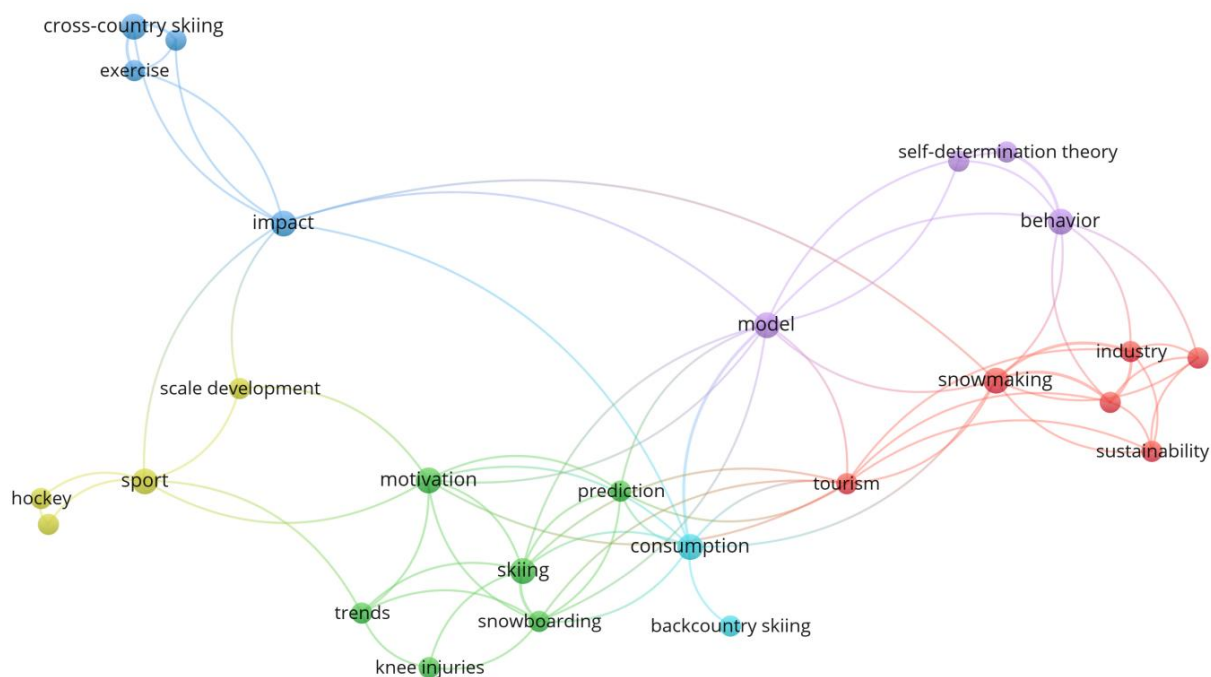
ZHAI S, WEI L, XU D, et al. Perceptions and experiences of self-initiated discontinuation of home-based exercise rehabilitation in people with coronary artery disease [J]. CLINICAL REHABILITATION, 2026, 40(5): 687-98.

ABSTRACT

Objective: To qualitatively explore the perceptions and experiences of patients with coronary artery disease regarding discontinuation of home-based exercise rehabilitation.**Design:** A qualitative, descriptive design was utilized in this study.**Setting** This study focused on home-based exercise rehabilitation.**Participants** A purposive sample of 24 patients who had voluntarily participated in the home-based exercise rehabilitation program was recruited.**Main measures** Semistructured interviews were undertaken. Data were analyzed using a framework approach.**Results:** A total of 24 participants (13 males and 11 females) from 28 to 77 years were recruited for this study to examine the endogenous and exogenous factors that influence withdrawal from exercise rehabilitation. The four major themes identified were (1) "exercise inertia," (2) "perception deviation," (3) "disruption of habit loop," and (4) "weakness in exercise literacy." These themes were further divided into 12 subthemes.**Conclusions:** Sustained implementation of home-based exercise rehabilitation is crucial for patients with coronary heart disease. Discontinuation of exercise regimens frequently stems from patients' internal perceptions, including exercise inertia, cognitive biases, disruptions in established habit loops, and insufficient exercise literacy. Consequently, enhancing patient awareness of exercise rehabilitation and strengthening supervision of exercise routines are imperative. Establishing a multidisciplinary home-based exercise management system would further facilitate the optimization of exercise-related benefits.

冰雪运动

本期冰雪运动学术研究共检索到英文相关文献277篇，研究热点主要集中在滑雪旅游产业发展、度假区运营的产业视角，也关注参与者风险行为、损伤预防，部分研究探究大众参与冰雪运动的影响因素。同时，另有部分研究集中在旅游文化与智能监测技术。检索结果如下：1) 关键词共词分析。提取关键词174个，经过数据清洗后关键词有172个，词频 ≥ 2 （含2）的关键词的关键词有10个，累计百分比为12.07%，高频关键词为滑雪、单板滑雪、越野滑雪等，生成可视化知识图谱（见下图）。2) 来源期刊分析。涉及期刊34种，其中载文2篇及以上的期刊有3种，累计百分比为23.53%，排名第一的期刊是Journal of Outdoor Recreation and Tourism-Research Planning and Management（JCR学科分区Q1）、International Journal of Sports Marketing&Sponsorship（JCR学科分区Q2）、International Journal of Sports Science&Coaching（JCR学科分区Q2）。3) 交叉学科分析。引用文献总计1910篇，最多的频次为3次，排在第一位的文献是：*Climate Change and Ski Tourism Sustainability: An Integrated Model of the Adaptive Dynamics between Ski Area Operations and Skier Demand*。4) 学术关注度分析。文献级别用量最多的是32次，排名前三位的文献分别为：*Nanocellulose-reinforced deep eutectic solvent-based smart hydrogel sensor for adaptive window regulation and machine learning-assisted low-temperature motion monitoring*、*Individuals' Motivations and Engagement With Paralympic Content on Social Media: A Longitudinal A neurofeedback-guided EEG and BCI framework for personalized attention rehabilitation in ADHD*。



ARENCHI A, BONETTI M, CESENA F, et al. Designing Inclusive Mountain Landscapes for Social Sustainability: A Flow-Chain Framework and Toolkit for Alpine Ski Areas [J]. SUSTAINABILITY, 2026, 18(11).

ABSTRACT

Ensuring accessibility in alpine ski areas remains a critical challenge for social sustainability and inclusive tourism because physical, seasonal and organisational constraints interact across the visitor experience. This paper reframes accessibility as a dynamic and relational landscape attribute and proposes a flow-chain framework for assessing accessibility as a sequence of interdependent phases, from pre-trip information to arrival, lift access, slope use, rest and return. Developed within the Ski-Ability project in the ArgeAlp working community, the study draws on exploratory field observations, stakeholder engagement and co-design activities conducted across seven Alpine pilot resorts. The pilot resorts are not treated as a statistically representative sample, but as field cases used to understand current operational conditions in a context where academic literature, technical standards and regulatory guidance specific to accessible ski areas remain limited. The framework is operationalised through a qualitative toolkit based on Basic, Comfort and Plus levels, priority categories and non-compensatory decision rules. The results provide methodological validation and practical guidance rather than quantitative benchmarking. They show that accessibility in alpine ski areas depends on the continuity of routes, services, information and assistance, and on coordination among multiple actors. The paper contributes to social sustainability research by linking Universal Design, accessible tourism and mountain governance within a transferable, process-oriented assessment model.

CHARBONNET B, Côté J, J S. From first ski day to Olympic gold: A mixed-methods case study of long-term ski-specific training and fitness development in one of the most successful alpine skiers in history [J]. INTERNATIONAL JOURNAL OF SPORTS SCIENCE & COACHING, 2026, 21(3): 1642-9.

ABSTRACT

This study examines the long-term training progression of one of the top ten alpine skiers of all time, following his pathway from his first ski day to Olympic gold. Using a longitudinal mixed-method case study, we analyzed 24 years of prospectively recorded on-snow training days, ski-specific participation and performance milestones, and general fitness test results from ages 11 to 18, complemented by a retrospective interview with the athlete's father. The athlete began skiing at the age of 2.2 years old, with early training centered on playful free skiing and task-oriented activities such as unicycling and slacklining. He did not participate in other organized sports. Summer glacier training was deliberately delayed and

limited to preserve motivation, and annual ski days peaked between ages 15 and 18. Periods of minor injury and overreaching coincided with high training loads. Although he achieved early success both on and off the snow, he did not fully dominate until adulthood and struggled internationally during puberty, likely due to late maturation and limited deliberate practice. This case demonstrates how a perfect fit between the athlete's characteristics, training, and environment contributed to his success. These findings do not suggest a universal pathway for alpine skiing development, but rather a pattern of training, environment, and social factors that change throughout development to achieve exceptional performance in adulthood.

CHOI Y, KO H, KIM H, et al. Skiing through climate change: How tourist specialization shapes adaptation preferences and willingness to pay [J]. JOURNAL OF DESTINATION MARKETING & MANAGEMENT, 2026, 41.

ABSTRACT

The global ski tourism industry faces unprecedented challenges from climate change, necessitating comprehensive adaptation strategies to ensure long-term sustainability. This study examines South Korean ski tourists' preferences for climate adaptation strategies using a choice experiment approach. Results revealed that technological adaptation strategies, particularly artificial snowmaking and operational reliability, generated the highest overall preferences and captured the largest market share across the entire sample. Substantial preference heterogeneity emerged when participants were segmented by skiing specialization. High specialization skiers showed strong preferences for spatial adaptations, exhibiting willingness to travel greater distances and pay premiums for high-altitude resorts. Conversely, low specialization skiers favored technological and operational adaptations, valuing slope availability and convenience. These findings demonstrate that effective climate adaptation requires differentiated strategies tailored to distinct market segments rather than uniform approaches, contributing to sustainable tourism development and climate resilience aligned with global sustainability goals.

CHUO J, YIN Y, ZHANG X. The key elements and theoretical logic of the cognitive threshold for participation in winter sports [J]. SCIENTIFIC REPORTS, 2026, 16(1).

ABSTRACT

At present, participation in winter sports in China faces multi-dimensional cognitive thresholds, which are formed with both the particularity of social and cultural contexts and the complexity of practical contradictions. In view of this, this study uses text analysis to construct a model of the threshold for participation in winter sports. The study found that resource accessibility prediction and environmental facility perception are external elements, while information awareness, cultural compatibility perception

and skill fit insight are internal elements. Extrinsic elements not only form the fundamental driving force of intrinsic elements, but also regulate the psychological pathways from cognitive formation to the transformation of behavioral intentions. Each factor has both independent and cumulative effects on the willingness to participate in winter sports. Boost the confidence of potential participants by lowering the cognitive threshold. Dig deep into the theoretical model of key elements of the cognitive threshold shape to provide a theoretical framework for the subsequent development of participation in winter sports.

DUBRAVCIC-SIMUNJAK S, ROMIC M, MISURA D, et al. ON THE EDGE: LUMBAR SPINE HEALTH AND INJURY RISK IN HIGH-LEVEL COMPETITIVE FIGURE SKATERS [J]. KINESIOLOGY, 2026, 58(1): 81-90.

ABSTRACT

The purpose of this study was to investigate the prevalence, risk factors, and rehabilitation strategies for low back pain among high-level competitive figure skaters across singles, pair, and ice dance disciplines. A total of 194 skaters completed a detailed questionnaire assessing training routines, on-and off-ice activities, and history of lumbar spine problems. Results indicated that 33.7% of singles skaters, 41.1% of pair skaters, and 25.9% of ice dancers reported low back pain interfering with training regime or competition. Statistical analysis showed that inclusion of trunk stability, balance, and strengthening exercises in off-ice training was associated with a significantly lower prevalence of low back pain ($p<.05$), with core stability exercises demonstrating the greatest effect: 94.6% of skaters without low back pain regularly performed these exercises compared with 24.6% of those with low back problems. Statistically significant associations ($p<.05$) were observed between low back pain and the execution of technically demanding lifts and complex spins, whereas no such association was found for less demanding skating elements. All participants reporting low back pain received individualized physiotherapy programs targeting core stability, strength, coordination, and proprioception, which were associated with effective recovery and return to sport-specific activities. These findings highlight the mechanical demands on the lumbar spine in high-level figure skaters and underscore the importance of structured on-and off-ice training programs, together with targeted physiotherapy, for the prevention and rehabilitation of low back pain.

FU X, WANG C, LIU J, et al. Integration of a state-space floor thermal model with DeST for annual load simulation of indoor ice rinks and ski resorts [J]. BUILDING SIMULATION, 2026, 19(5): 1177-99.

ABSTRACT

Indoor ice rinks and ski resorts consume substantial cooling energy to maintain low-temperature

environments, making energy efficiency a critical concern. Their unique floor structures, comprising an ice or snow layer and embedded cooling/heating coils, pose significant challenges for thermal modeling. This study proposes a state-space floor thermal model integrated with the building energy simulation tool, DeST, to simulate the dynamic thermal processes and annual hourly thermal loads of such arenas. The integrated model can efficiently handle the coupled heat and mass transfer between the floor frozen layer and the indoor air, and accurately calculate and distinguish the thermal loads borne by floor cooling coils, floor heating coils, and air coolers, respectively. The model is validated with theoretical and experimental data across three tiers (frozen layer, floor, and room levels), and the root-mean-square error of frozen surface temperatures remains within 0.3 degrees C. A simplified indoor ice rink case study demonstrates the integrated model's capability: hourly simulation results of temperatures and thermal loads exhibit reasonable seasonal and diurnal variations, aiding in analyzing floor insulation thickness and determining when floor heating coils are required. This work can provide a fundamental simulation analysis tool for the energy-efficient design and operation of indoor ice rinks and ski resorts.

GAFFURI F, GIANNINI L, MASPERO C. Dental Occlusion and Athletic Performance: The Impact of Customized Occlusal Splints on Postural Control in Professional Figure Skaters [J]. APPLIED SCIENCES-BASEL, 2026, 16(12).

ABSTRACT

Background: The relationship between the stomatognathic system and postural control has been widely investigated, suggesting that dental occlusion may influence neuromuscular coordination and athletic performance. However, evidence in figure skating remains limited. This study aimed to evaluate the effects of a customized occlusal splint on neuromuscular activity and postural balance in professional figure skaters. **Methods:** A prospective single-arm pre-post interventional study was conducted on 52 professional female figure skaters (mean age: 17.1 +/- 1.7 years). Electromyographic (EMG) activity of the masseter, anterior temporalis, sternocleidomastoid, and trapezius muscles, along with kinesigraphic parameters, were assessed at baseline and after six months of continuous occlusal splint use. Postural control was evaluated using the Flamingo Balance Test under three testing conditions. Statistical analysis included paired tests with a significance level set at $p < 0.05$. **Results:** After six months of splint therapy, a significant increase in EMG activity of the masseter and anterior temporalis muscles was observed in most participants, along with a reduction in muscular asymmetries. Improvement in sternocleidomastoid and trapezius activity was noted in a subset of subjects. All participants showed correction of mandibular retrusion. Postural performance significantly improved, with enhanced ability to maintain balance during the Flamingo Balance Test. No major adverse effects were reported. **Conclusions:** Within the limitations of this uncontrolled prospective single-arm study, customized occlusal splint use was associated with changes

in neuromuscular activity and postural balance parameters in professional figure skaters. However, causal relationships cannot be established, and randomized controlled studies are required to confirm the efficacy of this intervention.

HALLMANN K, PREECE S, SCHUMANN J, et al. The experiential dynamics of winter sports: Interrelationships of perceived experiences, norms, behavioural control and behavioural intentions [J]. JOURNAL OF OUTDOOR RECREATION AND TOURISM-RESEARCH PLANNING AND MANAGEMENT, 2026, 54.

ABSTRACT

This study explores how attitudes, subjective norms, and perceived behavioural control influence behavioural intention, using the experiential characteristics of winter sports through the lens of the theory of planned behaviour. Data from n = 2500 respondents were collected using an online survey. The dataset was split into three random sets to 1) explore experience dimensions using principal component analysis, 2) validate the experience dimensions and test the model by means of structural equation modelling, and 3) re-validate the structural model across different groups of winter sport participants based on their length of practising winter sports using multi-group analysis. Two core experience dimensions for winter sports tourists and participants were retrieved: Exploratory learning and Recreational pleasure. The results found a significant positive relationship between experiences, subjective norms, and intentions. Significant differences were identified between all three groups of winter sport participants, though the effects and their directions remained stable. Thus, destinations should create experiences that blend these dimensions for different levels of winter sport participants.

MAGRO-GARBAJOSA L, SÁNCHEZ-CANO A, ORDUNA-HOSPITAL E. Visual Behavior in Inline Speed Skating: An Eye-Tracking Evaluation for Performance Analysis [J]. EUROPEAN JOURNAL OF SPORT SCIENCE, 2026, 26(5).

ABSTRACT

This study analyzed oculomotor behavior (fixations and saccades) in 19 competitive inline speed skaters (5 males, 14 females; aged 10-26 years) from the Aragonese Skating Federation (Spain), comparing high-performance (N1) and intermediate (N2) groups. Participants completed optometric assessments and eye-tracking during 200 m time trials on a banked oval track using a Pupil Labs Neon device, with recordings taken before (PRE) and after (POST) intensive training. Results showed visual behavior remained stable overall, but curved segments (C1, C2) required significantly more fixations and saccades than straights. Skaters consistently focused on the inner track line during curves, suggesting an optimized visual strategy.

High-performance skaters (N1) demonstrated greater efficiency with fewer fixations and saccades in key segments. After training, N1 skaters showed increased fixations in C1 ($p = 0.012$) but reduced saccadic velocity (SS: PRE 8.00 deg/s vs. POST 6.82 deg/s; $p = 0.030$) and length (S1: PRE 3077.41 mm vs. POST 2564.71 mm; $p = 0.035$) on straights, consistent with fatigue. N1 exhibited different patterns of ocular abilities versus N2 pre- and post-training. Strong binocular coordination was observed (right-left eye correlations ≥ 0.85 ; $p < 0.001$). Conclusions indicate that experience enhances visual efficiency, with elite skaters showing more focused gaze patterns. Training-induced fatigue may primarily affect straight segments, reducing saccade speed and length. The finish line served as a consistent visual reference point. These findings highlight the importance of sport-specific visual training and fatigue management in inline speed skating. Future research should address study limitations including small sample size and gender imbalance.

MERZ C, GORGES T, THELEN M, et al. Go big or spin fast? Biomechanical deterministic models for snowboard halfpipe tricks performed at the Beijing 2022 Olympic winter games men's final [J]. INTERNATIONAL JOURNAL OF SPORTS SCIENCE & COACHING, 2026, 21(3): 1863-71.

ABSTRACT

In the Olympic snowboard halfpipe discipline, rotation is the key indicator of trick difficulty encouraging riders to perform multiple tricks involving a high amount of rotation in their runs. Therefore, this study explored the predictive capacity of angular velocity and airtime on the amount of rotation using deterministic models based on the performance parameters of the Men's Final at the Beijing 2022 Olympic Winter Games. IMU data and video recordings were used to determine the biomechanical performance parameters of 122 tricks performed by 12 riders with random intercept models being employed to develop the aforementioned deterministic models. The ratio between angular velocity and airtime at frontside/switch frontside was greater than 4:1, and at backside/switch backside it was close to 5:1. The coefficient of determination overall indicated a high level of fit, providing significant standardised estimates for all performance parameters investigated. The results showed that, regardless of the direction of rotation, angular velocity was the key performance indicator for increasing the amount of rotation, while airtime showed a comparably small influence. These results are important for coaches and riders in teaching and learning new skills as they indicate to focus more on rotation initiation than increasing jump height.

SEYHAN S, BILICI M, DEMIR H, et al. Oxidative stress and antioxidant enzyme activities in elite female Turkish cross-country skiers [J]. BMC SPORTS SCIENCE MEDICINE AND REHABILITATION, 2026, 18(1).

ABSTRACT

Background: Oxidative stress-related processes contribute to exercise physiology through redox-sensitive signaling, yet when oxidant production exceeds antioxidant buffering, oxidative modifications may be reflected in circulating biomarkers. Evidence in elite female endurance athletes remains limited, particularly in cross-country skiers, and interpretation should be restricted to biomarker-level descriptions within the constraints of cross-sectional designs. Methods: This cross-sectional comparative study included 17 elite female cross-country skiers and 17 age- and BMI-matched sedentary women (15-20 years). Following a 10-12 h overnight fast, participants attended the laboratory between 07:00 and 09:00 a.m.; venous blood was collected under standardized resting conditions. Serum catalase (CAT) activity, total glutathione (GSH), and TBARS-derived malondialdehyde (MDA) were quantified using spectrophotometric methods. Between-group differences were tested using the Mann-Whitney U test, with effect sizes expressed as Cliff's delta (delta) and 95% confidence intervals. Within-group associations among CAT, GSH, and MDA were examined using Spearman correlations (rho). Results Compared with controls, skiers showed higher CAT activity ($p < 0.001$; delta = 0.765, large) and higher GSH concentrations ($p = 0.006$; delta = 0.554, large), while TBARS-derived MDA was lower in skiers ($p < 0.001$; delta = -0.848, large; indicating higher values in controls). Within the skier group, CAT and GSH were moderately correlated ($\rho = 0.57$, $p = 0.017$), whereas no significant CAT-GSH association was observed in controls. No significant correlations were detected between CAT and MDA or between GSH and MDA in either group (all $p \geq 0.05$). Conclusions: Elite female cross-country skiers exhibited robust between-group differences in selected circulating redox-related biomarkers at rest, characterized by higher CAT and GSH and lower TBARS-derived MDA relative to sedentary women. These findings describe biomarker-level group separation and should be interpreted as association-level observations without causal attribution, claims of systemic redox homeostasis, or direct inference of training adaptation, recovery, or performance effects.

SKILLE T, SKILLE E. Backcountry skiing in Norway: Between global lifestyle sport and national tradition [J]. INTERNATIONAL REVIEW FOR THE SOCIOLOGY OF SPORT, 2026, 61(3): 755-75.

ABSTRACT

This article examines the cultural and social dynamics of backcountry skiing in Norway, an activity positioned between global lifestyle sport and national tradition. We investigate the characteristics of lifestyle sports within their specific contexts and highlight the elements of identity politics and social belonging. Utilizing social phenomenology and nature dwelling as theoretical perspectives, we focus on the sensuous experiences of backcountry skiing, the way meaning is created through being in active engagement with nature, and the emotional spectrum in which backcountry skiing unfolds. Through a methodology of embodied autoethnography, told from a skier-researcher perspective, this study generates and presents in-depth experiences through two contradictory in-situ vignettes from the winter mountains, shedding light on the dynamic processes of human-human and human-nature relationships in backcountry skiing. Most importantly, the study shows how the human-human relationship and the human-nature relationship are interrelated and how the perception and experience of nature are highly dependent on social dimensions among skiing partners. Our study demonstrates the potential for embodied autoethnography to enrich the understanding of lifestyle sports as unique experiences. This research contributes to an understanding of how backcountry skiing functions as a medium for both individual expression and communal belonging within the sociocultural context.

WACHHOLZ F, SCHNITZER M, ROTH J, et al. From snow to screens: resident support for Olympic esports games in a former winter Olympic games host city [J]. INTERNATIONAL JOURNAL OF SPORTS MARKETING & SPONSORSHIP, 2026, 27(3): 481-97.

ABSTRACT

Purpose: Resident support for Olympic events has faced considerable challenges in recent years. The Olympic esports games (OEG) may be viewed as the International Olympic Committee's (IOC) strategic response to these challenges, aiming to engage younger audiences and adapt to the digitalization of sport. Drawing on Social Exchange Theory and Legitimacy Theory, this study investigates support for the OEG in Innsbruck (Austria) - a former winter Olympic games (WOG) host city - addressing how demographics, trust in institutions and attitudes toward WOG relate to support of this event format. **Design/methodology/approach:** An on-site survey (n = 645) was conducted in Innsbruck between November and December 2024. To analyze resident support for hosting the OEG, regression models with binary outcomes were estimated. Independent variables included sociodemographic characteristics, interest

in esports, whether esports should be Olympic, tourism-income, trust in government/IOC and support for WOG. Marginal effects were calculated to facilitate the interpretation of key independent variables. Findings Interest in esports was the most consistent predictor of support for hosting the OEG. Age and tourism-related income were also associated with higher levels of support, while women expressed slightly lower support than men. Originality/value: The findings suggest that the OEG might support the IOC in engaging younger, esports-affine audiences and exploring new, more flexible event formats. Support is shaped by demographics and perceptions of esports legitimacy, highlighting the importance of inclusive communication and culturally sensitive designs. As empirical research on Olympic esports remains limited, further studies are needed to deepen the understanding of this emerging field.

YAN Q, ZHANG K, WANG Y, et al. Combined Action Observation and Motor Imagery Elicits Superior Frontoparietal Activation in Elite Ski Jumpers: An fNIRS Study [J]. BRAIN SCIENCES, 2026, 16(6).

ABSTRACT

Background: Action observation (AO) and motor imagery (MI) are widely used cognitive training strategies. Recent evidence suggests that their combination may enhance motor simulation through synergistic neural mechanisms. However, the effects of this approach on complex whole-body movements in elite athletes remain unclear. **Methods:** Twenty-seven elite ski jumpers performed AO, MI, and concurrent AO + MI tasks, while cortical hemodynamic responses were recorded using functional near-infrared spectroscopy (fNIRS). Channel-level changes in oxygenated hemoglobin (Delta HbO) were analyzed using one-sample and paired-sample t-tests, with false discovery rate (FDR) correction applied for multiple comparisons. Additionally, mixed-design ANOVAs were conducted to examine the potential modulation of athlete level (master-level vs. first-class). **Results:** Significant activation was observed only in the AO + MI condition after FDR correction, primarily in channels corresponding to the precentral gyrus, postcentral gyrus, and middle frontal gyrus. No channels in the AO and MI conditions survived FDR correction. Between-condition comparisons revealed significant differences in several channels located in frontoparietal regions, including the inferior parietal lobule, supramarginal gyrus, and middle frontal gyrus, with AO + MI generally showing stronger responses. No significant effects related to athlete level were found. **Conclusions:** These findings indicate that concurrent AO + MI is more effective than AO or MI alone in eliciting cortical activation in elite ski jumpers. This may reflect enhanced engagement of frontoparietal networks involved in action representation and visuomotor integration. These results may be compatible with a neural efficiency interpretation in highly trained athletes, although further studies with behavioral outcomes and broader skill-level comparisons are needed. AO + MI may represent a promising strategy for off-snow cognitive training in high-risk sports.

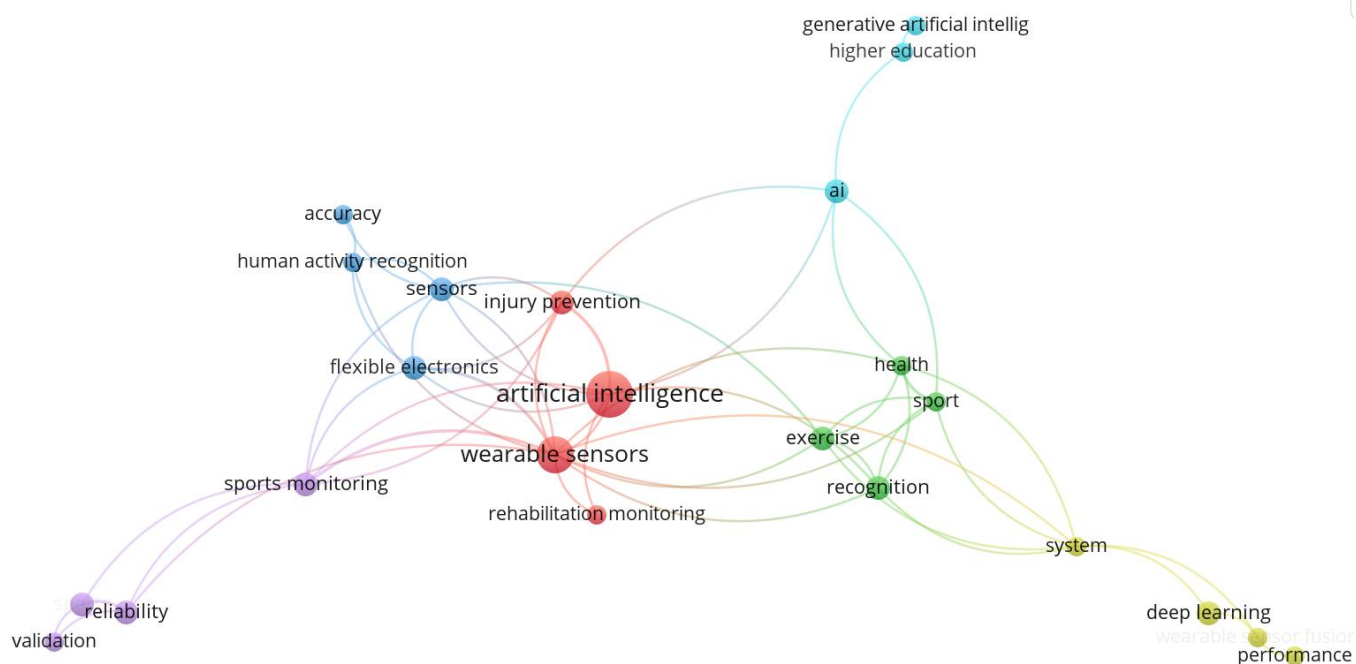
YU S, ONG Y, JANG J. Can winter sport nostalgia stimulate tourists' motivation during the off-season? A two-wave longitudinal study [J]. JOURNAL OF VACATION MARKETING, 2026, 32(3): 819-34.

ABSTRACT

Drawing on theories of sport nostalgia and motivation, this study proposed a Seasonal Nostalgia-Motivation-Intention (SNMI) framework within active sport tourism to explain seasonal transitions. Given the strong seasonality and alpine setting of winter sport tourism, as well as growing concerns about global warming, the influence of winter sport nostalgia on behavior may fluctuate more than in other contexts. This study employed a two-wave longitudinal design to analyze both cross-sectional and cross-lagged relationships using data from 515 Japanese winter sport tourists. Cross-sectional analysis showed a significant direct effect of nostalgia on revisit intentions at both waves, stronger at T-1 (the end of the snow season) than T-2 (the height of the summer season), with the relationships mediated by motivation. At cross-lagged setting, nostalgia at T-1 exerted a negative effect on motivation and an indirect negative effect on revisit intentions at T-2. This study provides pioneering empirical evidence of the beneficial short-term impact and the bittersweet nature of winter sport nostalgia over time. The findings provide practical implications for strategic initiative in winter sports industry.

体育工程

本期体育工程学术研究共检索到英文相关文献320篇，研究热点主要是一部分聚焦算法与硬件技术开发，另一部分将技术落地到运动训练、康复评估，用于识别人体动作、采集生理数据，提升训练和康复的量化评估能力。检索结果如下：1）关键词共词分析。提取关键词284个，经过数据清洗后关键词有281个，词频 ≥ 2 （含2）的关键词有15个，累计百分比为17.96%，高频关键词为人工智能、可穿戴传感器、深度学习、体育监测等，生成可视化知识图谱（见下图）。2）来源期刊分析。涉及期刊47种，其中载文2篇及以上的期刊有7种，累计百分比为40.23%，刊载体育工程前三位的期刊分别为：Frontiers in Public Health（JCR学科分区Q1）、Scientific Reports（JCR学科分区Q1），BMC Sports Science Medicine and Rehabilitation（JCR学科分区Q1），Journal of Mechanics in Medicine and Biology（JCR学科分区Q4）。3）交叉学科分析。引用文献总计3217篇，最多的频次为4次，排名第一的文献是：*IoT Solutions and AI-Based Frameworks for Masked-Face and Face Recognition to Fight the COVID-19 Pandemic*、*Diagnostic Applications of AI in Sports: A Comprehensive Review of Injury Risk Prediction Methods*、*Current Approaches to the Use of Artificial Intelligence for Injury Risk Assessment and Performance Prediction in Team Sports: a Systematic Review*。4）学术关注度分析。文献级别用量最多的是57次，排名前三位的文献分别为：*Wireless and in situ regenerable multimodal wearable bioelectronic sweat sensor for continuous biomarker monitoring in everyday settings*、*Discovery of Piezoelectricity in Natural Birch Bark for AI-Assisted Sports Violation Monitoring*、*Flexible wearable medical devices: from material innovations and data processing to intelligent healthcare applications*。



ALONAZI M, ABRO I, ABDELHAQ M, et al. Attention-Based Multimodal Framework for Athlete-Performance Analysis and Rehabilitation Monitoring Using Vision and Wearable Sensors [J]. BIOENGINEERING-BASEL, 2026, 13(7).

ABSTRACT

Background: Advances in monitoring systems featuring wearable sensors, computer vision, and artificial intelligence (AI) have been increasingly used in sports science and rehabilitation practices as a means of movement pattern analysis, injury prevention, and training optimization. These technologies are becoming essential components of athlete-performance analysis and rehabilitation-monitoring systems designed to support biomechanical assessment, athlete development, and movement-quality evaluation. Athlete-performance analysis and rehabilitation monitoring increasingly rely on intelligent multimodal sensing systems capable of continuously evaluating movement quality, biomechanical patterns, training execution, and recovery progress. Human activity recognition (HAR) serves as a key enabling technology for these applications by providing automated assessment of human movement using wearable and vision-based sensing modalities. Therefore, the purpose of this study was to develop and evaluate an attention-based multimodal framework that integrates wearable inertial sensing and RGB video analysis for robust athlete-performance assessment and rehabilitation monitoring through accurate recognition of human movement patterns. **Methods:** Athlete-performance analysis and rehabilitation monitoring combining inertial sensor data and RGB-based visual information was introduced. Inertial signals were segmented with adaptive windowing, whereas silhouette refinement was performed to analyze motion structures from visual inputs in support of athlete-performance analysis and rehabilitation monitoring. Temporal, spatial, and motion features such as trajectory, orientation, and skeleton-based space-time representations were calculated from multimodal inputs. The proposed framework was designed to capture complex movement dynamics associated with rehabilitation exercises and sports-related motion patterns across heterogeneous sensing environments. Extracted features were then combined and optimized with a multimodal feature fusion approach, while the Ranger optimization algorithm was utilized during the process. An attention-based deep learning classifier was implemented to classify movement activities. **Results:** The results showed that the proposed framework reached accuracy scores of 88.40% and 87.96% on the VIDIMU dataset and the UTD-MHAD dataset respectively. Recognition performance across both inertial and vision-based modalities provided greater robustness than single-modality solutions. The integration of wearable sensing and computer vision modalities further improved the ability of the framework to analyze complex movement behaviors under varying execution conditions and environmental variations. **Conclusion:** The proposed multimodal framework provides a foundation for intelligent athlete-performance and rehabilitation-monitoring systems by integrating wearable sensing, computer vision, and attention-based artificial intelligence for robust movement analysis. The findings highlight its

potential to support biomechanical assessment, movement-quality evaluation, training-performance monitoring, rehabilitation tracking, and injury-risk management in modern sports and healthcare environments.

BHAROT N, VERMA P, VIDYARTHI A, et al. Revolutionizing Wearable Sensor Data Analysis With an Automated Decision-Making Model for Enhanced Human Activity Detection [J]. IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, 2026, 30(6): 5400-8.

ABSTRACT

Human Activity Recognition (HAR) stands as a crucial technology, with applications ranging from healthcare monitoring to sports analytics. However, the traditional approach to HAR is often time-consuming and susceptible to human errors due to the high complexities involved in processing diverse sensor data. Recognizing the imperative for efficiency and accuracy in HAR systems, we propose the development of an Automated Decision-maker (ADM) system. This system serves to automate HAR pipelines, addressing the challenges posed by the huge sensor data. By harnessing the power of automation, ADM significantly streamlines the HAR process, reducing the time required for hyperparameter tuning and minimizing the risk of human errors. The results obtained from our proposed ADM system demonstrate notable improvements in HAR performance, showcasing achieved accuracy of 96.436% for UCI-HAR & 99.783% for PAMAP2 datasets. Moreover, ADM can be described as an innovative approach that contributes to the optimization of HAR systems while also establishing a foundation for building robust and reliable systems in complex environments.

CAO Y, LI F, ZHANG Y, et al. Prevalence and factors associated with adolescent idiopathic scoliosis in Shanghai, China: an artificial intelligence-assisted screening approach [J]. FRONTIERS IN PUBLIC HEALTH, 2026, 14.

ABSTRACT

Objective: To investigate the prevalence of adolescent idiopathic scoliosis (AIS) and major modifiable factors associated with AIS among school students in Shanghai, China, and assess the feasibility and validated accuracy of AI-assisted 3D screening in school health management. Methods: A multistage stratified cluster sampling design was employed in this cross-sectional study, conducted from July 2024 to June 2025. A structured-light 3D back-scanning AI system was used to screen 5,026 students aged 9-15 years from six schools in five districts of Shanghai. Physical fitness tests and questionnaires were used to collect data on body morphology, posture, physical activity, and lifestyle. Standing full-spine radiography

was used as the reference standard for AIS diagnosis, defined as Cobb angle ≥ 10 degrees. Because radiographic verification was performed for all screen-positive students but only for a random subset of screen-negative students, inverse probability weighting was applied to account for partial verification. Results Among the 5,026 screened students, 160 AIS cases were confirmed among 185 rescreen-positive students, and 2 additional AIS cases were identified among 300 randomly verified screen-negative students. The crude radiographically confirmed detection rate was 3.2% (162/5,026), and the IPW-adjusted estimated population prevalence was 3.8%. Thoracic curves and Cobb angles of 10 degrees- < 20 degrees were most common. Girls and middle school students had higher crude radiographic detection rates than boys and primary school students, respectively. Multivariable binary logistic regression identified female sex, improper sitting posture among girls, very low post-exercise fatigue among boys, and frequent one-sided exertion sports as factors associated with screening-detected AIS, whereas higher BMI, balanced walking posture, and satisfactory sleep quality showed protective associations. The AI-assisted structured-light screening workflow showed IPW-adjusted sensitivity of 0.832, specificity of 0.995, PPV of 0.865, NPV of 0.993, and overall accuracy of 0.989. Conclusion: AIS represents a non-negligible spinal health burden among school students in Shanghai. Most factors associated with AIS are modifiable. The AI-assisted structured-light screening workflow demonstrated acceptable diagnostic accuracy and promising feasibility for large-scale school-based health screening and management integration.

CHEN T, HUO G. MSBA-LSTM: a multi-scale bidirectional attention long short-term memory network for early risk prediction from multimodal wearable sensor time-series data in sports [J]. JOURNAL OF KING SAUD UNIVERSITY COMPUTER AND INFORMATION SCIENCES, 2026, 38(6).

ABSTRACT

Multimodal wearable sensor time-series data present fundamental challenges for sequential risk prediction, including high dimensionality, heterogeneous sampling rates, and cross-scale temporal dependencies. Existing recurrent architectures are constrained by unidirectional information flow, single-scale temporal receptive fields, and insufficient dynamic weighting across heterogeneous sensor channels. To address these limitations, we propose the Multi-Scale Bidirectional Attention Long Short-Term Memory Network (MSBA-LSTM), a hybrid feature-engineered deep learning framework integrating three synergistic modules: (i) a stacked Bidirectional LSTM (BiLSTM) encoder that exploits both forward and backward temporal context at every timestep; (ii) a Multi-Head Self-Attention (MHSA) module with 8 parallel heads ($d_k=32$), residual connection, and Layer Normalization that dynamically focuses on semantically critical timesteps; and (iii) a multi-scale feature extraction strategy that captures biomechanical dynamics at a 0.5 s window (impact-level), time-domain and frequency-domain patterns at 1.0 s (movement-level), and

physiological state at 5.0 s (fatigue-accumulation level), spanning three biomechanically meaningful temporal granularities. The model is trained with AdamW, cosine annealing scheduling, weighted binary cross-entropy, and SMOTE oversampling under stratified five-fold cross-validation, with additional subject-independent leave-one-subject-out (LOSO) validation to assess generalization to unseen athletes. On a self-collected dataset of 295 labeled sessions, MSBA-LSTM achieves 93.2% accuracy, 92.6% F1-score, and AUC-ROC of 0.967 under window-level cross-validation, and maintains an accuracy of 88.5% under the stricter LOSO protocol, outperforming standard LSTM by 5.9%, 6.8%, and 4.9 percentage points respectively, and surpassing the strongest deep-learning baseline (InceptionTime) by 3.4 percentage points in accuracy and 0.026 in AUC-ROC, with all pairwise improvements statistically significant ($p < 0.001$, paired Wilcoxon signed-rank tests). Ablation studies validate the contribution of each module, and SHAP analysis provides feature-level attribution scores together with sport-category-wise importance variations that confirm the interpretability of the learned representations.

CHIANG Y, CHANG J, LEE C, et al. Wearable Sports Vision Training May Improve Selected Visuomotor Outcomes and Hitting Precision in Collegiate Badminton Athletes: A Randomized Controlled Trial [J]. DIAGNOSTICS, 2026, 16(12).

ABSTRACT

Background: High-level badminton performance requires rapid perceptual processing, visuomotor coordination, and precise movement responses under continuously changing spatial conditions. Although wearable sports vision interventions have shown potential for enhancing perceptual-motor performance, evidence regarding their longitudinal effects and transfer to sport-specific outcomes remains limited. **Trial design:** A single-center, exploratory randomized controlled trial using a parallel-group structure. Simple randomization without blocking or stratification resulted in a final allocation ratio of 16:10 (approximately 1.6:1) between the training and control groups. **Methods:** Twenty-six collegiate badminton athletes aged 18-25 were randomized into a wearable sports vision training group ($n = 16$) or a control group ($n = 10$). The intervention group completed wearable sports vision training using Automatic Dual Rotational Risley Prisms (ADRRPs) for 15 min twice weekly over 4 weeks. **Results:** Baseline-adjusted ANCOVA demonstrated significant between-group effects for reaction time ($p = 0.003$) and target-zone accurate hits ($p = 0.004$), whereas binocular visual function outcomes did not show statistically significant between-group differences. No adverse events were reported. **Conclusions:** Four weeks of wearable sports vision training may be associated with improvements in selected visuomotor outcomes, particularly reaction performance and target-zone hitting accuracy, in collegiate badminton players. Larger trials are needed to evaluate long-term retention and broader sport-specific applicability.

FANG Q, LI Y, YIN Y. BehaviorDiff: a VAE-diffusion framework for AI-generated synthetic behavioral data in procrastination prediction for sports instruction [J]. BMC SPORTS SCIENCE MEDICINE AND REHABILITATION, 2026, 18(1).

ABSTRACT

Accurate prediction of procrastination remains a critical challenge in sports instruction, where behavioral data are often limited and constrained by privacy concerns. This study investigates whether AI-generated synthetic data can approximate real-world behavioral patterns to predict procrastination under controlled experimental conditions. A three-stage framework was developed. First, a multimodal dataset (MAP-487) was constructed from 487 university athletes, integrating IMU-derived physiological signals, training adherence records, and psychological self-reports. Second, a hybrid Variational Autoencoder-Diffusion model (BehaviorDiff) was trained to generate synthetic sequences that preserve key statistical and temporal characteristics of the original data. Third, identical BiLSTM-Transformer models were trained and evaluated on real and synthetic datasets using consistent preprocessing, feature space, and train-test splits to ensure comparability. Results show that models trained on synthetic data achieve performance comparable to those trained on real data (accuracy: 0.94 vs 0.91), with the observed difference not reaching statistical significance ($p = 0.072$). Additional analyses, including correlation-based validation, indicate that synthetic data preserves essential behavioral relationships and predictive structure. The observed performance differences are interpreted as a consequence of smoothing and regularization effects introduced during data generation rather than an increase in informational content. The findings suggest that synthetic data can serve as a privacy-preserving and structurally consistent complement to real-world data for behavioral modeling in sports instruction. However, conclusions are limited to controlled experimental settings, and further validation across independent datasets is required to establish generalizability.

FERNANDEZ-DE-OSSO A, SÁNCHEZ-TRIGO H. Artificial intelligence in padel performance assessment: A comparative study of result-based and computer vision-derived rankings [J]. INTERNATIONAL JOURNAL OF SPORTS SCIENCE & COACHING, 2026, 21(2): 941-9.

ABSTRACT

Background: Accurate evaluation of non-professional padel players is essential for optimizing training and ensuring fair competition. Traditional result-based ranking systems, often reliant on self-assessment, can be biased. In contrast, AI-driven methods utilizing computer vision and deep learning promise objective, real-time performance evaluations. **Methods:** In this study, evaluation scores for 180 players were derived from three sources: a self-assessed result-based system (Playtomic), an AI-based system (AIball), and expert coach assessments, which served as the benchmark. AIball is a computer-vision-based evaluation

system that automatically extracts key performance metrics. Data were collected from 50 matches across 9 clubs in Spain. Statistical analyses-including Pearson correlation, Intraclass Correlation Coefficient (ICC), Lin's Concordance Correlation Coefficient (CCC), paired t-tests, Bland-Altman analysis, and error metrics (mean squared error [MSE], root mean squared error [RMSE], and mean absolute error [MAE])-were employed to assess the reliability, agreement, and classification accuracy of the evaluation systems. Results: AIball demonstrated a strong positive correlation with coach evaluations ($r = 0.7769$; $CCC = 0.7144$) and yielded lower error metrics ($MSE = 0.6689$; $RMSE = 0.8178$; $MAE = 0.6678$) compared to Playtomic. Bland-Altman plots revealed that AIball's scores were more closely aligned with those of the experts, and pairwise comparisons showed a slightly higher classification accuracy for AIball (74.27%) relative to Playtomic (73.74%). Conclusion: The findings indicate that the AI-based evaluation system (AIball) offers a more reliable and objective assessment of non-professional padel players than traditional self-assessed methods. This approach has significant implications for enhancing training programs, standardizing player rankings, and promoting fairness in competitions.

HOU Y, ZHUO Y. From Passive Filling to Active Energy Dissipation: Evolution, Mechanisms, and Application Prospects of Impact Absorption and Damping Coatings in Modern Sports Protective Gear [J]. COATINGS, 2026, 16(4).

ABSTRACT

The rapid development of modern sports has placed higher demands on athlete protection. Traditional protective gear relying on passive energy dissipation through bulk materials such as foam and gel suffers from limitations like large volume and poor adaptability, driving the evolution of protection technology toward active and intelligent solutions. Impact absorption and damping coating technology, which integrates advanced functional materials in thin-film form onto the surface of protective gear, has achieved a paradigm shift in protective performance and is advancing toward lightweight, intelligent, and customizable designs. This review first systematically elaborates on the working principles and performance regulation mechanisms of novel coating systems centered on shear-thickening fluids, polymer gels, microstructural biomimetics, and phase-change materials. Secondly, it deeply analyzes the application modes and protective efficacy improvements of these technologies in specific scenarios such as helmets, joint protectors, and smart clothing. Furthermore, it explores the complex interaction mechanisms between coatings and human tissues under dynamic impact. Finally, we discuss the challenges and future trends in the evolution of this technology toward multifunctional integration, dynamic adaptability, and precise personalized design, aiming to provide a systematic reference for interdisciplinary innovation in fields such as materials science, biomechanics, and sports medicine.

KRISHNAMOORTHY U. Sweat-based electrochemical wearable biosensors for sports performance and fatigue monitoring: from laboratory prototypes to field deployment [J]. ANALYTICAL METHODS, 2026, 18(23): 4753-85.

ABSTRACT

Wearable biosensing technologies are advancing sports performance monitoring by enabling the continuous and real-time measurement of physiological and biochemical parameters. Among non-invasive biofluids, sweat has become the most widely studied medium due to its easy accessibility during physical activity and its presence of multiple relevant biomarkers. This review critically examines the recent developments in sweat-based wearable biosensing technologies and identifies the key challenges that hinder their transition from laboratory prototypes to practical sports-monitoring systems. The discussion includes a brief introduction to sweat generation, the important biomarkers present in sweat, and their significance in sports health monitoring. Various electrochemical sensing platforms designed for sweat analysis are reviewed, with an emphasis on their structural designs and operational mechanisms. Major application areas, including lactate monitoring for fatigue detection, electrolyte sensing for hydration assessment, and cortisol measurement for stress evaluation, are discussed. This review also highlights the important challenges, including sensor calibration, motion-related artifacts, variability in sweat composition among individuals, and long-term operational stability. Emerging approaches, including multimodal sensing, machine-learning-assisted data interpretation, nanomaterial-enabled sensors, and closed-loop feedback systems, are also discussed as potential solutions to improve the reliability and real-world applicability of sweat-based wearable biosensors for sports performance monitoring.

LI D. The role of artificial intelligence in structuring youth athletic training: implications for personality and motivational development [J]. JOURNAL OF SPORTS MEDICINE AND PHYSICAL FITNESS, 2026, 66(6): 795-804.

ABSTRACT

Background: This study examines the impact of AI-based training approaches on young athletes' motivation and personality traits. The analysis focuses specifically on graded training programs developed using artificial intelligence. Methods: The study involved 72 athletes from different provinces of China aged 16-18, divided into equal experimental and control groups. For the control group, graded training programs were developed using AI with the participation of a coach and a physician. Motivation and personality structure were studied using two tools-GLOBAL MOTIVATION SCALE (GMS-28) and The Big Five Personality Test (BFPT). A survey was conducted before and after the intervention using AI for 2 months. Result: The results of the study indicate a consistent increase in the experimental group in the level of

assessment of all motivation components, except for Amotivation and all five elements of the Big Five. But compared to the control group, only the indicators of Conscientiousness and Openness to Experience of the Big Five elements increased, which indicates the nature of the impact of increased training efficiency and the use of new technologies as a stimulus for openness, involvement and persistence in achieving a more clearly perceived and achievable goal. Conclusion: A high correlation was noted between the number of grades received during training and one of the types of external motivation, which indicates a significant dependence of young athletes on the impact of the team and the coach. In practice, the obtained results can be implemented for designing a long-term beneficial effect of training programs and sports management using AI on the personality of young athletes.

LIN B, WANG J, SAFARPOUR M, et al. AI-driven adaptive vibration control in smart plate systems: a sustainable approach for next-generation sports engineering [J]. SCIENTIFIC REPORTS, 2026, 16(1).

ABSTRACT

The current paper proposes an AI-based method for the vibration control of smart plate systems. The application is set for next-generation sports engineering, where performance enhancement is the main goal. The system consists of a core of coarse aggregate ultra-high-performance concrete (CA-UHPA) and piezoelectric face sheets, which are mounted on an elastic foundation. The properties of the material composite are foreseen based on the Halpin-Tsai models and the law of mixtures. Looking into the system's dynamic performance in a very thorough way is done using the quasi-3D theory having four variables. This theory gives the opportunity for the full consideration of the distribution of transverse shear strains and stresses throughout the plate thickness. The governing equations of the resonant response are derived by employing the concept of piezoelectricity together with Hamilton's energy principles. The elastic foundation is analyzed using both Winkler and Pasternak coefficients, thereby allowing the interaction of the plate and its support substrate to be included. The solution is achieved through using the physics-informed neural networks (PINNs) technique, which not only accurately and efficiently replaces the conventional Legendre Polynomial Expansions with deep neural networks (DNNs) for more computational efficiency and accuracy but also doubles the legacy of AI-powered methods in terms of real-time system adaptability and optimal vibration control under changing scenarios. A DNN-based verification process assists in obtaining and confirming the trustworthiness of the results. This research marks above all and the first time as a very promising new direction in the smart systems vibration control area in sports, and it is highly anticipated that the new development will have a positive impact on the performance and durability optimization of advanced sports equipment. The introduced method embodies a

patent-driven technology leap in vibration control, where AI and new materials join forces to solve challenging problems.

LISACEK-KIOSOGLIOUS A, LATOO A, PEACH Y, et al. Exploring the role of artificial intelligence in anterior cruciate ligament injuries in high-performing & elite athletes [J]. KNEE, 2026, 61.

ABSTRACT

Anterior cruciate ligament (ACL) injuries dramatically impact athletes and sporting organisations. Artificial Intelligence (AI) driven systems, such as those leveraging machine learning (ML) algorithms into wearable devices are showing promise in orthopaedic surgery from high level to the elite athlete population. The application of AI solutions has the potential to revolutionise injury risk assessment in elite sport by identifying abnormal movement patterns and providing real-time feedback during training with the potential to identify early, players at risk of career-ending injuries. This review comprehensively explores the role AI may have in addressing ACL injury burden in elite sport through the entire patient care pathway, from injury to return to sport and optimising performance. In addition, rehabilitation strategies, offering personalised recovery plans and monitoring progress to reduce reinjury rates and provide the clinician with useful, up-to-date knowledge of AI's capabilities in elite sports are explored. While AI holds immense potential, clinicians must remain cognisant of its limitations, external validity and generalisability before implementation into clinical practice.

LÓPEZ-CARRIL S, ALGUACIL M, GREGORI-FAUS C, et al. Artificial intelligence in sport management education: A students' perspective [J]. INTERNATIONAL JOURNAL OF MANAGEMENT EDUCATION, 2026, 24(3).

ABSTRACT

Artificial intelligence (AI) is transforming both higher education and the sport industry. This study qualitatively explores the perceptions of sport management students regarding AI's integration into academic contexts and the sport industry, guided by the Uses and Gratifications Theory (U&G) and the Disruptive Innovation Theory (DIT). Seventy-nine undergraduates from a Spanish university completed an open-ended questionnaire after a classroom debate on AI. Thematic analysis revealed that, consistent with U&G, students use AI to fulfil cognitive needs (e. g., acquiring and clarifying information, generating ideas) and instrumental needs (e.g., improving efficiency, solving problems quickly). Reported benefits included rapid access to information, enhanced learning support, and time savings, while concerns focused on plagiarism, reduced creativity, overreliance, and unreliable outputs. From a DIT perspective, students viewed AI as a potentially disruptive force capable of transforming sport management education and

industry practices, generating opportunities for innovation but also posing risks such as job displacement and over-automation. Overall sentiment was cautiously positive, with calls for ethical guidelines, targeted training, and balanced adoption that leverages AI's advantages without eroding essential human skills. This situated perspective provides practical and theoretical insights for integrating AI into sport management curricula and informs future quantitative or mixed-method research.

MORAN T, GROSS C, SLONE H. Innovation in 3D Printing and Applications in Orthopaedic Sports Medicine [J]. OPERATIVE TECHNIQUES IN SPORTS MEDICINE, 2025, 33(4).

ABSTRACT

Three-dimensional (3D) printing has evolved from an experimental technology to a tool with practical applications in sports medicine. Advances in materials science and manufacturing have enabled the fabrication of instrumentation compatible with the complexities of musculoskeletal anatomy. Current applications of 3D printing include patient-specific instrumentation (PSI) and guides, custom implants, anatomic modelling, and early-stage biologic scaffolds. Emerging literature has demonstrated potential clinical benefit for certain sports medicine procedures of the knee, shoulder, and hip, including anterior cruciate ligament reconstruction, peri-articular osteotomy, and complex biologic restoration procedures. Likewise, materials science continues to evolve to allow for further implant customization. Although nascent at present time, emerging work in soft tissue bioprinting yields the potential to engineer viable cartilage, meniscus, and osteochondral constructs, though significant challenges remain prior to these representing effective solutions in contemporary practice. Although applications for customized instrumentation and implants have growing clinical utility, barriers to routine use remain, including a dependence on high-quality imaging, variability in manufacturing accuracy, sterilization, regulatory gaps, and cost. Continued clinical and translational research, cost-benefit analyses, and development of regulatory standards highlight future directions for 3D printing in orthopaedic sports medicine.

PALERMI S, PUCCIATTI R, REGNARD N, et al. Artificial Intelligence in Sports Medicine: A Decision-Centered Framework for the Future Sports Physician [J]. DIAGNOSTICS, 2026, 16(10).

ABSTRACT

Background: Artificial intelligence (AI) is rapidly transforming healthcare, with increasing applications in sports medicine. Advances in machine learning, deep learning, and computer vision enable the analysis of large, heterogeneous datasets derived from imaging, wearable sensors, performance-monitoring systems, and electronic health records. While these technologies offer opportunities to enhance injury prevention, diagnostic accuracy, rehabilitation monitoring, and clinical decision-making, their integration into athlete

care remains complex and context-dependent. **Methods:** A structured narrative review of the PubMed/MEDLINE database was conducted to identify clinically relevant AI applications in sports medicine. The search focused on key domains including injury risk prediction, musculoskeletal imaging, rehabilitation monitoring, return-to-play assessment, performance management, and clinical workflow support. Evidence from original studies, reviews, methodological reports, and regulatory documents was qualitatively synthesized to provide an overview of current applications, methodological limitations, and decision-level implications. **Results:** AI demonstrates growing utility across multiple domains of sports medicine. Machine learning models can identify complex, non-linear relationships among training load, physiological responses, and injury risk, though their predictive performance varies widely and is often limited by dataset heterogeneity and a lack of external validation. In musculoskeletal imaging, AI-based algorithms support automated detection and quantification of abnormalities, with performance in selected tasks approaching that of expert readers, yet remaining task-specific and context-dependent. Emerging applications include movement analysis and rehabilitation monitoring through wearable sensors and computer vision systems, as well as data-driven support for return-to-play decisions and clinical workflow optimization. However, current evidence highlights important limitations, including algorithmic bias, limited generalizability, poor interpretability, and the risk of misapplication in complex clinical decision-making contexts. **Conclusions:** AI is likely to become an important decision-support layer in sports medicine by enabling data integration and longitudinal monitoring. However, model performance does not necessarily translate into improved clinical outcomes, and AI-generated predictions remain probabilistic and context-sensitive. Consequently, clinical decisions-particularly high-stakes processes such as return-to-play-require structured integration of AI outputs within a broader clinical framework. The sports physician remains central as a human-in-the-loop integrator, responsible for contextualizing AI-derived information, mitigating potential errors, and ensuring safe, individualized athlete management.

TANNOUBI A, GEANTA V, ARDELEAN V, et al. Rethinking ethical governance of generative AI in sport pedagogy research: a discipline-sensitive perspective [J]. FRONTIERS IN PUBLIC HEALTH, 2026, 14.

ABSTRACT

Generative artificial intelligence (GenAI)-including large language models, image synthesis, and learning analytics tools, is increasingly used in pedagogical research for instructional design, feedback generation, data analysis, and manuscript preparation. However, discipline-specific ethical guidance remains limited, particularly in fields characterized by embodied learning and performance-based pedagogy. In sport sciences, GenAI applications intersect with motor learning, sensorimotor feedback, and learner autonomy, raising distinctive challenges related to academic integrity, transparency, authorship, data protection, and

pedagogical validity. In this Perspective, we argue that existing institutional and international AI ethics frameworks, while essential, remain predominantly text-oriented and insufficiently responsive to the embodied, safety-sensitive, and movement-based characteristics of sport pedagogy research. This creates a governance gap in which AI-generated feedback may directly affect motor learning processes, learner safety, and skill acquisition trajectories in ways not adequately captured by generic AI ethics guidance. Drawing on research integrity standards, global AI governance principles, and motor learning theory, we identify key ethical tensions emerging from the integration of generative systems into sport pedagogical research and practice. This article develops a discipline-sensitive ethical framework through a structured, purposive, and theory-guided synthesis of relevant literature. We propose a set of priority orientations to support responsible GenAI use in this context, including strengthened human accountability, transparent disclosure practices, discipline-informed validation of AI-generated feedback, and enhanced protection of learner data. These propositions require empirical validation in real world sport pedagogy contexts. We position pedagogical validity, defined as alignment between AI-supported processes and established motor learning principles, as a novel ethical criterion not yet explicitly articulated in AI education governance. Finally, we outline a research and policy agenda for empirically validating this framework across diverse embodied learning environments and clarify the logic used to identify and synthesize literature across AI governance, research integrity, and motor learning scholarship. This conceptual, theory-guided Perspective is intended to inform researchers, ethics committees, and higher education institutions seeking disciplines-sensitive approaches to the responsible integration of GenAI in embodied learning and performance-based education contexts.

XI Y, HUANG T, YANG Z. Multimodal human action recognition and personalized sports health promotion: a deep learning framework integrating wearable sensor fusion [J]. FRONTIERS IN NEUROBOTICS, 2026, 20.

ABSTRACT

Introduction: In real-world sports scenarios, Human Action Recognition (HAR) is often hindered by data complexity, limited dynamic adaptability, and fragmented integration of physiological and kinematic information. To address these challenges, this study proposes a multimodal HAR framework for personalized sports health promotion by integrating wearable sensor streams with deep learning architectures. **Methods:** The proposed system employs a robust sensing layer to capture 12-dimensional multimodal data and synchronize physiological indicators with behavioral signals in real time. A novel Transformer-GCN hybrid model was developed to extract complex spatiotemporal dependencies for accurate action recognition and dynamic state analysis. In addition, a reinforcement learning module was

incorporated to generate adaptive exercise prescriptions based on user progress. The framework was deployed through a responsive interface for real-time intervention and evaluated in a 12-week randomized controlled trial. Results: The results demonstrated that the proposed framework achieved effective multimodal fusion and reliable action recognition in sports scenarios. After the 12-week intervention, participants in the intervention group showed a 20.1% increase in cardiorespiratory fitness (VO2 max), a 99.3% improvement in muscular endurance, and a sports injury rate maintained below 15%. These findings indicate that the framework can support accurate motion analysis and safe, personalized intervention. Discussion: The proposed multimodal fusion architecture effectively bridges the gap between action recognition and personalized sports health intervention. By combining wearable sensing, hybrid deep learning, and reinforcement learning, the framework provides a practical solution for AI-driven motion analysis and adaptive health promotion in land sports scenarios.

XU H, YANG Z, LAW R, et al. Impact of the artificial intelligence robot applications in the mega-sport event on destination loyalty formation process: The case of Hangzhou Asian Games 2022 [J]. JOURNAL OF DESTINATION MARKETING & MANAGEMENT, 2026, 41.

ABSTRACT

Despite the widespread adoption of artificial intelligence (AI) robots in the tourism and travel industry, their effectiveness in enhancing service quality and tourist satisfaction remains understudied, particularly in their application in mega-events. Drawing on affective event theory, this study examines the impact of AI robot applications on event quality, spectator satisfaction, and destination loyalty. Data were collected from 377 tourists attending the 19th Asian Games in Hangzhou, China, in 2023. Results confirm that AI robot applications enhance event quality, satisfaction, and destination loyalty. Whereas robot anthropomorphism improves overall robot value, functional and emotional values demonstrate differing impacts. Functional value emerges as the strongest driver, directly influencing event quality, satisfaction, and subsequently, destination loyalty. Conversely, emotional value has a direct impact on satisfaction, which positively affects destination loyalty. However, it does not directly influence event quality. Findings extend our understanding of AI robot applications in mega-events, broadening perspectives from event-specific outcomes to destination marketing and management implications.

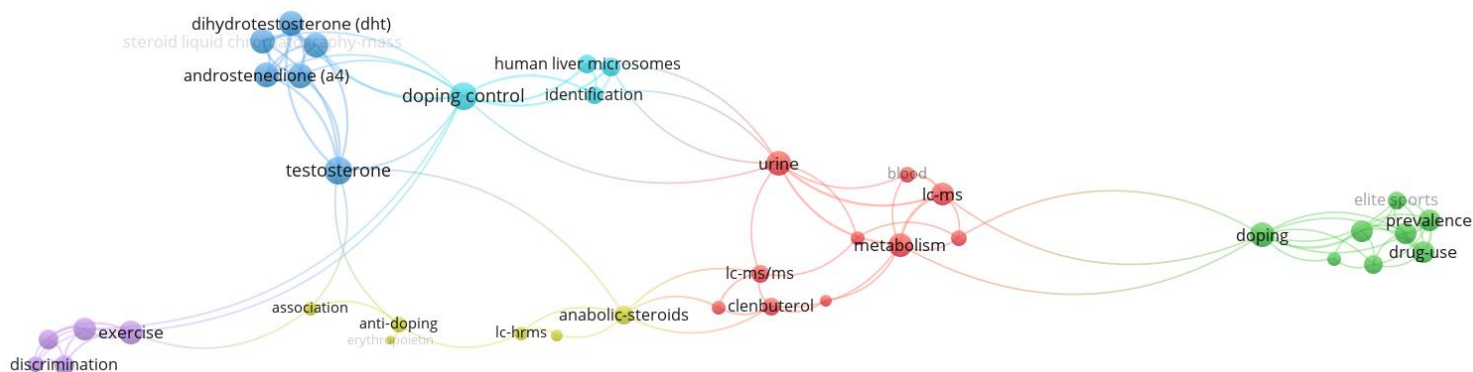
ZHAO D, ALOTAIBI K, REHMAN S, et al. From AI coaching to athletic engagement: the mediating roles of cognitive adaptability and growth mindset in sports students [J]. BMC SPORTS SCIENCE MEDICINE AND REHABILITATION, 2026, 18(1).

ABSTRACT

Background: AI-supported coaching tools are increasingly incorporated into sport education, yet limited research has examined how students' perceptions of these technologies relate to their cognitive and motivational functioning. This study investigates perceived AI-supported coaching and its relationship to athletic learning engagement among sports-major students, with cognitive adaptability and a growth mindset as mediators. **Methods:** A cross-sectional survey was conducted in March 2025 at universities in Dezhou, Shandong Province, that offer sports degree programs. The final analytic sample comprised 1,794 sports-major students. Validated Chinese measures assessed perceived AI-supported coaching, cognitive adaptability, growth mindset, and athletic learning engagement. Structural equation modeling with bootstrapped indirect effects was used to examine mediation pathways, and sensitivity analysis was conducted to assess the robustness of indirect effects across alternative model specifications. **Results:** Perceived AI-supported coaching was positively associated with cognitive adaptability and, to a lesser extent, with engagement. Cognitive adaptability was positively associated with both growth mindset and engagement. The indirect effect of AI-supported coaching on engagement via cognitive adaptability was significant, as was the sequential pathway through cognitive adaptability and growth mindset. In contrast, the indirect pathway through growth mindset alone was not significant. Sensitivity analyses indicated that the pattern and significance of indirect effects remained stable across alternative model specifications, supporting the robustness of the mediation findings. **Conclusions:** The findings suggest that cognitive adaptability serves as a meaningful intermediary linking perceived AI-supported coaching with students' engagement in athletic learning, whereas growth mindset primarily operates within a sequential cognitive-motivational pathway. These results underscore the importance of considering both cognitive and belief-based processes when integrating AI-supported tools into sport education.

反兴奋剂

本期反兴奋剂学术研究共检索到英文相关文献67篇，研究热点主要集中在兴奋剂检测技术、运动员心理、反兴奋剂政策法规、违规行为等方面。检索结果如下：1）关键词共词分析。提取关键词94个，经过数据清洗后关键词有89个，词频 ≥ 2 （含2）的关键词有14个，累计百分比为27.31%，高频关键词为兴奋剂、反兴奋剂、世界反兴奋剂机构等，生成可视化知识图谱（见下图）。2）来源期刊分析。涉及期刊45种，其中载文2篇及以上的期刊有5种，所载文献累计百分比为53.33%，刊载反兴奋剂研究前三位的期刊分别为：Drug testing and analysis（JCR学科分区Q3）、Analytical and Bioanalytical Chemistry（JCR学科分区Q2）Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz（JCR学科分区Q3）。3）学科交叉分析。引用文献总计2002篇，最多的频次为4次，近两年排名并列第一的文献分别为 *Athletes and Supplements: Prevalence and Perspectives*、*Athlete Performance Monitoring in Anti-Doping*。4）学术关注度分析。文献级别用量最多的是7次，排名前两位的文献分别为：*Rapid Analysis of Urinary AICAR by Liquid Chromatography-Isotope Ratio Mass Spectrometry*、*Trends in microchemical detection methods for illegal adulterants and heavy metals in sports nutrition supplements*。



BEJDER J, SCHLECHTEN C, MUMENTHALER C, et al. Comparison of Dried Blood Spot Sampling Methods for RNA-Based Biomarker Measurement in Anti-Doping [J]. DRUG TESTING AND ANALYSIS, 2026, 18(8): 959-66.

ABSTRACT

Dried blood spot (DBS) sampling offers logistical advantages, but it remains unexplored whether analytical results are comparable across DBS sampling methods. This study investigated whether venous or capillary blood spotted on cellulose cards or collected with the Tasso-M20 device provides comparable results for the anti-doping RNA-based biomarkers of erythropoiesis, 5-aminolevulinic acid synthase (ALAS2), and carbonic anhydrase 1 (CA1). In the population of Swiss athletes ($n = 12$), DBS samples (venous-cellulose and Tasso-M20) were collected in routine anti-doping procedures. In healthy volunteers ($n = 12$), DBS samples (venous-cellulose, capillary-cellulose and Tasso-M20) were collected at baseline, after 1 week and 10 days post a 3-week recombinant human erythropoietin (rEPO) administration study. ALAS2 and CA1 mRNA were quantified using RT-qPCR, and agreement between matrices was assessed via Passing-Bablok regression. ALAS2 and CA1 expression showed strong linear agreement ($r \geq 0.96$) across matrices. Passing-Bablok regression indicated no constant or proportional bias for ALAS2 across all comparisons. For CA1, no bias existed between venous-cellulose and Tasso-M20 in the athlete population, whereas a proportional bias of similar to 9%-22% was observed when comparing Tasso-M20 DBS with venous- or capillary-cellulose DBS in the rEPO study. No significant differences in relative RNA expression were observed across matrices at any timepoint in the administration study. ALAS2 and CA1 are reliably quantified across venous- and capillary-cellulose-based DBS and Tasso-M20 DBS samples. Strong agreement and minimal bias, with the modest CA1 bias being small relative to expected biological or treatment-induced variability, support their use for longitudinal monitoring, enabling less invasive, flexible, and decentralized sampling in research and anti-doping.

BRITO D, COLAMONICI C, CURCIO D, et al. Comprehensive Profiling of 6 α -Chloro-Testosterone Metabolism in Human Urine Using Gas Chromatography-Mass Spectrometry [J]. DRUG TESTING AND ANALYSIS, 2026, 18(8): 967-75.

ABSTRACT

According to its structure, 6 α -chloro-17 β -hydroxyandrost-4-en-3-one (6-CT) can exhibit both anabolic and antiestrogenic effects, and as such, it is prohibited in sports according to the World Anti-Doping Agency rules. The aim of this paper was to study the metabolism of 6-CT in humans by gas chromatography couple to mass spectrometry in tandem (GC-MS/MS), time-of-flight (GC-qTOF) and isotopic ratio (GC-C-IRMS), to describe changes in the endogenous steroid profile and the influence of

6-CT consumption on the carbon isotope ratio (CIR). One single oral dose of 6-CT (25 mg) was administered to two volunteers, and preadministration and postadministration samples of urine were collected for, at least, 4 days. Halogenated and dehalogenated metabolites were detected considering the accurate mass of the structure, the endogenous steroid profile was quantified and CIR values were measured. All urinary concentrations or areas were adjusted to a specific gravity of 1.020. The results showed halogenated and dehalogenated metabolites of 6-CT, considering the Phase I main reactions of steroids. The potential favoured 5 beta- reduction pathway allowed the formation of 5 beta- metabolites that are known to have weak or null androgenic activity (e.g., 6 beta-hydroxy-etiocholanolone, 5 beta-dihydrotestosterone and 5 beta-androstenediol), but the impact on the steroid profile evaluated in the Athlete Biological Passport (ABP) should be carefully assessed.

COLL S, BRESSAN C, MONFORT N, et al. Revisited Pharmacokinetic Profiles of Methylprednisolone in Plasma and Urine After Single and Multiple Oral Administrations: Relevance in Sports Drug Testing [J]. CLINICAL PHARMACOKINETICS, 2026, 65(8): 1243-56.

ABSTRACT

Background:The pharmacokinetic profiles of methylprednisolone (MP) in plasma and urine were evaluated after single and multiple oral doses. MP is prohibited in sports competitions when administered systemically (oral, injectable, or rectal administrations) whereas other routes remain permitted for therapeutic purposes.**Objective:**The aim of this study was to characterize the urinary MP excretion after oral administration to assess whether the current World Anti-Doping Agency minimum reporting level of 30 ng/mL in urine is appropriate for distinguishing permitted from prohibited administrations, as well as whether the recommended washout period is adequate. Another aim was to better define MP elimination kinetics and evaluate its systemic effects.**Methods:**Sixteen healthy male participants were enrolled and divided into two groups. One group received a single oral dose of 12 mg of MP, while the other received 12 mg daily for 3 consecutive days. Urine and blood samples were collected before, during, and after administration. Urine samples were analyzed for MP and 15 metabolites using a sensitive and selective liquid chromatography-tandem mass spectrometry method. Plasma samples were analyzed for unchanged MP and cortisol using liquid chromatography-tandem mass spectrometry. A pharmacokinetic analysis was performed using a one-compartment model with first-order absorption, combining plasma concentrations and urinary excretion data.**Results:**MP represented only a small proportion of the administered dose, confirming that metabolism is the main elimination pathway. After a single oral dose, urinary MP concentrations above 30 ng/mL were observed up to 12 h, while all samples collected later were below this concentration. After multiple dosing, most samples above 30 ng/mL were also found within 12 h, although a few participants still showed concentrations above the minimum reporting level in the 12 to 24 h period.

All samples collected more than 24 h after the last dose were below 30 ng/mL. In plasma, MP reached peak concentrations around 1.6-2.3 h after administration and was not detectable 24 h after the last dose. Cortisol concentrations were markedly suppressed after dosing, with recovery to baseline within 24-48 h depending on the regimen. **Conclusions:** This study confirms that the current urinary minimum reporting level of 30 ng/mL is appropriate for detecting oral MP use while minimizing the risk of false adverse analytical findings. The results also support the adequacy of the current 3-day washout period. Modern liquid chromatography-tandem mass spectrometry analysis and combined plasma-urine pharmacokinetic modeling provided robust evidence that MP is rapidly eliminated, extensively metabolized, and associated with transient cortisol suppression after oral administration.

DIETZ P, ULRICH R, SIMON P. Doping in recreational sports [J]. BUNDESGESUNDHEITSBLATT-GESUNDHEITSFORSCHUNG-GESUNDHEITSSCHUTZ, 2026, 69(7): 774-9.

ABSTRACT

Doping is commonly perceived as being primarily associated with professional sports rather than recreational sports. This article is a discussion paper and addresses doping in recreational sports from conceptual, methodological, and empirical perspectives. Established doping definitions, particularly those of the World Anti-Doping Agency, are only partially transferable to recreational sports contexts due to their strong focus on organizational affiliation and competitive settings. For large segments of recreational sport, the concept of performance-enhancing substance use therefore provides a more appropriate description. Assessing the prevalence of such use is methodologically challenging due to the sensitive nature of the topic and the lack of control mechanisms. Indirect survey techniques reduce socially desirable responding and yield more realistic estimates. The unrelated question model (UQM) is a randomized response technique that ensures full anonymity and enables robust prevalence estimates of sensitive behaviors at the population level. Empirical findings using the UQM among recreational athletes in endurance, fitness, and bodybuilding contexts indicate that the use of performance-enhancing substances is not a marginal phenomenon. Prevalence estimates suggest a relevant and stable level over time. Strong associations are observed with non-therapeutic use of pain medication and an increasing medicalization of performance optimization. Evidence of access via healthcare structures highlights the structural embedding of this phenomenon. Overall, the use of performance-enhancing substances in recreational sport represents a socially and medically relevant field of action that requires differentiated prevention strategies and greater integration into medical education and training.

GOODRUM J, NAIR V, CROUCH A, et al. Comparing the Stability and Detectability of Testosterone Esters in Capillary Serum, Sodium Fluoride-Containing Plasma, and Dried Blood Spots After Testosterone Ester Administration [J]. DRUG TESTING AND ANALYSIS, 2026, 18(8): 1088-96.

ABSTRACT

Steroid esters are a frequently used ergogenic aid among athletes, and their direct detection represents an important approach to anti-doping efforts. However, the presence of esterase enzymes in blood complicates these efforts. Although dried blood spots (DBS) have emerged as a promising solution to the esterase problem, the limited sample volume creates both analytical and practical challenges. The larger collection volume for liquid blood may allow for higher analytical sensitivity, thus offsetting the effects of esterase activity in practical scenarios. First, to evaluate the effects of blood esterases *ex vivo*, 10 individuals were administered a single dose of either testosterone propionate or testosterone cypionate. Venous blood was collected into serum separator tubes (SST) serum and NaF-containing tubes and stored at varying conditions. Both esters significantly decreased in serum while no ester loss was observed in the NaF-containing plasma. Next, to compare the detectability across matrices stored at conditions meant to mimic real-world scenarios, the individuals administered testosterone propionate collected capillary serum, capillary NaF-containing plasma, and capillary DBS at various times postadministration. Each sample type was stored at different conditions designed to mimic what may be encountered during real-world shipping scenarios. Similar detectability of testosterone propionate was observed between all NaF, DBS, and SST samples stored under cool conditions, whereas detectability was better in NaF and DBS samples under ambient and warm conditions. These results indicate that for samples not shipped in temperature regulated conditions, DBS and NaF-containing plasma are the preferred matrices.

HOU J, YANG S. Characterization of Novel Metabolites of the HIF Stabilizer JNJ-42041935 in Rats Using LC-HRMS for Doping Control Purposes: A Pilot Study [J]. DRUG TESTING AND ANALYSIS, 2026, 18(8): 976-90.

ABSTRACT

Hypoxia-inducible factor prolyl hydroxylase inhibitors (HIF-PHIs) stimulate erythropoiesis and enhance performance, and were banned by the World Anti-Doping Agency in the year 2011. JNJ-42041935, a potent and selective PHD inhibitor, was administered orally to Sprague-Dawley rats, and its metabolites were tentatively characterized using liquid chromatography-high-resolution mass spectrometry (LC-HRMS) in positive and negative ionization modes. Eleven metabolites were identified, with Phase I reactions including monohydroxylation, dechlorination, and decarboxylation, and Phase II reactions comprising

methylation, glucuronidation, sulfation, glycine, and taurine conjugation. These results provide insights into JNJ-42041935 biotransformation and support the development of analytical methods for HIF-PHI detection in anti-doping control. Future studies will continue to identify and characterize the valuable metabolites of JNJ-42041935, with a view to providing a more comprehensive understanding of its in vivo metabolic profile and developing improved detection methods.

JING J, LIANG X, CHEN X, et al. Comprehensive metabolic characterization of GBT1118 in humans using a combined approach via UHPLC-HRMS for doping control [J]. ANALYTICAL AND BIOANALYTICAL CHEMISTRY, 2026, 418(12): 3749-61.

ABSTRACT

Artificially enhancing muscular oxygen (O₂) delivery represents a major cheating method in competitive sports. GBT1118, an emerging hemoglobin S polymerization inhibitor (HbS-PI), has demonstrated considerable performance-enhancing effect by increasing the Hb affinity for O₂, raising concerns about potential abuse in athletics. However, the lack of metabolic knowledge and ethical restrictions on human subjects hinder the effective doping control of GBT1118. In this study, comprehensive metabolic profiling of GBT1118 was characterized by combining a human liver microsomes in vitro model and a multi-dimensional data mining strategy. Orbitrap-based ultra-high-performance liquid chromatography-high resolution mass spectrometry (UHPLC-HRMS) in data-dependent acquisition (DDA) mode was utilized to detect both phase-I and phase-II reaction products, together with in silico prediction and a home-made HbS-PI biotransformation database for in-depth metabolite screening. After duplicate exclusion, manual identification and verification with synthetic standards, extensive metabolism including 21 phase-I metabolites and 8 phase-II metabolites was discovered for GBT1118. Structure assignment revealed several key metabolic sites and diverse biotransformation pathways, including ester hydrolysis, aldehyde reduction, aldehyde oxidation, hydroxylation (monohydroxylation and dihydroxylation), glucuronidation, and the cross-combination of these pathways. Notably, the high proportion of glucuronide conjugates (> 60%) suggests the necessity of implementing enzymatic hydrolysis in routine anti-doping analyses. Furthermore, based on metabolite abundance and a comparative analysis with a recent in vivo metabolic study of an analogue, the drug prototype and two metabolites are proposed as promising urinary markers for abuse monitoring. This study provides the first comprehensive insight into the human-relevant metabolic profile of GBT1118, offering valuable guidance for doping control, which also serves as an effective tool for human metabolic research of other HbS-PIs.

KROMBHOLZ S, KORSMEIER L, THOMAS A, et al. Analysis and Characterization of Kisspeptin and Its Analogues in Serum and Urine Samples by Liquid Chromatography-High-Resolution Mass Spectrometry for Doping Control Purposes [J]. DRUG TESTING AND ANALYSIS, 2026, 18(7): 862-76.

ABSTRACT

The use of testosterone-stimulating peptides for doping purposes is prohibited for male athletes by the World Anti-Doping Agency (WADA). Among these substances is kisspeptin (KP-54), its isoforms (KP-14, KP-13, and KP-10), and synthetic receptor agonists such as TAK-448. Thus, they have been included in the WADA Prohibited List in 2024. To enable effective detection of kisspeptin misuse, reliable analytical methods are required. Consequently, this study aimed to develop liquid chromatography-high-resolution mass spectrometry-based (LC-MS) methods for the detection of kisspeptin and its analogues in human serum and urine. In addition, peptide stability in different biological matrices was investigated, and metabolic stability was characterized in vitro. Extraction methods based on cation-exchange solid-phase extraction were optimized, enabling a selective and sensitive LC-MS analysis with limits of identification (LOI) ranging from 0.8 ng/mL (KP-54) to 10 pg/mL (TAK-448). Analysis of a reference population comprising $n = 20$ serum samples and $n = 100$ urine samples revealed no detectable signals of endogenous kisspeptins and/or its degradation products. All native kisspeptins investigated showed poor stability in urine and blood; however, several degradation products could be identified. These metabolites could serve as complementary target analytes and improve the detectability of kisspeptins in doping control samples. Overall, the study provides an important foundation for the confirmatory analysis of kisspeptins in doping controls and delivers in vitro insights into their metabolic behavior. Analysis of samples collected after administration of the peptides remains necessary to further assess the detectability and metabolic profiles in authentic samples.

LEMETILÄ M, VUORI N, SHAMMA S, et al. Psychoactive drug use among athletes: motives and risk factors beyond sports performance - A scoping review [J]. INTERNATIONAL JOURNAL OF DRUG POLICY, 2026, 155.

ABSTRACT

Organised competitive sport represents a unique socio-cultural environment in which performance demands, social influences within sport and anti-doping frameworks shape athletes' substance use behaviours. In 2021, the World Anti-Doping Agency introduced a 'Substances of Abuse' category to address athletes' drug use outside the context of sport. Athletes may use psychoactive drugs, for example, to manage sports related pressure, stress and mental health challenges rather than to enhance performance. While doping in sport

remains a widely studied phenomenon, less attention has been given to psychoactive drug use behaviours among athletes involved in organised sports that are driven by motives other than performance enhancement. This scoping review explored psychosocial motivations and associated risk factors for psychoactive drug use across varied athletic populations including young, professional, elite and retired athletes. A scoping review was conducted using a systematic search strategy in the Scopus, Web of Science and PsycINFO databases. The review followed JBI guidelines and the PRISMA-ScR framework. It focused on peer reviewed studies published between 2014 and 2024. Covidence software was utilised for researchers' independent screening processes and the Sport Drug Control Model guided the review's thematic analysis. 38 studies were included. Most studies were conducted in a North American context and were primarily focused on young athletes (55.3%). Cannabis was the most examined drug (68.4%). Athletes' motives for psychoactive drug use were related to benefit appraisal, especially perceived benefits for mood enhancement (for example, relaxation after a game or coping with injuries). Risk factors included young age, male gender, low perceived competence, mood disorders, peer use, contact sports, injuries and career transitions. The findings highlight the importance of ensuring that drug use prevention and harm reduction interventions reach at-risk athletic populations, particularly adolescent athletes, while also addressing sport specific risk factors.

LIU Y, GUO Z, QIN S, et al. Metabolic profiles of MK-3984 (SARM) in zebrafish using ultra high performance liquid chromatography Q extractive HF hybrid quadrupole orbitrap mass spectrometry (UPLC-QE-HF-MS) for doping control [J]. ANALYST, 2026, 151(16): 4690-702.

ABSTRACT

In this study, the metabolic profiles of MK-3984, a selective androgen receptor modulator (SARM) targeting muscle and bone tissues, were comprehensively investigated for the first time using quadrupole orbitrap LC-MS/MS in a zebrafish model. The analysis revealed 82 metabolites (M1-M82) and identified 12 distinct metabolic pathways. Phase I metabolism was predominantly characterized by reductive defluorination, while phase II metabolism primarily involved cysteinylolation and sulfation. Notably, this study first reported the characteristic neutral losses (87 and 129 Da) associated with cysteinylated and N-acetylated-cysteinylated metabolites in negative ion mode. Three key metabolites-M1 (reductive defluorinated metabolite), M28 (reductive defluorinated, monohydroxylated and sulfated metabolite), and M55 (reductive defluorinated, monohydroxylated and cysteinylated metabolite) were identified as potential biomarkers for monitoring MK-3984 abuse. These findings provide valuable insights into the metabolic fate of MK-3984 and establish a foundation for its detection in anti-doping controls.

PAZ A, DHORNE-POLLET S, LOUP B, et al. Towards a Comprehensive Screening Approach for Detecting Gene Doping in Racehorses and Sport Horses by Targeting Common and Intrinsic Plasmid Sequences [J]. DRUG TESTING AND ANALYSIS, 2026, 18(8): 1122-38.

ABSTRACT

The evolution of biotechnology and gene therapy has unfortunately facilitated the emergence of gene doping. Those misused applications are prohibited in equestrian sports (International Equestrian Federation (FEI)) and in horseracing (International Federation of Horseracing Authorities [IFHA]), reflecting major concerns regarding horse welfare and the integrity of competitions. Among the biotechnological tools that could be misused, eukaryotic expression plasmids represent a particular threat due to their ease of production, customisable design and ability to carry a wide range of performance transgenes. Current detection methods are mainly based on the identification of these transgenes, but if the sequence is unknown or modified, administration may not be detected. The aim of this work was to overcome this limitation by developing an untargeted transgene screening approach in equine plasma. A database of 349 mammalian expression plasmids was compiled, allowing identification of four conserved targets: the ampicillin resistance gene (AmpR), the cytomegalovirus promoter (pCMV) and two unannotated sequences between the features, which together covered 100% of the plasmids database. A set of PCR hydrolysis probe assays targeting these sequences has been developed and exhibited excellent efficiency, linearity and robustness. The method was able to discriminate, in plasma, 100% of suspicious samples from background noise down to 1200 copies/mL. Following plasmid administration to a horse, all four targets remained detectable up to 48 h using qPCR and dPCR, demonstrating the proof of concept. Overall, this work presented a sensitive, reliable and transgene-independent method that strengthens plasmid detection and reinforces gene doping control in equine athletes.

POLET M, VAN EENOO P. Rapid Analysis of Urinary AICAR by Liquid Chromatography-Isotope Ratio Mass Spectrometry [J]. ANALYTICAL CHEMISTRY, 2026, 98(15): 11168-78.

ABSTRACT

5-Aminoimidazole-4-carboxamide-1-beta-d-ribofuranoside (AICAR) is prohibited in sports according to the World Anti-Doping Agency (WADA). Currently, AICAR concentrations are measured during the initial testing procedure, and urine samples showing elevated levels are flagged as suspicious and forwarded for confirmation. Here, gas chromatography combustion isotope ratio mass spectrometry (GC-C-IRMS) is employed to distinguish endogenous from exogenous AICAR, as synthetic AICAR exhibits a different carbon isotope ratio (CIR). However, a GC-C-IRMS method comes with multiple challenges as AICAR is very polar, making it particularly difficult to analyze using GC. It is clear that there are a number of issues related to the existing protocol, and efforts should be made to develop new, more effective, and less expensive approaches.

For polar substances, liquid chromatography-isotope ratio mass spectrometry (LC-IRMS) provides a more straightforward approach. There is no need for derivatization, AICAR can be directly analyzed with LC-IRMS, and many GC-C-IRMS related issues are avoided. LC-IRMS also allows condensing of the workflow and lowering of the turnaround time. In this study, a rapid protocol for AICAR CIR determination was developed, employing solid-phase extraction and 2D-LC cleanup prior to LC-IRMS analysis. Etiocholanolone and androsterone were used as endogenous reference compounds, and the method was fully validated according to WADA regulations. Reference population ($n = 50$) thresholds, used to declare an adverse analytical finding (AAF, i.e., a positive AICAR sample), were determined (6.9 parts per thousand and 5.8 parts per thousand for AICAR-etiocholanolone and AICAR-androsterone, respectively) and found to be approximately 2 parts per thousand lower than those previously reported using GC-C-IRMS, facilitating AAF identification.

REQUENA-TUTUSAUS L, ANSELMO I, COLL S, et al. Detection capabilities of a single dried blood spot for recombinant erythropoietin micro-dose testing in sport [J]. JOURNAL OF PHARMACOLOGICAL AND TOXICOLOGICAL METHODS, 2026, 139.

ABSTRACT

Objectives: Dried blood spot (DBS) micro-sampling is gaining prominence in anti-doping testing, particularly for the detection of erythropoietin-receptor agonists (ERAs) such as recombinant erythropoietin (rEPO). However, detecting micro-doses of rEPO remains challenging due to the low concentrations in blood. This study explores the detection capabilities of micro-doses of rEPO using a single collection pad of a DBS device. **Design and methods:** A single subcutaneous micro-dose of rEPO (Procrit (R), 15 IU/kg) was administered to four healthy participants. DBS samples (4 & times; 17.5 μ L) were collected using the polymeric Tasso-M20 (R) device at multiple time points post-administration, and compared with 15 mL urine samples. All samples were analyzed using SAR-PAGE and Western-Blot techniques. In line with the new WADA regulations, two MAIA immunopurification methods with different capture antibodies were validated for the initial testing and confirmation of rEPO in DBS. **Results:** All ERAs were detectable in polymeric DBS matrix at the limits of detection required by WADA. In polymeric DBS, analytes remained stable for at least six months at room temperature and at -20 degrees C. rEPO microdose was detectable in DBS up to 72-96 h post-dose, and in urine up to 84-96 h. **Conclusions:** These findings support the suitability of DBS as a complementary matrix to urine for the detection of rEPO, reinforcing confidence in its effectiveness for the detection of ERAs.

ROSENKE D. From Lip Service to Leader: A Forgotten Scandal and Canada's Emergence as a Trailblazer in the Global anti-Doping Movement [J]. INTERNATIONAL JOURNAL OF THE HISTORY OF SPORT, 2026, 43(8): 1158-88.

ABSTRACT

On October 31, 1983, four Canadian national team weightlifters were arrested at Montreal's Mirabel Airport after customs agents discovered a large cache of doping agents in their luggage. Returning home from the World Weightlifting Championships in Moscow, the men had collectively purchased 22,000 Dianabol pills and 414 vials of injectable testosterone from their Soviet counterparts with the alleged intention of reselling the drugs in Canada at a substantial mark-up. Having already contended with a major drug scandal at the Caracas Pan-American Games in August, sporting bureaucrats in Canada scrambled to extinguish the public relations firestorm set ablaze by a second drug-related incident just nine weeks later. By January 1984, Canada had ratified the sporting world's first national drug testing programme and thenceforth served as a world leader in the fight for clean sport and fair competition. Scholars have characterized the Caracas affair as a scandal for the ages and a seminal moment in the history of anti-doping in Canada, and across the globe, but it was only after a second 'national embarrassment' that policymakers came to the table, in earnest.

SIRVENT-LLAMAS A, ALBENTOSA-MORA J, CANO-ESQUIBEL G, et al. Enhancing the athlete biological passport with blockchain: A secure and transparent anti-doping approach [J]. INTERNATIONAL JOURNAL OF SPORTS SCIENCE & COACHING, 2026, 21(2): 1103-13.

ABSTRACT

The Athlete Biological Passport (ABP), established by the World Anti-Doping Agency (WADA), serves as a cornerstone in the ongoing fight against doping in sports. By creating individual electronic records that track athletes' biological markers and test results over time, the ABP enables the detection of abnormal variations that may suggest doping. Despite its effectiveness, the ABP faces significant challenges, particularly concerning data privacy, system interoperability, and the risk of unauthorized record manipulation. These issues underscore the need for more robust and transparent technological solutions. This article introduces a novel framework that integrates blockchain technology into the management of the ABP. Blockchain's decentralized and immutable ledger provides a secure and transparent platform for recording, sharing, and auditing anti-doping data among authorized stakeholders. Our proposal outlines a consortium-governed blockchain network, involving sports organizations and regulatory bodies, which ensures that data integrity is maintained while respecting athletes' privacy rights and complying with international anti-doping regulations. We detail the technical architecture, governance model, and implementation roadmap for this blockchain-based system, emphasizing its capacity to prevent data tampering, streamline access control, and enhance the overall transparency of the anti-doping process. By leveraging blockchain's unique features, our

approach aims to strengthen athlete integrity, increase trust in anti-doping measures, and support the evolution of fair and accountable sports governance. The integration of blockchain into the ABP represents a significant step forward in safeguarding the credibility of competitive sports and protecting athlete welfare.

STOJANOVIC B, PFEFFER S, GMEINER G. A Comparison of Three Analytical Procedures for Oxandrolone Long-Term Metabolite Determination in Urine Samples [J]. DRUG TESTING AND ANALYSIS, 2026, 18(7): 852-61.

ABSTRACT

In contemporary antidoping analysis, doping control laboratories are confronted with a wide range of evolving analytical challenges. Continuous methodological refinement is required in this dynamic field, particularly with respect to analytical strategies for the detection and confirmation of prohibited substances. The present study focuses on the comparative evaluation of three analytical strategies for the determination of long-term metabolites (LTMs) of the anabolic androgenic steroid (AAS) oxandrolone (Oxa) in human urine. The identification and implementation of LTMs in routine doping control have substantially enhanced the detection capabilities of antidoping laboratories, leading to an increased number of adverse analytical findings, particularly for AAS compounds. The primary objective of this work was to develop and validate novel confirmatory analytical procedures for Oxa LTMs and to compare their performance with that of an already established method. The investigated approaches comprise the following: (1) gas chromatography-mass spectrometry (GC-MS) following enzymatic hydrolysis of phase II metabolites and subsequent silylation, (2) liquid chromatography-high-resolution mass spectrometry (LC-HRMS) of methylated phase II metabolites, and (3) LC-HRMS analysis of hydrolyzed phase II metabolites. The first two approaches are reported here for the first time in the context of LTM analysis in antidoping applications. These methodologies represent innovative analytical strategies that may be transferable to other target analytes and thereby contribute to further improvements in sports drug testing.

STRIEGEL H. Legal and societal aspects of doping in sport [J]. BUNDESGESUNDHEITSBLATT -GESUNDHEITSFORSCHUNG-GESUNDHEITSSCHUTZ, 2026, 69(7): 744-9.

ABSTRACT

This narrative review provides an overview of the legal and societal aspects of doping in sports phenomenon, which is both complex and multifaceted. Doping is not merely an issue confined to elite and professional sports but also, and especially, a problem within recreational and fitness sports. The legal aspects of doping encompass the legal framework governing the use of doping substances as well as the penalties and sanctions that can be imposed for violations. The sports-law regulations of the World Anti-Doping Agency (WADA) and Nationale Anti-Doping Agentur (NADA) Codes, as well as national anti-doping regulations, are intended

to prevent the use of doping substances in sports and protect athletes from the health risks associated with doping. In Germany, a dedicated Anti-Doping Act was enacted in 2015 to address this issue. The societal aspects of doping concern its impact on society and the culture of sport by undermining established values and norms. Doping in sport compromises the fairness, equal opportunities, and integrity of athletic competition. Furthermore, the use of doping substances and methods can lead to serious health problems and injuries. Therefore, preventive anti-doping measures are not only a responsibility of sport itself, but a societal responsibility to protect fairness and transparency, public trust in sport, and the health of athletes. Only through close cooperation among all stakeholders in sport can a sustainable solution to the problem of doping be found.

WASSONG S. Institutional initiatives of the International Olympic Committee's anti-doping policies: historical and contemporary perspectives [J]. BUNDESGESUNDHEITSBLATT -GESUNDHEITSFORSCHUNG-GESUNDHEITSSCHUTZ, 2026, 69(7): 736-43.

ABSTRACT

The use of performance-enhancing substances can be traced back to before the first modern Olympic Games were held. The International Olympic Committee (IOC), founded in 1894, issued its first guidelines on doping in 1938. These guidelines condemned doping and proposed the exclusion of athletes who consumed performance-enhancing substances. Since the 1960s, institutions dedicated to combating doping in sport have been continuously established. Regulations became more precise, and in 1968, doping controls were conducted for the first time at the Winter Olympics in Grenoble. This article provides an overview of the development of the institutional anti-doping network, with a particular focus on the IOC's Doping Subcommittee, the IOC Medical Commission (MC), the World Anti-Doping Agency (WADA), the National Anti-Doping Agencies (NADAs), and the International Testing Agency (ITA). In addition, the article examines the current challenges facing the anti-doping network in connection with the privately organized "Enhanced Games," in which doping is explicitly permitted.

YUEN B, WONG K, LIN V, et al. Direct LC-HRMS/MS characterisation and RT-qPCR detection for potential mRNA-based doping agent [J]. ANALYTICAL AND BIOANALYTICAL CHEMISTRY, 2026, 418(13): 4191-202.

ABSTRACT

Messenger ribonucleic acid (mRNA) therapeutics offer unprecedented potential for in vivo protein expression but raise emerging risks of misuse for gene doping. We investigated an online-available product purported to be codon-optimised, 5-methoxyuridine-substituted human erythropoietin (EPO) mRNA and developed a corresponding detection assay for equine anti-doping. Product identity was verified using a mass spectrometry

(MS)-based bottom-up workflow comprising RNase 4 digestion, liquid chromatography-high-resolution tandem MS analysis, and automated sequence mapping against an mRNA database of potential doping genes. This workflow enabled direct detection of base modifications and achieved mean sequence coverage above 74%, verifying the mRNA sequence and its chemical composition. Method optimisation shows that partial RNase 4 digestion with a 10-min incubation time produced more consistent coverage by generating longer, informative oligoribonucleotides. The enhanced consistency would be advantageous for single-analysis scenarios typical of doping investigations. Building on the verified product identity, we developed a corresponding reverse transcription-quantitative polymerase chain reaction (RT-qPCR) assay for equine plasma. We explored the simple use of naked mRNA for matrix spiking as a reference material for doping control analysis. The method was validated with a limit of detection at 1250 copies/mL of EPO mRNA in equine plasma. In addition to EPO mRNA, the combined MS and RT-qPCR approach provides a practical framework that can be extended for surveillance of emerging mRNA-based agents in sport.