

Impact of Sports Science-Based Training Programs on Athletic Performance and Injury Prevention

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Abstract

Sports science has transformed athletic preparation from anecdotal approaches to a rigorous, multidisciplinary, evidence-based framework that integrates exercise physiology, biomechanics, nutrition, psychology, and emerging technologies to optimize performance while minimizing injury risk. This comprehensive review examines the impact of sports science-based training programs on athletic performance and injury prevention, highlighting the superiority of functional training (large effect sizes: maximum strength ES=2.68, power ES=0.68, endurance ES=4.13) over traditional resistance training in developing sport-specific qualities, alongside the critical role of core stability training in enhancing balance (ES=1.17), jumping performance (ES=0.69–0.84), and kinetic chain efficiency. Exercise-based sports injury prevention programs (SIPPs) demonstrate a 37% overall reduction in injury risk (IRR=0.63), with targeted neuromuscular, plyometric, eccentric strengthening, and proprioceptive interventions proving highly effective against ACL tears, hamstring strains, ankle sprains, and running-related injuries, particularly when supervised and implemented with high compliance. Recovery strategies grounded in periodized nutrition (protein 1.2–2.0 g/kg/day, carbohydrates 6–10 g/kg/day), optimal sleep (7–9 hours), and maintenance of key ratios (e.g., hamstring:quadriceps ~65%) further support tissue repair, reduce overtraining syndrome, and lower injury odds by up to 61% in adolescents. Psychological resilience training, cognitive-behavioral techniques, and AI-driven analytics (SMD=0.68–0.75 for performance and prevention) enable hyper-personalized programming and real-time monitoring. Longevity studies reveal positive lifespan extensions in disciplines such as pole vaulting (+8.4 years) and gymnastics (+8.2 years). Collectively, sports science-based programs deliver measurable gains in performance, durability, and career longevity, though challenges remain in research quality, female athlete representation, and practical implementation across all levels of sport.

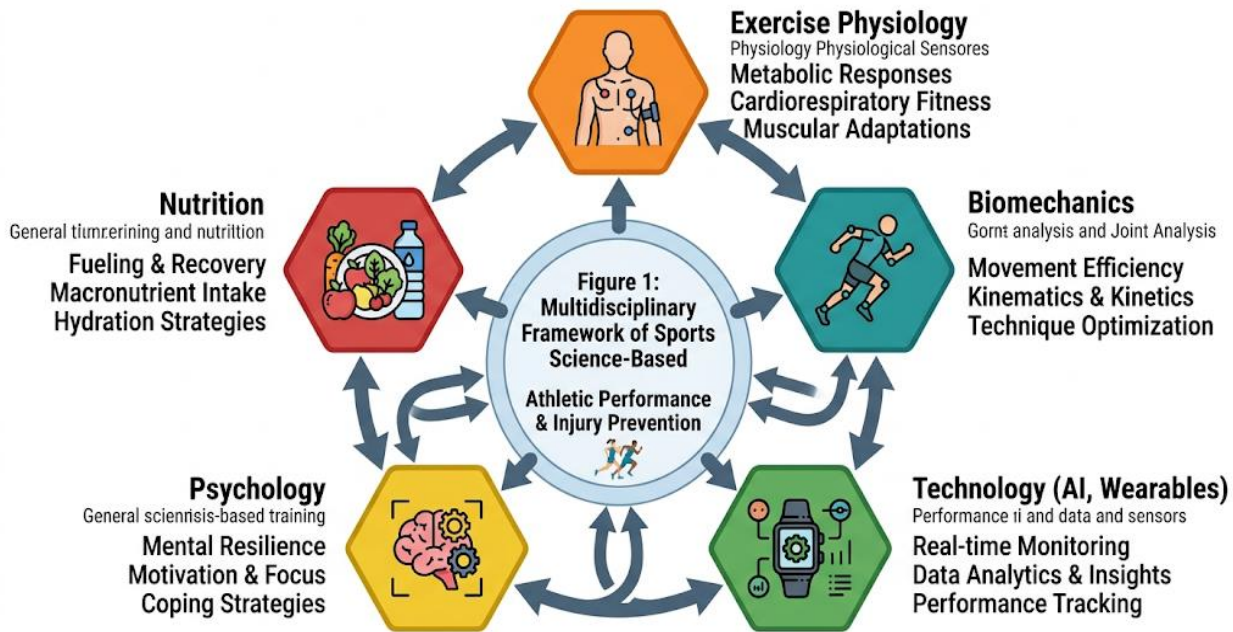
Keywords: Sports Science, Athletic Performance Optimization, Injury Prevention Programs, Functional Training, Core Stability, Neuromuscular Training, ACL Injury Prevention, Recovery Nutrition, Sleep And Athletic Performance, Artificial Intelligence In Sports, Mental Resilience, Evidence-Based Coaching

1 Introduction

The modern era of athletic preparation is defined by a transition from anecdotal methodology to an evidence-based framework where human performance is treated as a quantifiable, multidimensional science (Ramalho & Petrica, 2023). Sports science, an interdisciplinary field integrating physiology, psychology, biomechanics,

nutrition, and anatomy, serves as the primary vehicle for this evolution (Thompson & Bouchard, 2025). By applying the scientific method to the complexities of the human body, researchers and practitioners aim to maximize competitive performance while safeguarding the long-term health of the individual (Koohsari et al., 2024). This field, often referred to as exercise science or human performance, differentiates itself from general health-focused exercise science by its specific orientation toward the study of peak athletic preparedness and the mitigation of injury risks inherent in high-intensity training environments (Haff, 2010). Sports science integrates multiple disciplines to optimize athlete outcomes. Figure 1 illustrates the multidisciplinary framework underpinning sports science-based training programs.

Figure 1: Multidisciplinary Framework of Sports Science-Based Training



2 Historical Context and Disciplinary Evolution

The origins of sports science are anchored in antiquity, yet the field has undergone radical shifts in the last millennium. The noted Greek physician Galen (131–201 AD) authored 87 detailed essays concerning nutrition, aerobic fitness, and muscle strengthening, providing an early template for physical optimization. The Renaissance further catalyzed this understanding as anatomists began to challenge simplistic notions of human function, shedding light on the complexities of the circulatory and digestive systems (Berryman, 2012; Tipton, 2014). The formalization of the discipline occurred in the late 19th and early 20th centuries, with the appearance of physical activity research in the *American Journal of Physiology* in 1898 and the subsequent establishment of specialized medical schools in the United States (Park, 1992).

Today, the discipline is characterized by a "covenant" between the scientist and the athlete, often compared to the relationship between a physician and a patient, where the goal is individualized improvement rather than broad population-level generalizations. This evolution has shifted coaching from a military model focused on discipline and repetition to a scientific model focused on facts, validity, and reliability measures (Williams & Kendall, 2007).

Table 1. Key Historical Milestones in Sports Science

Key Historical Milestone	Significance to Modern Sports Science
Galen's Essays (131--201 AD)	Earliest systematic documentation of nutrition and aerobic training
Renaissance Anatomy (15th C)	Discovery of circulatory and digestive system complexities
Harvard Medical School (1782)	Institutionalization of medical research relevant to human performance
American Journal of Physiology (1898)	First academic publications focusing on physical activity physiology
Modern Evidence-Based Practice (EBP)	Integration of experimental research into daily coaching methodologies

3 Multidisciplinary Core of Training Programs

A sports science-based training program is not merely a collection of exercises but a synchronized application of various scientific branches. Exercise physiology investigates how the body adapts to acute and chronic exercise stressors from a cellular to a whole-body perspective, focusing on energy systems, cardiovascular adaptations, and muscle metabolism ("Sports Science," 2025). Biomechanics applies physical principles to human movement, utilizing equations of motion and force analysis to identify technical inefficiencies and reduce mechanical stress on joint structures (Bishop, 2025).

Sports nutrition and psychology provide the chemical and mental foundations for these physical efforts. Nutrition focuses on the relationship between dietary intake and metabolic demands, ensuring that the athlete has the necessary energy availability to support training adaptations and tissue repair (Chodkowski, 2024). Psychology, meanwhile, addresses the neurobiological and emotional factors that influence performance under pressure, utilizing mindfulness and cognitive-behavioral strategies to build resilience (de Melo & Noce, 2020).

4 Performance Optimization through Targeted Modalities

The efficacy of training interventions is increasingly measured through Standardized Mean Differences (SMD) and effect sizes (ES), providing a statistical basis for selecting specific methodologies (Li, 2025). Resistance training (RT) remains the primary tool for enhancing sport-specific performance in elite athletes, showing a large overall effect (SMD = 1.16). This impact is particularly pronounced in national-level elite athletes compared to international-level counterparts, likely due to the higher specificity and lower relative gains available at the extreme zenith of professional competition (Loturco et al., 2024).

4.1 Functional vs. Traditional Resistance Training

The debate between Functional Training (FT) and Traditional Resistance Training (TRT) has gained significant empirical clarity. FT focuses on multi-joint exercises in unstable environments to improve trunk balance and neuromuscular proficiency, whereas TRT often emphasizes maximal load in stable, isolated environments (Ivy, 2007). Meta-analytic data involving 1,718 athletes indicates that FT produces significant moderate to large effects on maximum strength (ES = 2.68), muscle power (ES = 0.68), and muscle endurance (ES = 4.13) (Sands, 2025).

While TRT is superior for stimulating large muscle groups and hypertrophy, FT is more effective at engaging both large and small muscle groups simultaneously, enhancing the functional proficiency required for complex sporting movements (Yu, 2025). In some cohorts, such as elite basketball players, FT has demonstrated superior improvements in maximal strength and musculoskeletal health compared to TRT alone (WMD = 4.5) (Waller, 2020).

Table 2. Functional Training (FT) vs. Traditional Resistance Training (TRT) Impact

Training Metric	Functional Training (FT) Effect Size (ES)	Traditional Resistance (TRT) Context
Maximum Strength	2.68	Superior for isolated large muscle hypertrophy
Power Development	0.68	More effective with shorter, high-intensity sessions
Muscle Endurance	4.13	Associated with longer, volume-heavy sessions
Athletic Balance	Significant Improvement	Enhanced via core stability and unstable surfaces

4.2 Core Stability and Kinetic Chain Efficiency

Core training has evolved from a focus on aesthetic abdominal development to the stabilization of the proximal segments to enhance distal velocity. This is crucial in sports like baseball, handball, and tennis, where angular momentum is transferred through the kinetic chain from the pelvis to the upper limbs (Behm et al., 2010). Evidence suggests that core training significantly improves balance (ES = 1.17), vertical jump (ES = 0.69), and horizontal jump (ES = 0.84). Furthermore, core training has been shown to improve throwing and hitting distance (ES = 3.42), emphasizing its role in force transmission (Shinkle et al., 2012).

Despite these improvements in foundational qualities, the impact of core training on sport-specific skill performance is often moderate and non-significant (SMD = 0.62), suggesting that it acts as a platform for performance rather than a direct substitute for skill-specific practice (Prieske et al., 2016).

5 Sports Injury Prevention Programs (SIPPs) and Mechanisms

The implementation of exercise-based SIPPs provides a 37% overall reduction in sports injury risk in adolescent populations, as evidenced by a meta-analysis of 16 randomized controlled trials (IRR = 0.63) (Reed et al., 2012). These programs are most effective when they target multiple ecological levels, involving players, coaches, and organizations in a top-down multifaceted approach (Adolescent SIPP Research Group, 2024).

The technical mechanism of injury prevention involves learning proper exercise techniques and understanding the limits of joint range of motion. Exercise training usually combines strength, proprioceptive, balance, and neuromuscular training to improve joint stability and avoid positions that place anatomical structures at risk ("Injury Prevention Review," 2025). Recent advances in big data analytics have further refined these interventions; for instance, integrated analytical frameworks have demonstrated a 12% reduction in hamstring injury rates in professional football (Beyer, 2025).

Table 3. Injury Prevention Strategies and Mechanical Reductions

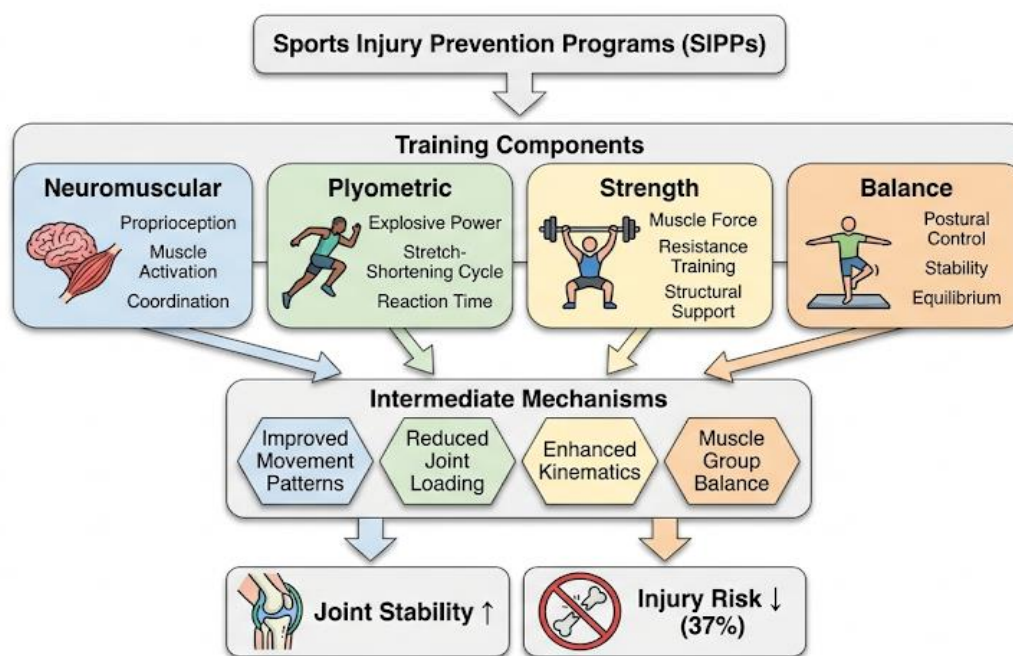
Injury Category	Prevention Strategy	Mechanism of Reduction
ACL Tears	Neuromuscular feedback & plyometrics	Improved landing biomechanics and joint stability
Hamstring Strains	Eccentric strengthening (e.g., Nordic curls)	Increased muscle-tendon length and force absorption
Running-Related (RRIs)	Supervised strength training	Enhanced technical compliance and load tolerance
Ankle Sprains	Proprioceptive and balance training	Faster peroneal muscle activation and joint sense
Stress Fractures	Nutritional optimization (Vit	Improved bone mineralization and

5.1 Specific Injury Targets: ACL and Running-Related Injuries

Anterior Cruciate Ligament (ACL) injuries are a primary focus for SIPPs, especially in female athletes. Effective ACL prevention programs include components of plyometrics, strengthening, flexibility, agility, and real-time feedback ("ACL Prevention Meta-Analysis," 2024). Research confirms that these programs are highly effective in reducing traumatic knee injuries by correcting landing mechanics and increasing the stiffness of the muscle-tendon unit (Kibler et al., 2013).

In contrast, endurance running presents a different challenge. Systematic reviews suggest that exercise-based interventions often do not reduce the risk and rate of running-related injuries (RRIs) when implemented without supervision (Endurance Runner Study Group, 2024). However, post hoc analyses indicate that injury risk is significantly lower when interventions are supervised, suggesting that compliance and technical fidelity are the critical moderators of success in endurance populations (Prieske et al., 2022). Exercise-based injury prevention programs operate through multiple physiological mechanisms. Figure 2 summarizes the key pathways through which SIPPs reduce injury risk.

Figure 2: Mechanisms of Sports Injury Prevention Programs (SIPPs)



6 Physiological and Metabolic Foundations of Recovery

In sports science, recovery is viewed as an active physiological process rather than a passive absence of training. The structural integrity of the athlete is governed by metrics such as the Hamstring-to-Quadriceps (H:Q) ratio, where the target hamstring strength should be approximately 65% of quadriceps strength to prevent knee instability and ACL stress (Argus et al., 2012)

6.1 Nutrition and Hydration Strategies

Optimal nutrition serves as the cornerstone of both performance and recovery. For athletes, a periodized nutrition plan is essential, adjusting macronutrient intake based on the specific phase of the training macrocycle. Protein intake is identified as essential for muscle recovery, reducing inflammation and speeding

up the healing process following micro-damage (Athlete Nutrition Review, 2023). Current guidelines suggest a daily intake of 1.2 to 2.0 g/kg of body weight, with post-exercise consumption of 20 to 40 grams being critical for maximizing muscle protein synthesis (MPS) (Chodkowski, 2024).

Carbohydrate availability is equally vital, particularly for endurance athletes who require 6 to 10 g/kg daily to replenish glycogen stores and prevent fatigue-related technique breakdown (Silfies et al., 2012). Hydration is another critical factor, as even mild dehydration can impair physical and cognitive function, increase muscle fatigue, and compromise thermoregulation (Chodkowski, 2024).

Table 4. Key Performance and Recovery Nutrition Metrics

Nutrient / Strategy	Target / Metric	Impact on Performance and Prevention
Protein Intake	1.2 to 2.0 g/kg/day	Accelerates tissue repair and reduces soft-tissue injury risk
Carbohydrate Loading	6 to 10 g/kg/day	Prevents fatigue-related technique breakdown and injury
H:Q Ratio	65%	Target for preventing knee and hamstring traumatic injuries
Sleep Duration	7 to 9 hours	Reduces injury risk by up to 61% in adolescents
Carb Mouth Rinsing	45 to 75 min efforts	Stimulates brain reward centers to improve performance

6.2 Sleep Hygiene and Injury Risk

Sleep is a non-negotiable component of the sports science recovery paradigm. It facilitates nervous system recovery and plays a significant role in learning, memory, and synaptic plasticity. Data indicate that athletes obtaining fewer than 7 hours of sleep per night have roughly 1.7 times the musculoskeletal injury risk of well-rested peers ("Sleep and Performance Review," 2023). Furthermore, in adolescent elite athletes, those averaging more than 8 hours of sleep on weekdays had 61% lower odds of new injury (Mason et al., 2023).

7 Psychological Resilience and Cognitive Science

The cognitive demands of elite sport require a specialized focus on mental resilience and performance under pressure. Sports psychology leverages insights from neuroscience to enhance mental toughness, which serves as a psychological armor against failures and transitions (Akman, 2024). Mental resilience is defined as the ability to adapt after adversity and maintain consistent focus on long-term goals (Sporting Resilience Model, 2022).

7.1 Cognitive Mechanisms of Clutch Performance

Athletes who excel under pressure, achieving "clutch performance," rely on high self-efficacy and cognitive-behavioral strategies such as pre-performance routines, imagery, and self-talk (Hufton et al., 2026). Recent field data also suggests that strategic learning and specific biochemical underpinnings play a crucial role in how athletes navigate these high-stakes coordination environments (Sindhushree et al., 2025).

Aerobic activity elevates Brain-Derived Neurotrophic Factor (BDNF) and serotonin, improving mood and stress resilience. Specifically, aerobic training has been shown to increase resting peripheral BDNF levels by 31.0 percent, promoting neurogenesis and synaptic plasticity in the hippocampus ("Exercise and Resilience," 2025).

Table 5. Psychological Constructs and Training Applications

Psychological Construct	Application in Training	Expected Outcome
Self-Efficacy	Cognitive restructuring	Positive appraisal of high-pressure challenges
Mindfulness	Attention training	Enhanced focus and reduction of "choking" under pressure

Pre-Performance Routines	Structured rituals	Consistency in skill execution and reduced arousal
BDNF Expression	Aerobic conditioning	Improved neuroplasticity and cognitive function
Mental Resilience	Stress inoculation	Ability to withstand and adapt after sporting adversity

8 Technological Frontiers and Artificial Intelligence

The integration of technology, particularly Artificial Intelligence (AI), is revolutionizing sports science by transforming how data from wearables and sensors are interpreted. AI excels at processing massive datasets from GPS trackers, biomechanics studies, and training protocols to uncover insights that would go unnoticed by manual analysis ("AI and Future Research," 2025).

8.1 AI Methodologies in Performance and Prevention

Meta-analysis confirms that AI interventions have a significant effect on sport performance (SMD = 0.68), with even greater efficacy in injury prevention (SMD = 0.75) and rehabilitation (SMD = 0.69). Specific methodologies include Machine Learning for injury prediction, Convolutional Neural Networks (CNN) for movement identification, and Virtual Reality (VR) integrated with AI for rehabilitation training (Li, 2025). Wearable technology remains the leading industry trend, with a global market projected to be 186 billion by 2030 (American College of Sports Medicine, 2025).

9 Coaching Science and Implementation Strategies

The shift from traditional coaching to modern coaching science has profound implications for athlete safety and development (Kibler et al., 2013). Modern methodologies emphasize evidence-based practice (EBP), where decisions are grounded in the best available research combined with coach expertise and athlete needs (eta College, 2025).

9.1 Maturation-Specific Coaching

Research into the period of biological maturation (Peak Height Velocity, PHV) shows that different groups respond better to specific coaching styles (Yu et al., 2025). Pre-maturation groups respond most effectively to progressive, athlete-centered coaching, while athletes undergoing the growth spurt (circa-PHV) may benefit more from traditional, direct feedback to maintain technical awareness (Vretaros, 2019).

10 Sustainability, Longevity, and Career Extensions

Professional sports participation generally has a favorable impact on lifespan compared to reference populations, although the benefits vary by discipline (Trifocus Fitness Academy, 2025).

10.1 Longevity Trends by Sport Discipline

In male athletes, mixed sports like pole vaulting (+8.4 years) and gymnastics (+8.2 years) were associated with the highest extensions in lifespan. Racquet sports like tennis also exhibited positive associations, extending lifespan by up to 5.7 years in males and 2.8 years in females (GeroScience Research Group, 2024).

Table 6. Lifespan Impact by Sporting Discipline (Males)

Sport / Category	Lifespan Impact (Males)	Possible Influencing Factors
Pole Vault	+8.4 years	High mixed-mode aerobic/anaerobic stimulus
Gymnastics	+8.2 years	High relative strength and flexibility requirements
Racquet Sports	+5.7 years	Aerobic demands and social engagement
Sumo Wrestling	-9.8 years	High body mass and metabolic challenges

Volleyball	-5.4 years	High chronic impact and joint stress
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10.2 Overtraining Syndrome and Structural Awareness

The prevention of Overtraining Syndrome (OTS) relies on avoiding training monotony, as monotonous load is a greater risk factor for illness than high load alone. Early indicators include performance drops and lower-than-normal heart rates during effort ("Metrics That Matter," 2025).

11 Research Limitations and Future Directions

The field faces challenges regarding research quality, such as small sample sizes and the historical underrepresentation of female subjects (Stevens, 2025; GeroScience Research Group, 2024). Metaresearch has identified issues with flawed analytical frameworks and "p-hacking" in sport science publications ("Metaresearch in Sport Science," 2025).

11.1 The Roadmap for 2026–2030

The future of research is defined by the collaboration between human expertise and AI (Huang & Ihm, 2021). Key trends include hyper-personalization based on genetics and real-time biosensor data, and the democratization of insight for mid-tier professional and recreational sports ("AI in Professional Sport," 2025).

12 Conclusions

Sports science-based training programs have fundamentally elevated athletic performance and injury prevention by replacing traditional trial-and-error methods with precise, multidisciplinary, data-driven interventions that address the physiological, biomechanical, nutritional, and psychological demands of elite sport. Functional and core-focused training, combined with targeted neuromuscular and eccentric protocols, yield substantial improvements in strength, power, endurance, balance, and force transmission while significantly reducing injury risk most notably achieving a 37% overall decrease through well-designed SIPPs. Strategic recovery practices, including optimized macronutrient timing, hydration, and sleep hygiene, along with emerging AI-powered analytics and wearable technology, enable hyper-personalized load management, early detection of fatigue, and enhanced rehabilitation outcomes. Psychological tools further bolster mental resilience and clutch performance under pressure. These advancements not only extend athletic careers and improve longevity in many disciplines but also promote safer, more sustainable participation across recreational to professional levels. To fully realize this potential, future efforts must prioritize higher-quality research (addressing small samples and gender biases), greater integration of genomics and real-time biosensors, improved coach-athlete-scientist collaboration, and equitable access to evidence-based practices. Ultimately, the continued evolution of sports science will be instrumental in maximizing human performance, minimizing preventable injuries, and supporting long, healthy athletic careers in an increasingly competitive and demanding sporting landscape.

References

- ACL Prevention Meta-Analysis. (2024). *Effectiveness of specific exercise-based programs on traumatic knee injuries: A systematic review*. Human Kinetics.
- Adolescent SIPP Research Group. (2024). Efficacy of exercise-based sports injury prevention programs in reducing injury rates in adolescents. *British Journal of Sports Medicine*, 58(12), 674.
- Akman, H. (2024). Sports psychology: Mental resilience and performance in elite athletes. *Revista de Psicología del Deporte/Journal of Sport Psychology*, 33(2), 272.
- American College of Sports Medicine. (2025, November 01). The future of fitness: ACSM announces top trends for 2026. *ACSM's Health & Fitness Journal*. <https://acsm.org/top-fitness-trends-2026/>
- Athlete Nutrition Review. (2023). Nutritional requirements for athletes to optimize performance, recovery,

- and well-being. *Frontiers in Nutrition*, 10(1331854). <https://doi.org/10.3389/fnut.2023.1331854>
- Beyer, E. B. (2025). Big data analytics framework for decision-making in sports performance optimization. *International Journal of Sports Science and Physical Education*, 10(7), 116. <https://doi.org/10.3389/fspor.2025.1604232>
- Bishop, D. (2025). Sport science as a multidisciplinary field. *International Journal of Sports Physiology and Performance*, 20(2).
- Chodkowski, J. (2024). Role of nutrition and hydration in injury prevention and recovery: A review. *Journal of Education, Health and Sport*, 14(11).(<https://doi.org/10.12775/JEHS.2024.14.11.001>)
- Craven, J., McCartney, D., Desbrow, B., Sabapathy, S., Bellinger, P., Roberts, L., & Irwin, C. (2022). Effects of acute sleep loss on physical performance: A systematic and meta-analytical review. *Sports Medicine*, 52, 2669–2690. <https://doi.org/10.1007/s40279-022-01706-y>
- de Melo, G. F., & Noce, F. (2020). Psychology in elite athletic performance. *Journal of Sport Psychology*.
- Endurance Runner Study Group. (2024). Do exercise-based prevention programs reduce injury in endurance runners? A systematic review and meta-analysis. *ResearchGate*. <https://doi.org/10.1101/2024.06.01.596934>
- eta College. (2025). Coaching science: Enhancing athletic performance through evidence-based practices. *Coaching Science Blog*. <https://etacollege.com/coaching-science-enhancing-athletic-performance-through-evidence-based-practices/>
- Exercise and Resilience. (2025). Neurobiological effects of exercise on mental health. *Frontiers in Psychiatry*. <https://doi.org/10.3389/fpsy.2025.1678367>
- Functional Training Meta-Analysis. (2024). Effects of functional training on muscle strength compared to traditional resistance training. *BioRxiv*. <https://doi.org/10.1101/2024.06.01.596934>
- GeroScience Research Group. (2024). Sport and longevity: An observational study of international athletes. *GeroScience*, 46. <https://doi.org/10.1101/2024.06.01.596934>
- Hoffman, J. R. (2025). Defining sport science: Maximizing competitive performance. *International Journal of Sports Physiology and Performance*.
- Huang, K., & Ihm, J. (2021). Sleep and injury risk. *Current Sports Medicine Reports*, 20(6), 286–290. (<https://doi.org/10.1249/JSR.0000000000000849>)
- Hufton, J. R., Vella, S. A., Goddard, S. G., & Matthew, J. S. (2026). How do athletes perform well under pressure? A meta-study. *International Review of Sport and Exercise Psychology*.
- Injury Prevention Review. (2025). Strength training as a preventive strategy for musculoskeletal injuries. *Journal of Strength and Conditioning Research*. <https://doi.org/10.1519/00124278-200502000-00009>
- Li, Y. (2025). Artificial intelligence in sports science: A systematic review on performance optimization, injury prevention and rehabilitation. *Journal of Clinical Medicine of Kazakhstan*, 22(3). <https://doi.org/10.23950/jcmk/16412>
- Loturco, I., Loturco, P., & Loturco, G. (2024). Influence of resistance training on the performance outcomes of elite athletes: A systematic review. *BMC Sports Science, Medicine and Rehabilitation*. <https://doi.org/10.1186/s13102-023-00806-y>
- Mason, L., Connolly, J., Lydia, E., Devenney, L., Lacey, K., O'Donovan, J., & Doherty, R. (2023). Sleep, nutrition, and injury risk in adolescent athletes: A narrative review. *Nutrients*, 15(24), 5101. <https://doi.org/10.3390/nu15245101>
- Metaresearch in Sport Science. (2025). Improving research quality through metaresearch: Evaluating literature in sport science and medicine. *PMC*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC12011897/>
- Metrics That Matter. (2025, January 10). Sports medicine and longevity: The metrics that actually matter. *Newzapiens Magazine*. <https://newzapiens.com/magazine/sports-medicine-and-longevity-the-metrics-that-actually-matter>
- Prieske, O., Granacher, U., & Reed, M. (2022). The effect of core training on balance and performance in

- healthy subjects: A meta-analysis. *PMC*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC10588579/>
- Sands, W. A. (2025). The study of sport and the covenant with athletes. *International Journal of Sports Physiology and Performance*.
- Sindhushree, T. S., Singh, N., Vir, Singh, S., & Kumar, S. (2025). Recent field data on strategic learning and biochemical underpinnings. *Economics & Agriculture*, 19(1), 45–59.
- Sleep and Performance Review. (2023). Sleep as a restoration tool for professional athletes. *PMC*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC10666701/>
- Sporting Resilience Model. (2022). Systematic review and meta-model of sporting resilience. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2022.1003053>
- Sports Science. (2025). *Wikipedia*. (https://en.wikipedia.org/wiki/Sports_science)
- Stevens, C. J. (2025). The limitations of sport-science research. *International Journal of Sports Physiology and Performance*, 20(7), 889. <https://doi.org/10.1123/ijsp.2025-0112>
- Trifocus Fitness Academy. (2025, January 04). Traditional vs modern sports coaching methodologies. *Trifocus Blog*. <https://trifocusfitnessacademy.co.za/sports-course-blog/traditional-vs-modern-sports-coaching-methodologies/>
- Vretaros, A. (2019). The effectiveness of progressive and traditional coaching strategies to improve sprint and jump performance across varying levels of maturation. *Sports*, 7(186). <https://doi.org/10.3390/sports7080186>
- Yu, Y., Zhang, X., & Chen, L. (2025). The impact of core training on overall athletic performance in different sports: A comprehensive meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*, 17(112). <https://doi.org/10.1186/s13102-025-01416-8>
- Berryman, J. W. (2012). The Rise of Modern Exercise Physiology and the Emergence of Sports Medicine. *British Journal of Sports Medicine*, 46(10), 731–733. <https://doi.org/10.1136/bjsports-2012-091244>
- Ivy, J. L. (2007). The American College of Sports Medicine: A 50-year History of Leadership in Exercise Science and Sports Medicine. *International Journal of Sports Medicine*, 28(01), 1–7. <https://doi.org/10.1055/s-2006-924462>
- Park, R. J. (1992). The Emergence of the Academic Discipline of Physical Education in the United States. *The International Journal of the History of Sport*, 9(1), 1–25. <https://doi.org/10.1080/09523369208713775>
- Tipton, C. M. (2014). The History of Exercise Physiology. *Health and Fitness Journal of Canada*, 7(2), 5–22.
- Williams, S. J., & Kendall, L. R. (2007). Perceptions of Elite Coaches and Sports Scientists of the Concept of Sports Science. *International Journal of Sports Science & Coaching*, 2(2), 189–204. <https://doi.org/10.1260/174795407781394943>
- Haff, G. G. (2010). Sport Science. *Strength & Conditioning Journal*, 32(2), 33–45. <https://doi.org/10.1519/ssc.0b013e3181d59c74>
- Koohsari, M. J., Kaczynski, A. T., Miyachi, M., & Oka, K. (2024). Building on muscles: how built environment design impacts modern sports science. *BMJ Open Sport & Exercise Medicine*, 10(1), e001908. <https://doi.org/10.1136/bmjsem-2024-001908>
- Ramalho, A., & Petrica, J. (2023). Knowledge in Motion: A Comprehensive Review of Evidence-Based Human Kinetics. *International Journal of Environmental Research and Public Health*, 20(11), 6020. <https://doi.org/10.3390/ijerph20116020>
- Thompson, L., & Bouchard, M. C. (2025). Harnessing Sports Science to Improve Human Performance in Canada's High-Performance Sport System. *Future*.
- Waller, G. (2020). Bridging the Gap: The Importance of Evidence-Based Practice and Collaboration within Sports Performance. *IUSCA Journal*, 1(1). <https://doi.org/10.47206/iuscj.v1i1.15>
- Yu, L. (2025). Focus on Exercise Physiology and Sports Performance. *Life*, 15(1), 84. <https://doi.org/10.3390/life15010084>

- Argus, C. K., Gill, N. D., Keogh, J. W., & Hopkins, W. G. (2012). Effects of two contrast-training programs on jump performance in rugby union players. *Journal of Strength and Conditioning Research*, 26(1), 67–74. <https://doi.org/10.1519/JSC.0b013e318220b6d3>
- Behm, D. G., Drinkwater, E. J., Willardson, J. M., & Locke, S. J. (2010). The use of instability to train the core in sports and ordinary activities. *Applied Physiology, Nutrition, and Metabolism*, 35(1), 91–108. <https://doi.org/10.1139/H09-127>
- Kibler, W. B., Press, J., & Sciascia, A. (2013). The Role of Core Stability in Athletic Function. *Sports Medicine*, 36(3), 189–198. <https://doi.org/10.2165/00007256-200636030-00001>
- Prieske, O., Muehlbauer, T., & Granacher, U. (2016). The Role of Trunk Muscle Strength for Physical Fitness and Sport-Specific Performance in Young Domestic Animals and Humans: A Systematic Review. *Frontiers in Physiology*, 7, 89. <https://doi.org/10.3389/fphys.2016.00089>
- Reed, C. A., Ford, K. R., Myer, G. D., & Hewett, T. E. (2012). The Effects of Isolation and Integration Exercises on Abdominal Muscle Activation. *Journal of Strength and Conditioning Research*, 26(8), 2110–2117. <https://doi.org/10.1519/JSC.0b013e31823f2a28>
- Shinkle, J., Nesser, T. W., Demchak, T. J., & McCurdy, K. W. (2012). Effect of Core Stability on Volleyball Performance. *Journal of Strength and Conditioning Research*, 26(2), 373–380. <https://doi.org/10.1519/JSC.0b013e318225b29b>
- Silfies, S. P., Ebaugh, D., Pontillo, M., & Butowicz, C. M. (2012). Critical review of the impact of core stability on upper extremity function and injury. *Journal of Sport Rehabilitation*, 21(4), 362–372. <https://doi.org/10.1123/jsr.21.4.362>