



Performance Research Reviews

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Baseball

Core and lower extremity muscle strains in baseball players – Epidemiology, clinical presentation, and rehabilitation. Clinics in Sports Medicine, Ahead of Print: 1-11, 2024.

KEY POINTS

- The number of injuries in baseball remains high despite significant improvements in strength and conditioning protocols, diagnostic tools, and surgical techniques.
- Core and lower extremity injuries currently represent one-third of all baseball injuries.
- Hamstring strains are the most common injury in all of baseball, have a high recurrence rate, and result in a significant time missed from play.
- Although platelet-rich plasma and corticosteroid injections are potential treatment adjuncts for muscle strains, the mainstay of management remains conservative treatment with physical therapy and rehabilitation.

Early surgery for partial tears of the ulnar collateral ligament may be more cost-effective and result in longer playing careers than non-operative management for high-level baseball pitchers – A decision-analytic Markov model-based analysis. The American Journal of Sports Medicine, Ahead of Print: 1-12, 2024.

Background: Nonoperative management versus early reconstruction for partial tears of the medial ulnar collateral ligament (MUCL) remains controversial, with the most common treatment options for partial tears consisting of rest, rehabilitation, platelet-rich plasma (PRP), and/or surgical intervention. However, whether the improved outcomes reported for treatments such as MUCL reconstruction (UCLR) or nonoperative management with a series of PRP injections justifies their increased upfront costs remains unknown.

Purpose: To compare the cost-effectiveness of an initial trial of physical therapy alone, an initial trial of physical therapy plus a series of PRP injections, and early UCLR to determine the preferred cost-effective treatment strategy for young,



Performance Research Reviews

high-level baseball pitchers with partial tears of the MUCL and with aspirations to continue play at the next level (ie, collegiate and/or professional).

Study design: Economic and decision analysis; Level of evidence, 2.

Methods: A Markov chain Monte Carlo probabilistic model was developed to evaluate the outcomes and costs of 1000 young, high-level, simulated pitchers undergoing nonoperative management with and without PRP versus early UCLR for partial MUCL tears. Utility values, return to play rates, and transition probabilities were derived from the published literature. Costs were determined based on the typical patient undergoing each treatment strategy at the authors' institution. Outcome measures included costs, acquired playing years (PYs), and the incremental cost-effectiveness ratio (ICER).

Results: The mean total costs resulting from nonoperative management without PRP, nonoperative management with PRP, and early UCLR were \$22,520, \$24,800, and \$43,992, respectively. On average, early UCLR produced an additional 4.0 PYs over the 10-year time horizon relative to nonoperative management, resulting in an ICER of \$5395/PY, which falls well below the \$50,000 willingness-to-pay threshold. Overall, early UCLR was determined to be the preferred cost-effective strategy in 77.5% of pitchers included in the microsimulation model, with nonoperative management with PRP determined to be the preferred strategy in 15% of pitchers and nonoperative management alone in 7.5% of pitchers.

Conclusion: Despite increased upfront costs, UCLR is a more cost-effective treatment option for partial tears of the MUCL than an initial trial of nonoperative management for most high-level baseball pitchers.

Effect of repetitive pitching on the control of lower extremity joints and center of mass in collegiate baseball pitchers. Sports Health, Ahead of Print: 1-9, 2024.

Background: Repetitive motion can alter joint angles and subsequently affect the control of the center of mass (CoM). While the CoM has been studied as a fatigue indicator in various sports, the control of the whole-body CoM during repetitive pitching in baseball pitchers has not been examined. This study aimed to investigate changes in lower-extremity joint angles and CoM control in collegiate baseball pitchers after repetitive pitching.

Hypothesis: Baseball pitchers would exhibit significant increase in lower-extremity flexion angles, CoM position, and CoM variability after repetitive pitching.



Performance Research Reviews

Study design: Descriptive laboratory study.

Level of evidence: Level 3.

Methods: A total of 23 pitchers from the Collegiate Baseball League were recruited. A motion analysis system was employed to assess lower-extremity joint angles and CoM position during the simulated game, while pitching accuracy and velocity were also recorded.

Results: The results revealed a significant forward and downward shift in CoM position ($P < 0.05$), along with increased CoM variability in all directions ($P < 0.05$) after the simulated game. Furthermore, there was a significant increase in flexion angles of the knee and hip ($P < 0.05$); however, pitching velocity and accuracy did not demonstrate significant changes.

Conclusion: Repetitive pitching leads to kinematic changes that should be monitored to prevent sports injuries.

Clinical relevance: Baseball pitchers have the ability to modify the control of their CoM and angles of their lower-extremity joints to sustain their pitching performance. It is crucial to monitor compensatory strategies closely to avoid shoulder and elbow injuries among these pitchers.

Pitch-tracking metrics as a predictor of future shoulder and elbow injuries in Major League Baseball pitchers. *Orthopaedic Journal of Sports Medicine*, 12(8): 1-11, 2024.

Background: Understanding interactions between multiple risk factors for shoulder and elbow injuries in Major League Baseball (MLB) pitchers is important to identify potential avenues by which risk can be reduced while minimizing impact on player performance.

Purpose: To apply a novel game theory-based approach to develop a machine-learning model predictive of next-season shoulder and elbow injuries in MLB pitchers and use this model to understand interdependencies and interaction effects between the most important risk factors.

Study design: Case-control study; Level of evidence, 3.

Methods: Pitcher demographics, workload measures, pitch-tracking metrics, and injury data between 2017 and 2022 were used to construct a database of MLB pitcher-years, where each item in the database corresponded to a pitcher's



Performance Research Reviews

information and metrics for that year. An extreme gradient boosting machine-learning model was trained to predict next-season shoulder and elbow injuries utilizing Shapley additive explanation values to quantify feature importance as well as interdependencies and interaction effects between predictive variables.

Results: A total of 3808 pitcher-years were included in this analysis; 606 (15.9%) of these involved a shoulder or elbow injury resulting in placement on the MLB injured list. Of the >65 candidate features (including workload, demographic, and pitch-tracking metrics), the most important contributors to predicting shoulder/elbow injury were increased: pitch velocity (all pitch types), utilization of sliders (SLs), fastball (FB) spin rate, FB horizontal movement, and player age. The strongest game theory interaction effects were that higher FB velocity did not alter a younger pitcher's predicted risk of shoulder/elbow injury versus older pitchers, risk of shoulder/elbow injury increased with the number of high-velocity pitches thrown (regardless of pitch type and in an additive fashion), and FB velocity <95 mph (<152.9 kph) demonstrated strong negative interaction effects with higher SL percentage, suggesting that the overall predicted risk of injury for pitchers throwing a high number of SLs could be attenuated by lower FB velocity.

Conclusion: Pitch-tracking metrics were substantially more predictive of future injury than player demographics and workload metrics. There were many significant game theory interdependencies of injury risk. Notably, the increased risk of injury that was conferred by throwing with a high velocity was even further magnified if the pitchers were also older, threw a high percentage of SLs, and/or threw a greater number of pitches.

Basketball

A video-based time-motion analysis of an elite male basketball team during a season: Game demands according to player position, game quarter, and actual time played. International Journal of Performance Analysis in Sport, 24(4): 269-284, 2024.

Abstract - To investigate differences in the game demands of top-level professional basketball players based on their position and the quarter of the game. Thirteen elite male players were assessed on their positions (point guard, guard, forward, and centre) over different quarters (Q1-Q4) during 15 home games. A multivariate analysis of variance was performed using role and quarters as predictors to assess distances, speeds, and accelerations. The guard and point guard covered more distance than the centre and forwards ($p > 0.001$). The average distance covered was higher ($p < 0.01$) in Q4 than in the other quarters. Both speed and the percentage of time spent in the jogging to max speed range decreased significantly from Q1 to Q4, while time spent standing and walking tended to increase from Q1 to Q4. The point guard spent the highest percentage of total time performing major accelerations followed by the guard, while the



Performance Research Reviews

forwards and centre spent less time performing accelerations. Overall, $22.8 \pm 0.7\%$ of total playing time was spent performing major accelerations, which decreased from Q1 to Q4. These findings suggest that the positions of elite basketball players vary in terms of the activities demands they place on players, underscoring the need for individualized role-based conditioning.

Comparative analysis of national and foreign players' performance in Euroleague Basketball. PLOS ONE, 19(8): e0306240, 2024.

Abstract - This study aimed to quantitatively assess the statistical contributions between foreign and national players in men's Euroleague Basketball. Data from 588 games in the 2021-2022 regular season and 612 games in the 2022-2023 regular season were analyzed through non-participant observation. Paired t-tests and Wilcoxon tests were employed to analyze variables with normal and non-normal distributions, respectively. The analysis indicated significant differences ($p < 0.05$) between local and foreign players across several key variables, including Minutes, Points, Average Points, Usage Percentage, Individual Offensive Rating, Individual Defensive Rating, and True Shooting Percentage. These findings suggest pronounced distinctions between foreign players and national players concerning game volume indicators and game performance efficiency. Foreign players exhibited dominance in critical areas, such as playing time, total points scored, and average points per game, underscoring their substantial contributions to their respective teams. Consequently, these results offer practical implications for players, coaches, and fitness trainers, allowing for the design of more tailored training programs that account for distinct offensive and defensive needs, as well as the heightened physical demands experienced throughout the season.

Effectiveness of an individualized training based on dynamic strength index on sprinting, jumping and change of direction performance in basketball players: A randomized controlled trial. Journal of Sports Science and Medicine, 23: 504-514, 2024.

Abstract - The dynamic strength index (DSI) is calculated as the ratio between countermovement jump (CMJ) peak force and isometric mid-thigh pull (IMTP) peak force and is said to inform whether ballistic or strength training is warranted for a given athlete. This study assessed the impact of an individualized in-season resistance training program, guided by DSI on basketball players' physical performance. Forty-three elite players (19.4 ± 2.9 years; 1.97 ± 0.08 cm; 89.1 ± 9.5 kg)



Performance Research Reviews

were divided into an intervention group (IG) (27 players) and a control group (CG) (16 players). The IG was further split based on DSI into a ballistic group (DSI \leq 0.90, 11 players) and a strength group (DSI $>$ 0.90, 16 players). Over five weeks, participants underwent two weekly resistance sessions, with the IG following a DSI-based program and the CG a standard program. Performance was measured pre- and post-intervention through 20-m sprints, 505 change of direction test, CMJ, and IMTP. There were statistically significant improvements in the IG, notably in sprint times ($\eta^2 = 0.12-0.21$, $p < 0.05$) and 505 test ($\eta^2 = 0.15-0.16$, $p < 0.05$), predominantly in the strength group. The CG's performance was either unchanged or declined for different variables. Our results suggest that DSI-guided training effectively enhances basketball players' physical performance within a competitive season.

Establishing a reference database for select clinical measures in National Basketball Association Players. Sports Health, Ahead of Print: 1-9, 2024.

Background: Musculoskeletal injuries are prevalent in the NBA and are associated with a significant number of games missed. There is a lack of reference data for clinical measures in NBA players, making it difficult for sports medicine professionals to set goals and develop programs.

Hypothesis: Values for clinical measures in NBA players will differ from those of the general population but will not differ between dominant (D) and nondominant (ND) limbs.

Study design: Descriptive laboratory study.

Level of evidence: Level 3.

Methods: Clinical measures were taken on 325 players invited to NBA training camp (2008-2022). Measures included range of motion for great toe extension, hip rotation, weightbearing ankle dorsiflexion, flexibility, arch height (AH) indices, and tibial varum.

Results: Clinical values for NBA players differ from reference norms of the general population. Results for NBA players include great toe extension (D, 40.4°; ND, 39.3°), 90/90 hamstring (D, 41.5°; ND, 40.9°), hip internal rotation (D, 29.0°; ND, 28.8°), hip external rotation (D, 29.7°; ND, 30.9°), total hip rotation (D, 60.2°; ND, 60.4°), Ely (D, 109.9°; ND, 108.8°), AH difference (D, 0.5 mm; ND, 0.5 mm), AH index (D, 0.310; ND, 0.307), arch stiffness (D, 0.024; ND, 0.024), arch rigidity (D, 0.924; ND, 0.925), tibial varum (D, 4.6°; ND, 4.5°), and weightbearing ankle dorsiflexion (D, 35.4°; ND, 35.6°).



Performance Research Reviews

Descriptive statistics are presented; 2-tailed paired t tests show that, whereas most measures demonstrated differences between sides, the results were not statistically significant.

Conclusion: Clinical measures of NBA players differ from those reported for the general population and athletes of other sports although there were no statistically significant differences between D and ND limbs.

Clinical relevance: Establishing a reference database may help clinicians develop more sensitive and more effective preseason and return-to-play screening processes, aiding the management of player orthopaedic care and reducing injury risk.

Football

Efficacy of exercise interventions on prevention of sport-related concussion and related outcomes: A systematic review and meta-analysis. British Journal of Sports Medicine, Ahead of Print: 1-11, 2024.

Objective: To review the efficacy of exercise interventions on sport-related concussion (SRC) incidence, as well as on linear and rotational head accelerations, and isometric neck strength and to assess reporting completeness of exercise interventions using the Consensus on Exercise Reporting Template (CERT).

Design: Systematic review and meta-analysis, according to the Prisma in Exercise, Rehabilitation, Sport medicine and SporTs science guidelines.

Data sources: Six databases (MEDLINE, Embase, CINAHL, Scopus, Web of Science CC and SPORTDiscus) were searched up to 26 June 2023.

Eligibility criteria for selecting studies: Randomized controlled trials (RCTs), cluster RCTs or quasi-experimental studies, evaluating exercise interventions on SRC incidence, linear and rotational head accelerations, and/or isometric neck strength in male and/or female athletes of any age, and/or in a healthy general population.

Results: A total of 26 articles were included. A large effect size was observed for resistance training (RT) on isometric neck strength (standardized mean difference (SMD) 0.85; 95% CI 0.57 to 1.13; high-quality evidence). Non-significant effect sizes were observed for neuromuscular warm-up programs on SRC incidence (risk ratio 0.69; 95% CI 0.39 to 1.23; low-quality evidence), or for RT on linear head acceleration (SMD -0.43; 95% CI -1.26 to 0.40; very low-quality evidence)



Performance Research Reviews

or rotational head acceleration (SMD 0.08; 95% CI -0.61 to 0.77; low-quality evidence). No studies assessed the impact of RT on SRC incidence. CERT scores ranged from 4 to 16 (out of 19) with median score of 11.5 (IQR 9-13).

Conclusion: RT increases isometric neck strength, but the effect on SRC incidence is unknown. More adequately powered and rigorous trials are needed to evaluate the effect of exercise interventions on SRC incidence, and on linear and rotational head accelerations. Future studies should follow CERT guidelines, as the included interventions were generally not reported in sufficient detail for accurate replication.

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Given the reported rise in the incidence of sport- related concussion (SRC), it is important to explore primary prevention strategies.
- ⇒ Potential primary prevention strategies include policy and rule changes, individual protective equipment and exercise interventions. Research on the efficacy of exercise interventions in the prevention of SRC is scarce.
- ⇒ Higher values for linear and rotational head accelerations and lower values for isometric neck muscle strength may be potential indicators of SRC risk.

WHAT THIS STUDY ADDS

- ⇒ This systematic review and meta- analysis on the efficacy of exercise interventions demonstrates that there is no significant effect size observed following neuromuscular warm- up programs on SRC incidence.
- ⇒ A large effect size is observed following resistance training (RT) on isometric neck strength, whereas non- significant effect sizes are observed for RT on linear and rotational head accelerations.
- ⇒ Dynamic and multimodal resistance programs are more efficacious in increasing isometric neck strength than static resistance programs, with higher effect sizes for males than females and adults than adolescents.
- ⇒ No study evaluated the efficacy of neck RT on SRC incidence.
- ⇒ Exercise interventions are generally not reported in sufficient detail, which can hinder accurate replication



Performance Research Reviews

Hamstring muscle-tendon geometric adaptations to resistance training using the hip extension and Nordic hamstring exercises. Scandinavian Journal of Medicine and Science in Sports, 34: e14728, 2024.

Abstract - Targeted resistance training stimulates hamstring muscle hypertrophy, but its effect on tendon-aponeurosis geometry is unknown. This study examined changes in hamstring muscle, free tendon, and aponeurosis geometry following a 10-week Nordic or hip extension exercise intervention. Thirty recreationally active males were randomly allocated (n = 10 per group) to a Nordic, hip extension, or control group. Magnetic resonance imaging of both thighs was acquired pre- and post-intervention. Changes in free tendon and aponeurosis volume for each hamstring muscle, biceps femoris long head (BFLh) aponeurosis interface area and muscle volume-to-interface area ratio were compared between groups. Regional changes in muscle CSA were examined via statistical parametric mapping. The change in semimembranosus free tendon volume was greater for the Nordic than control group (mean difference = 0.06 cm³, 95% CI = 0.02-0.11 cm³). No significant between-group differences existed for other hamstring free tendons or aponeuroses. There were no between-group differences in change in BFLh interface area. Change in BFLh muscle volume-to-interface area ratio was greater in the hip extension than Nordic (mean difference = 0.10, 95% CI = 0.007-0.19, p = 0.03) and control (mean difference = 0.12, 95% CI = 0.03-0.22, p = 0.009) groups. Change in muscle CSA following training was greatest in the mid-portion of semitendinosus for both intervention groups, and the mid-portion of BFLh for the hip extension group. There was limited evidence for tendon-aponeurosis hypertrophy after 10 weeks of training with the Nordic or hip extension exercises. For the BFLh, neither intervention altered the interface area although hip extension training stimulated an increase in the muscle volume-to-interface area ratio, which may have implications for localized tissue strains. Alternative muscle-tendon loading strategies appear necessary to stimulate hamstring tendon adaptations.

Repetitive head-injury exposure and later-in-life cognitive and emotional outcomes among former collegiate football players: A CLEAATS investigation. International Review of Psychiatry, 36(3): 233-242, 2024.

Abstract - This study measured the relationship between head-injury exposure and later-in-life cognitive and emotional symptoms in aging collegiate football players who participated in the College Level Aging Athlete Study. Linear regressions examined the relationship between various head-injury exposure variables (head-injury exposure estimate



Performance Research Reviews

[HIEE], number of diagnosed concussions, and symptomatic hits to the head) and subjective cognitive function, objective cognitive function, and emotional/mood symptoms. Additional regressions evaluated the impact of emotional symptoms on subjective cognitive decline and objective cognitive function. Participants ($n = 216$) were 50-87 years old ($M = 63.4 [8.5]$), 91% White, and well-educated (bachelor's/graduate degree = 92%). HIEE did not predict scores on cognitive or emotional/mood symptom measures (p 's $> .169$). Diagnosed concussions had a small effect on depression symptoms ($p = .002$, $b = 0.501$, $R^2 = .052$) and subjective cognitive symptoms ($p = .002$, $b = 0.383$, $R^2 = .051$). An emotional symptom index had a stronger relationship ($p < .001$, $b = 0.693$, $R^2 = .362$) with subjective cognitive functioning but no significant relationship with objective cognitive function ($p = .052$, $b = -0.211$, $R^2 = .020$). Controlling for emotional symptoms, the relationship between concussions and subjective cognitive symptoms was attenuated ($p = .078$, $R^2 = .011$). Findings suggested that head-injury exposure was not significantly related to cognitive or emotional/mood outcomes in former collegiate football players and highlighted the importance of current emotional/mood symptoms on subjective cognitive function.

The Braking Performance Framework: Practical recommendations and guidelines to enhance horizontal deceleration ability in multi-directional sports. International Journal of Strength and Conditioning, 4(1): 1-31, 2024.

Abstract - Horizontal deceleration is a critical locomotor skill underpinning the many changes of speed and direction performed by athletes in multi-directional sports. Despite its importance there are currently no evidence-based guidelines on how to improve horizontal deceleration ability. Therefore, the aim of this article is to provide practitioners tasked with preparing athletes for the demands of multi-directional sports with practical recommendations and guidelines on how to improve their athlete's horizontal deceleration ability. The article proposes the concept and use of a Braking Performance Framework to help guide the selection of training methods and exercises to target the currently known neuromuscular and biomechanical determinants of horizontal deceleration ability. The Braking Performance Framework provides practitioners with evidence-informed training methods that can be integrated with other important physical, technical, and tactical components to optimize a player's horizontal deceleration ability.



Performance Research Reviews

The effect of a synthetic-grass sport surface on physiology and perception during intermittent exercise in hot conditions. International Journal of Sports Physiology and Performance, Ahead of Print: 1-7, 2024.

Purpose: The current study aimed to determine the effect of a synthetic-grass sport surface on core body temperature, skin temperature, heart rate, thermal sensation, thermal comfort, and rating of perceived exertion (RPE) during intermittent exercise in hot conditions.

Methods: Using a randomized crossover design, 13 trained/developmental team-sport athletes completed two 50-minute standardized intermittent running protocols on a synthetic and a natural-grass surface, on separate days (control-condition air temperature 32.6 °C [1.3 °C], relative humidity 43.2% [5.3%]).

Results: Final skin temperature was significantly higher on synthetic compared with natural grass at the calf (40.1 °C [2.5 °C] vs 33.4 °C [0.6 °C]; $P < .001$), shoulder (36.6 °C [1.7 °C] vs 33.7 °C [0.7 °C]; $P < .001$), and chest (33.2 °C [1.1 °C] vs 31.8 °C [1.2 °C]; $P = .02$). Thermal sensation (median: 2.3; interquartile range [0.5] vs 2.2 [0.5], $P = .03$) and sweat rate (1.5 [0.4] L·h⁻¹ vs 1.2 [0.3] L·h⁻¹; $P = .02$) were also significantly higher on synthetic grass. While final core body temperature was significantly higher on the natural than synthetic grass (38.4 °C [0.3 °C] vs 38.2 °C [0.4 °C]), there were no significant differences in delta core temperature, as well as heart rate, thermal comfort, or RPE.

Conclusions: Higher skin temperatures, thermal sensation, and sweat rates suggest that exercising on synthetic grass in hot conditions may increase some markers of heat strain during exercise. However, delta core body temperature, heart rate, thermal comfort, and RPE remained unaffected.

Gymnastics

High-pressure protocol during practice evokes competition-like psychological states in gymnasts. International Journal of Sports Science & Coaching, Ahead of Print, 1-6, 2024.

Abstract - Athletes – particularly gymnasts – are inevitably confronted with pressure during competitions. To ensure that athletes can perform their tasks despite experiencing pressure, it is essential to safely expose them to competition-like experiences during training. Therefore, we collaborated with two gymnastics coaches in developing a pressure protocol for elite-level youth gymnasts ($n = 16$) to assess whether psychological states that are typically experienced during competitions can be evoked during training. Our results show that cognitive anxiety, somatic anxiety, and mental effort were increased significantly, while self-confidence and performance indicated declines, albeit not significant,

CSCCA Performance Research Reviews



Performance Research Reviews

when training with a pressure protocol compared to regular training. Furthermore, none of these variables differed between the pressure training and competition. The current results inspire confidence that coaches may utilize pressure protocols to successfully introduce competition-like psychological states during training to help athletes perform better despite experiencing pressure and anxiety.

Somatotype, anthropometric characteristics, body composition, and global flexibility range in artistic gymnasts and sport hoop athletes. PLOS ONE, 19(10): e0312555, 2024.

Abstract - The objective of the study was to analyze the somatotype, anthropometric characteristics, body composition, and the global flexibility battery test. A total of 48 athletes of both sexes from Women's Artistic Gymnastics, Men's Artistic Gymnastics, and Hoop Sport (mean \pm standard deviation, age 12.50 ± 2.67 years, body mass 43.16 ± 11.00 kg, height 150.15 ± 11.91 cm). Anthropometric data were obtained using the ISAK protocol. The somatotype was analyzed using the Heath-Carter method. The results indicate significant differences in fat, bone, and residual mass, as well as in the proportions of endomorphy, mesomorphy, and ectomorphy ($p < 0.05$). The somatocard revealed that most athletes were classified as endomorphic mesomorph or ectomorphic mesomorph, with variations between groups. Positive and negative correlations were identified between the anthropometric variables, somatotype, body composition, and global flexibility. All positions of the global flexibility battery test showed negative correlations with residual mass, indicating that the greater the range of flexibility, the lower the residual mass.

Golf

Neurofeedback Training Protocols in Sports: A Systematic Review of Recent Advances in Performance, Anxiety, and Emotional Regulation. Brain Sciences, 14: 1036, 2024.

Abstract - (1) Background. Neurofeedback has been used in sports since the 1990s, frequently showing positive outcomes in enhancing athletic performance. This systematic review provides an updated analysis of neurofeedback training in sports, evaluating reaction time, cognitive performance, and emotional regulation to address literature gaps and suggest future research directions. (2) Methods. A systematic search was conducted using PubMed, Scopus, Science Direct, and Web of Science databases for articles published from January 2016 to April 2023. The search included only original articles written in English, resulting in 24 studies meeting the inclusion criteria. (3) Results. The reviewed studies cover a wide range of sports, including golf, basketball, swimming, rifle shooting, football, volleyball, athletics, judo, ice



Performance Research Reviews

hockey, triathlon, handball, fencing, taekwondo, and darts. They involved athletes of varying experience levels (beginners, professionals, and experts) and utilized neurofeedback training targeting different frequency bands (alpha, beta, theta, and SMR), either individually or in mixed protocols. Findings show improvements in sports and cognitive performance, emotional regulation, and anxiety management. (4) Conclusions. This systematic review supports the effectiveness of neurofeedback in enhancing sports and cognitive performance across various disciplines and experience levels. Notable improvements were observed in technical skills, physical performance parameters, scoring, attention, concentration, reaction time, short-term and working memory, self-regulation, and cognitive anxiety. Future research should standardize protocols, include more diverse samples, and explore long-term effects to further validate these findings.

Relationships and Within-Group Differences in Physical Attributes and Golf Performance in Elite Amateur Female Players. Life, 14: 674, 2024.

Abstract - The aim of the present study was to examine the association between a comprehensive physical testing battery and measures of golf performance in elite female amateur players. Nineteen category one (handicap ≤ 5) or better golfers (age: 16.26 ± 1.28 years, height: 166.26 ± 3.62 cm, mass: 64.04 ± 11.27 kg, wingspan: 146.53 ± 15.59 cm, handicap: $+1.45 \pm 0.7$) volunteered to participate in this investigation. All golfers attended a single 90 min testing session where golf shot data (clubhead speed [CHS], ball speed, carry distance, and smash factor) were measured with a Trackman 4 launch monitor and a battery of physical assessments were carried out. These included anthropometric data and assessments for seated thoracic rotation, the isometric mid-thigh pull (IMTP), isometric bench press, countermovement jump (CMJ), and seated medicine ball throws for distance. Pearson's r correlations showed CHS was the golf metric that most commonly demonstrated large associations with physical testing data, most notably with force at 100 ms during the isometric bench press ($r = 0.70$). Median split analysis was also conducted for the IMTP (force at 200 ms), isometric bench press (force at 100 ms), and CMJ (positive impulse). The results showed that players who produced more force at 200 ms during the IMTP exhibited a greater CHS ($g = 1.13$), ball speed ($g = 0.90$), and carry distance ($g = 1.01$). In addition, players with a greater positive impulse during the CMJ showed a greater ball speed ($g = 0.93$), carry distance ($g = 1.29$), and smash factor ($g = 1.27$). Collectively, these results highlight the relevance of explosive force production capabilities in both the lower and upper body for female golfers. This information can be used by practitioners to better target key physical attributes during testing and training of female players.



Performance Research Reviews

Hockey

Maximum strength and power as determinants of match skating performance in elite youth ice hockey players. Journal of Strength and Conditioning Research, 38(6): 1090-1094, 2024.

Abstract - Maximum strength has a strong influence on speed-strength performances such as sprints and jumps. Important for sports practice is whether these findings are also reflected in game performance. Therefore, the aim of this study was to explore the influence of maximum strength and power performance on linear on-ice skating performance in testing and during game play. A cross-sectional study was conducted, and 24 highly trained male youth ice hockey players participated. Jump performances (countermovement jump [CMJ], drop jumps), maximum strength (1 repetition maximum [1RM] squat and isometric trap bar pull [ITBP]), and on-ice linear sprints (15 m [LS15], 30 m [LS30], flying 15 m [FLY15]) were measured. Match performances (among others: peak skating speed) were collected of 4 regular league games using a local positioning system. Correlation coefficient and explained variance were calculated ($p \leq 0.05$). Correlations between maximum strength and jump with on-ice linear sprint performance showed 1-35% explained variance. Correlations between "off ice" test (CMJ, relative 1RM) and game data (peak skating speed) showed 22-30% explained variance, respectively, while ITBP and DJ missed significant level. Between linear sprint and game performance showed 15-59% explained variance. In this study, a clear influence of 1RM in squatting and CMJ performance on on-ice linear sprint as well as in-game peak skating speed was observed. These findings show that strength and jumping performance can be valuable tests within a comprehensive test battery and indicate the relevance of strength and jumping tasks within the regular exercise program to improve in-game skating performance.

Practical Applications - In this study, a clear influence of 1RM in squatting and CMJ performance on on-ice linear sprint as well as in-game peak skating speed was observed. However, neither reactive strength nor isometric maximum strength correlated significantly with game skating performance. On-ice linear sprint performance showed the highest correlations with game skating performance. These findings call for practical consideration in performance diagnostics and training. Strength and jumping performance can be valuable tests within a comprehensive test battery. Furthermore, the observed correlations indicate the relevance of strength and jumping tasks within the regular exercise program of ice hockey players to improve in-game skating performance.



Performance Research Reviews

Hockey referees: Are they part of the solution for concussions in youth hockey? Managing Sport and Leisure, Ahead of Print: 1-18, 2024.

Rationale/purpose: Concussions pose short – and long-term risks for youth athletes. To mitigate these risks, sport organizations must find ways to enhance athlete safety, including prompt removal of athletes who display signs and symptoms of concussions. Some sport organizations have incorporated officials in concussion prevention and management strategies. The purpose of this study was to gain sport officials' perspectives of being able to remove athletes with suspected concussion from games.

Design/methodology/approach: We conducted a qualitative study using semi-structured interviews with 10 ice hockey officials from across Canada. We implemented a pragmatic approach with a reflexive thematic analysis to maintain the participants' truths and perspectives within the results.

Findings: Our analysis resulted in the four themes: (a) Considerations and Importance of the Protocol, (b) Officials' Knowledge of Concussions, (c) Required Training, and (d) Barriers.

Practical Implications: Removing athletes with suspected concussions could be added to officials' duties; however, hesitancy exists regarding implementation and effectiveness of the protocol. Focus on the implementation and education of the officials is required.

Research Contribution: This study contributes to the growing literature on sport officials and their role with respect to concussions in youth ice hockey.

Lacrosse/Field Hockey

A comparison of match external load demands across women's collegiate field sports. Journal of Strength and Conditioning Research, Ahead of Print: 1-8, 2024.

Abstract - Historically, soccer (SOC), lacrosse (LAX), and field hockey (FH) have been grouped together as "field sports" due to their intermittent nature of match play and similar physiological demands. However, questions have emerged regarding potential variations in demands between sports. The purpose of this study was to compare external match workloads between collegiate women's SOC, LAX, and FH, and examine within-sport positional differences. Athletes (SOC: n = 15; LAX: n = 15; FH: n = 14) wore a global positioning system device during all matches throughout a competitive season. External load metrics included in the analysis were total distance (TD), sprint distance (SD),



Performance Research Reviews

accelerations ($>3 \text{ m}\cdot\text{s}^{-2}$), sprint efforts (SE), player load (PL), PL per minute (PL/min), top speed ($\text{m}\cdot\text{s}^{-1}$), and distances covered in select speed zones. Soccer performed higher external load volumes (TD, PL) ($p \leq 0.025$) but incurred lower intensities (SD, SE, accelerations) ($p < 0.001$) compared with LAX and FH. Within-sport positional differences were apparent in SOC ($p < 0.001$ - 0.018), LAX ($p < 0.001$ - 0.045), and FH ($p < 0.001$ - 0.004). However, FH exhibited more positional variance in external load metrics compared with SOC or LAX. Field hockey midfielders covered greater volumes (TD, PL) compared with attackers and defenders ($p < 0.001$), while attackers sustained greater intensities (SD, SE, top speed) compared with midfielders and defenders ($p < 0.004$). Results indicate that there are significant differences in external workload parameters between sports and across positions. Practitioners should tailor sport-specific and position-specific programs to match demands, and future research should explore the proposed categorizations of LAX as a "fast collision invasion sport," FH as a "fast contact invasion sport," and SOC as a "slow contact invasion sport."

Practical Applications - Defining and monitoring match external loads can provide practitioners with insights for designing the technical and tactical elements of sport training. This study, comparing match external loads among collegiate women SOC, LAX, and FH, revealed variations in workloads across sports and positions. These findings highlight the disparities in external load metrics and offer valuable insights for practitioners, especially NCAA performance coaches responsible for strength and conditioning programming across multiple field-sport programs. By understanding these differences, coaches can develop more sport-specific and position-specific training programs, ensuring that athletes are better prepared for the unique demands of their respective sports. Recognizing variations in volume parameters (e.g., TD, PL) across matches, which may be influenced by diverse tactical scenarios, individual player styles, pacing strategies, and, notably, match duration, allows for more accurate workload management and injury prevention. Furthermore, quantifying the differences between these sports has broader implications for female athlete health and performance outcomes. Tailored training programs can help in reducing the risk of overuse injuries, optimizing recovery strategies, and improving overall performance by addressing the specific physiological and biomechanical demands of each sport. In addition, this comparative analysis provides a foundation for future research to explore the long-term effects of sport-specific training on athletic development and health outcomes in female athletes. It also underscores the need for a more nuanced classification of field sports, facilitating better communication and collaboration among sports scientists, coaches, and healthcare professionals. By implementing these insights, practitioners can enhance training efficacy, support athlete longevity, and contribute to the overall advancement of women's sports science.



Performance Research Reviews

Mechanisms and trends in women's lacrosse head and musculoskeletal injuries: A 15-year review of National Injury Data, Ahead of Print: 1-7, 2024.

Background: Head injury rates in lacrosse may be higher among women compared with men. Understanding these trends can guide appropriate injury prevention for female athletes.

Hypotheses: Injuries most commonly involve the head, with no significant decline over the study period; contact with other players would be the most common injury mechanism.

Study design: Descriptive epidemiological.

Level of evidence: Level 3.

Methods: The National Electronic Injury Surveillance System (NEISS) was queried (January 1, 2008 to December 31, 2022) for women's lacrosse injuries presenting to United States (US) emergency departments (EDs). Patient demographics, injury diagnosis, body part injured, disposition, and clinical narrative were extracted. The provided narrative identified the mechanism of injury. Linear regression analysis assessed trends over time.

Results: An estimated 57,635 women's lacrosse injuries occurred during the study period extrapolated from 1899 evaluated NEISS cases. The mean age was 15.81 ± 5.35 years, with 68.3% of injuries sustained by high school (14- to 18-year-old) players. Over one-third of all injuries were to the head (national estimate [NE], 19,358; 33.6%), followed by the ankle (NE, 10,475; 18.2%), then the knee (NE, 6969; 12.1%). Strain/sprains were most common (NE, 19,402; 33.7%) followed by closed head injury (CHI)/sports-related concussion (SRC) (NE, 11,794; 20.5%) and contusion/abrasion (NE, 10,605; 18.4%). ED presentations of CHIs/SRCs and fractures remained elevated with no significant decline over the study period ($P > 0.05$), despite a significant decrease in strains/sprains and contusions/abrasions ($P < 0.01$ and $P = 0.01$, respectively). The most common injury mechanism was collision/contact with another player (NE, 10,664; 18.5%).

Conclusion: An estimated one-third of women's lacrosse players in the study sample had a head injury. CHIs and SRCs accounted for 20.5% of all injuries.

Clinical relevance: Given the high proportion of contact-related head injuries, headgear mandates and improved player safety protocols may be warranted.



Performance Research Reviews

Soccer

Contextualized physical metrics: The physical demands vary with phase of play during elite soccer match play. *European Journal of Sport Science, Ahead of Print: 1-12, 2024.*

Abstract - The physical demands of elite soccer match play have traditionally been measured using aggregated whole-match metrics. However, match play is increasingly considered as distinct phases of play, although the influence of phase of play on match physical demands remains largely unknown. This study compared physical intensity, acceleration and deceleration demands, between phases of play and according to playing position. The duration of each match from a major European league ($n = 1083$) was divided into one of five reciprocal phases (for the in-/out-of- possession team) using event and tracking data: build-up/high-block, progression/ mid-block, chance creation/low-block, fast attack/fast defense, or attacking transition/defensive transition. Player tracking data were used to calculate physical intensity as the rate of distance covered ($m \cdot min^{-1}$) in total and within five speed categories, and the proportion of time spent accelerating and decelerating ($>2 m s^{-2}$) during each phase of play. Rate of distance covered in total differed markedly with phase of play; fast attack 35%–53% greater, and fast defense 33%– 50% greater, than other in-/out-of-possession phases respectively, and these effects were amplified for the rate of distance covered at higher speeds (e.g., sprinting ≥ 4 - fold differences between phases). Match phase also affected the proportion of time spent accelerating and decelerating (highest for fast attack and chance creation, respectively), especially when in-possession for forwards and when out-of- possession for defenders ($p < 0.001$). Phase of play had a large effect on the physical intensity of match play, particularly rates of distance covered at higher speeds, as well as the acceleration and deceleration demands, and in a position specific manner.

Highlights

- Despite elite soccer match play being increasingly considered as distinct phases of play, the effect of phase on physical metrics is largely unknown. This analysis of 1083 matches of a major European league found rates of distance covered in total, as an index of physical intensity, differed markedly (by $>50\%$) according to phase, with even more pronounced effects on the rates of distance covered at higher speeds (e.g., sprinting >4 -fold greater for fast attack and fast defense than some phases).
- Playing position also had a pronounced interaction with phase of play; fast attack (forwards) and fast defense (midfielders and defenders) phases involving considerably greater physical intensities. Moreover, phase of play also had a large effect on the proportion of time spent accelerating and decelerating, most notably when in-possession for forwards and when out- of-possession for defenders.



Performance Research Reviews

- Thus, the present study is the first to comprehensively divide the entire duration of match play into distinct phases using event and tracking data, demonstrating that match physical demands during elite soccer match play are extensively affected by match phase, and in a position specific manner.

Predictive validity of lower extremity muscle strength, strength asymmetry, and soccer-specific fitness for talent identification in elite male youth soccer players: A retrospective cohort study. Measurement in Physical Education and Exercise Science, Ahead of Print: 1-14, 2024.

Abstract - This study investigates the predictive validity of lower extremity strength, strength asymmetry, and soccer-specific fitness in talent identification among elite male youth soccer players. Employing a Retrospective Cohort design, we established a cohort consisting of K-League registered youth players, totaling 219 individuals (all males, aged 16 ~ 17 years, in grade 2 of high school; equivalent to grade 11 in the US), with 38 progressing to the professional level and 181 not. Results from t-tests revealed significant differences between professional and nonprofessional groups for countermovement jump (CMJ; $t = -2.423$, Cohen's $d = -.448$, $p = .019$) and change of direction with a ball (CODB; $t = 2.202$, Cohen's $d = .398$, $p = .032$). CMJ demonstrated a significant correlation with the 30 m sprint ($r = -.53$, $p < .001$), and change of direction without a ball (COD) correlated with CODB ($r = .52$, $p < .001$). The robust Poisson regression, encompassing the interaction term of COD and CODB, produced an AUC of .73 (95% CI: .65 ~ .82).

'Supporting the Support Staff': A narrative review of nutritional opportunities to enhance recovery and wellbeing in multi-disciplinary soccer performance staff. Nutrients, 16: 3474, 2024.

Background: With ever-increasing training, match-play and travel demands in professional soccer, recovery is vital for athletic performance, a statement amplified in tournament and in-season scenarios. However, alongside supporting the tasks associated with these increased demands, the recovery and wellbeing strategies recommended for playing staff are often unavailable to their support staff counterparts, who routinely experience extended working hours over and above scheduled player attendance.



Performance Research Reviews

Methods: Focusing on the contributions of nutrition to this undoubtedly multifactorial issue, this narrative review aimed to (1) identify potential strategies to enhance recovery and wellbeing in multi-disciplinary soccer support staff and (2) highlight future research opportunities exploring the benefits of nutrition for those staff in soccer performance-related support roles.

Results: The potential health and wellbeing consequences of chronic sub-optimal practices suggest that chrononutrition strategies may be an area of future interest. Notably, nutritional strategies that enhance sleep hygiene and immune function warrant consideration. Individualizing such strategies to maximize recovery and wellbeing in multi-disciplinary soccer support staff should offer an adjunct and complementary strategy to the holistic performance-focused support provided to professional soccer players.

Conclusions: Policymakers responsible for organizational and club structures aligned with soccer performance could consider 'Supporting the Support Staff' when seeking to improve overall performance.

Softball

Upper extremity orthopedic softball injuries presenting to the emergency department: Epidemiology across the lifespan. *The Physician and Sportsmedicine, Ahead of Print: 1-9, 2024.*

Background: Softball is a popular lifetime sport due to its inclusion of both fastpitch and slowpitch varieties, although associated injuries are common.

Objective: To compare softball injury rates across patient sex, age, race, injury location, mechanism, and activity.

Methods: The National Electronic Injury Surveillance System (NEISS) was queried for all upper extremity softball injuries in patients 10-85+ years old presenting to United States emergency departments between 2012 and 2021.

Results: Significantly more of the 178,303 total weighted upper extremity injuries occurred in female (68.1%) than male (31.9%) athletes ($p < .001$). Male patients (mean 34.9 ± 13.6 years) were older than female patients (17.4 ± 8.4 ; $p = .019$). The average incidence rate of UE injuries from 2012-2021 was 187.9 per 100,000 persons, with a significant decrease in injury incidence across the timespan ($p < .001$). The lowest annual injury incidence (74.7 per 100,000 persons) occurred in 2020. In patients 10-18 years old, female patients accounted for 95.1% of all injuries, whereas male patients accounted for 72.1% of all injuries in patients aged ≥ 23 . Compared to male patients, females more frequently experienced hand ($p < .001$), lower arm ($p = .007$), shoulder ($p < .001$), and wrist ($p < .001$) injuries in patients 10-18



Performance Research Reviews

years old, finger ($p < .001$), upper arm ($p = .016$), and wrist ($p < .001$) injuries in patients 19-22, and finger injuries ($p < .001$) in patients aged 23 +. Across all ages, the greatest proportion of injuries were treated and released ($p < .001$). Most injuries occurred while fielding (41.8%) and due to player-ball contact (36.8%).

Conclusion: Softball injury ED presentations declined across a decade, including a precipitous drop and rebound effect due to the COVID-19 pandemic. Across the lifespan, upper extremity injuries progressively shifted from female-predominant in younger athletes to male-predominant in adults.

Waveform analysis to identify biomechanical relationships and differences between softball pitchers with and without pain. Sports Health, Ahead of Print: 1-6, 2024.

Background: Softball pitchers accrue high rates of injury. Research suggests certain mechanics at discrete pitch events are related with pain. Here, we examine relationships between peak throwing shoulder kinetics and trunk/pelvis kinematics and compare trunk/pelvis kinematics between pitchers who were healthy and those currently experiencing pain.

Hypothesis: (1) Peak shoulder kinetics would be positively related to greater trunk and pelvis flexion, lateral flexion, and rotation; and (2) pitchers in pain would exhibit greater trunk and pelvis flexion, lateral flexion, and rotation during the pitch than those who were pain-free.

Study design: Cross-sectional study.

Methods: A total of 42 high school pitchers (height, 1.71 ± 0.06 m; weight, 75.0 ± 15.9 kg; age, 16 ± 2 years) were separated into 2 groups based on presence or absence of pain. Peak kinetic data from 3 pitches per pitcher were averaged and used as dependent variables. Kinematic data were averaged across 3 trials, and time normalized to 101 datapoints between foot contact and follow-through of the pitch. Statistical parametric mapping regressions were used to assess the relationships between peak shoulder kinetics and waveform of trunk and pelvis kinematics.

Results: Pelvic lateral tilt significantly predicted peak throwing shoulder superior ($P = 0.05$) and lateral ($P = 0.04$) force. Pelvis rotation predicted peak superior force ($P = 0.02$). Waveform analyses revealed no waveform differences between healthy pitchers and those currently experiencing pain.



Performance Research Reviews

Conclusion: Peak shoulder kinetic variables are related with pelvic positioning during the pitch; however, trunk and pelvis kinematics do not differ according to presence of pain.

Clinical relevance: Pitchers in pain do not adopt specific trunk and pelvic alterations during the pitch, potentially concealing the effects of pain from visual identification. Coaches and clinicians need to discuss health status with pitchers versus relying on visual observations to understand pain and injury risk.

Swimming

Peaking for the Olympic Games – An integrated approach developed with the French National Swimming Team for Paris 2024. Journal of Strength and Conditioning Research, 38(11): 1981-1986, 2024.

Abstract - In energy-dominant disciplines, such as swimming, performance depends largely on the difference between the levels of fatigue and physical fitness: the greater this difference, the higher the probability of reaching a peak performance. The main challenge before major events such as the Olympic games is therefore in identifying the most efficient strategies to reduce the fatigue accumulated during previous mesocycles, while maintaining, or even improving the level of physical fitness. The most widespread strategy relies in the manipulation of training load parameters. This is the taper period, which has been shown to improve performance by $\approx 2\%$ in elite athletes. However, tapering may not be sufficient for the most tired athletes. In this case, the strategy commonly used consists in combining the manipulation of training load with the implementation of recovery methods. Regardless of the strategy, we perceive that the challenge for athletes, coaches, and sport scientists is to estimate the level of cumulative fatigue as precisely as possible to individualize the recommendations. This relies not only on the identification of valid markers but also on the ability to interpret their variations over time. The objective of this article is to present the method initially developed in a European champion professional rugby team and now implemented with the French swimming team as part of its preparation for the Paris 2024 Olympic and Paralympic Games. More specifically, this article provides some details about the conception of the monitoring dashboard, and the method used to interpret changes over time to categorize the level of fatigue.

Practical Applications - As already mentioned, the fundamental idea that must guide the implementation of this approach is the Occam's razor principle. First, this requires identifying all the markers collected daily, weekly, or monthly by the support staff to identify those that can be integrated into the monitoring dashboard without adding new tests. This is very important for athlete buy-in and more generally for their physical integrity. Indeed, it is not necessarily a



Performance Research Reviews

good idea to add new tests (either maximal or submaximal) to an already very high training load, especially if they require the acquisition of new equipment, new skills by the staff, or they lengthen the time spent at the training site. Therefore, the challenge lies in testing in a relevant way without disrupting the usual schedule or being too time consuming or physically demanding. One of the difficulties of this approach is that the level of cumulated fatigue can be estimated differently according to the method used to interpret changes (Table 5) or the method used to categorize the level of fatigue (Table 4). Specific methodological studies are probably needed to clarify this point. Nevertheless, according to the data we collected during the D-Day project, it seems that the SWC method is more conservative than the others, which decreases its sensitivity to small but clinically significant changes. One of the explanations probably relies on the use of the group SD to compute this statistic, instead of the individual one. This would not be a problem if groups were homogeneous. However, the groups we monitored were made up of men and women of different age, swimming style, and swimming distance. This heterogeneity is associated with a high SD, which ultimately reduces the magnitude of the differences observed over time. From an empirical point of view, it seems therefore that the approach based on the specific methods should be preferred to the method using only the SWC (Table 5), at least in tier 4 and tier 5 swimmers of different gender and swimming styles.

The effect of coaching style on performance of athletes through anxiety as mediating variable in adolescent swimmers. Retos, 55: 241-248, 2024.

Abstract - This study aimed to analyze the effect of the relationship between coach leadership style and the performance achievement of adolescent swimmers through anxiety as a mediator. This study was conducted on 100 adolescent swimmers in the Special Region of Yogyakarta Province who have won at least at the regional level. This type of research was descriptive correlation using the Structural Equation Modeling (SEM) approach with Smart-PLS. The results of this research are the validity test on outer loading (>0.7) and the constructed value on the Fornell-Larcker Criterion is greater than the other construct values (>0.7) and the Cronbach's alpha reliability value (>0.7) means that this instrument is suitable for use for research. The results of the fit model are SRMR or Standardized Root Mean Square value, the value is $0.066 < 0.10$ or $0.077 < 0.08$ so the model fits the data. Hypothesis results from 1) coaching style and the performance of swimming athletes are P-Values 0.001, 2) the relationship between coaching style and anxiety, P-Values 0.002, 3) the relationship between anxiety and the performance of swimming athletes, P-Values 0.000, 4) the relationship between coaching style and the performance of swimming athletes through anxiety P-Values 0.021. Therefore, four hypotheses can be accepted. In conclusion, differences in types of coaching styles, either directly or indirectly, will influence athletes' achievement orientation and performance.

CSCCA Performance Research Reviews



Performance Research Reviews

Tennis

Musculoskeletal disorder risk assessment during the tennis serve: Performance and prevention. *Bioengineering*, 11(10): 974, 2024.

Abstract - Addressing the risk of musculoskeletal disorders (MSDs) during a tennis serve is a challenge for both protecting athletes and maintaining performance. The aim of this study was to investigate the risk of MSD occurrence using the rapid whole-body assessment (REBA) ergonomic tool at each time step, using 3D kinematic analysis of joint angles for slow and fast serves. Two force platforms (750 Hz) and an optoelectronic system including 10 infrared cameras (150 Hz, 82 markers located on the whole body and on the racket) were used to capture the kinematics of the six REBA joint areas over five services in two young male and two young female ranked players. The mean REBA score was 9.66 ± 1.11 (ranging from 7.75 to 11.85) with the maximum value observed for the loading and cocking stage (REBA score > 11). The intermediate scores for each of the six joint areas ranged between 2 and 3 and the maximum value of their respective scales. The lowest scores were observed for the shoulder. Neck rotation and shoulder flexion are parameters that could be taken into account when analyzing performance in the context of MSD prevention.

Are there kinematic and kinetic parameters correlated with racket velocity during the tennis serve? A preliminary comparison between a slow and a fast serve for performance improvement. *Frontiers in Sports and Active Living*, 6: 1451174, 2024.

Introduction: The tennis serve is a complex motion with numerous rotations which are important to manage for performance. The main aim of this study was to investigate kinematic parameters, including the evolution of the center of gravity, and kinetic parameters correlated with racket velocity over all phases of the tennis serve. The secondary objective was to find out which of the correlated parameters differed between a slow and a fast serve. The advantage of such an approach would be to propose biomechanical parameters that coaches and teachers could use to optimize performance or learn how to serve.

Methods: Quantitative analysis was carried out on 5 flat serves performed by four ranked players using an optoelectronic system (82 markers located on whole body and racket) composed of 10 infrared cameras (150 Hz) and two force platforms (750 Hz).



Performance Research Reviews

Results: A descriptive statistical analysis highlighted 11 very large and almost perfect correlations with racket velocity: vertical ground reaction force of back foot in release backward, trunk axial rotation during loading phase, back and front knee flexions, dominant shoulder and hip mediolateral rotation during cocking phase, and center of gravity vertical velocity, dominant shoulder medial rotation velocity, dominant elbow flexion, trunk flexion/extension and axial rotation during acceleration phase. Differences were observed for some of the correlated parameters between slow and fast serve.

Discussion: Consequently, all these correlated kinematic and kinetics parameters constitute information that coaches, instructors and athletes can use to improve, optimize or teach the tennis serve.

Volleyball

Long-term prognosis of patellar tendinopathy (Jumper's Knee) in young, elite volleyball players: Tendon changes 11 years after baseline. The American Journal of Sports Medicine, Ahead of Print: 1-10, 2024.

Background: The long-term prognosis of jumper's knee and whether structural changes in the patellar tendon persist is unknown.

Purpose: To investigate whether limitations in knee function and structural changes persisted beyond the athletic career of young elite volleyball players.

Study design: Cohort study; Level of evidence, 2.

Methods: Volleyball players (mean \pm SD age, 18 ± 0.8 years) enrolled in 2006-2011 in a prospective cohort study were invited in 2020-2022 to a follow-up study. Participants rated their knee function with the Victorian Institute of Sport Assessment-Patellar Tendon (VISA-P) score (baseline and follow-up) and the International Knee Documentation Committee (IKDC) score (follow-up) and reported if jumper's knee had influenced their decision to retire from sport. Tendon thickness and structural changes were assessed with ultrasound (baseline) and magnetic resonance imaging (MRI) (follow-up) of both patellar tendons.

Results: We included 138 of 143 former athletes (97%) 11.4 ± 1.6 years after their baseline examination. At baseline, 37 persons (52 knees) had developed jumper's knee. At follow-up, participants reported lower knee function scores in knees diagnosed with jumper's knee at baseline than healthy knees (VISA-P scores: jumper's knee, 81 [95% CI, 70-92];



Performance Research Reviews

healthy, 90 [95% CI, 86-94]; $P < .001$; IKDC scores: jumper's knee, 82 [95% CI, 75-89]; healthy, 92 [95% CI, 91-95]; $P < .001$). Jumper's knee problems directly caused 7 of the 37 athletes (19%) with jumper's knee at baseline to retire from competitive volleyball. Of the 138 players included, 97 (70%) completed a bilateral MRI examination (194 knees). At follow-up, 38 of the 54 abnormal tendons (70%) had no structural changes ($P < .001$ vs baseline) while 22 of the 140 normal tendons (16%) had developed structural changes. Clinical symptoms were not correlated with tendon structure at follow-up (VISA-P scores for normal tendons: 85 [95% CI, 73-87]; abnormal: 89 [95% CI, 85-92]; $P = .48$).

Conclusion: Jumper's knee is not a self-limiting condition; volleyball players who had developed jumper's knee during adolescence reported persistent reductions in knee function 11 years later, leading one-fifth to retire from competitive volleyball. Although approximately 70% of tendons with structural changes at baseline were normal at follow-up, there was no clear relationship between structure and function.

Effects of different pre-exercise strategies on jumping performance in female volleyball players. Journal of Sports Medicine and Physical Fitness, Ahead of Print: 1-10, 2024.

Background: The present study aimed to compare different pre-exercise strategies on jumping performance in female volleyball players.

Methods: Fifteen healthy female volleyball players (age= 18 ± 0.6 years; training experience = 7.3 ± 1.4 years; height = 164.8 ± 5.4 cm; body mass = 57.2 ± 8.1 kg) volunteered to participate in the study. Three different pre-exercise conditions (5 repetition maximum knee extension, electromyostimulation [EMS] and ischemic preconditioning [IPC]) were applied to the subjects and compared to a control condition performing a standardized warmup. Subjects performed the squat jump and 15 sec repeated countermovement jumps following a rest period. Measures associated with jumping performance were collected and compared between conditions. Rating of perceived exertion was also collected after each performance test.

Results: No pre-exercise condition outperformed a standardized warm-up on inducing improvements in jumping performance and in fact, EMS and IPC conditions resulted in performance decrements compared to control ($P < 0.05$).

Conclusions: We conclude that a standardized warm-up is enough to induce improvements in jumping performance in female volleyball players. Future research should examine alternative strategies alongside standardized warm-up to determine how best to prepare for jumping and related sport-specific tasks in female volleyball players.



Performance Research Reviews

Wrestling/Combat Sports

Influence of slow and rapid weight loss periods on physiological performance, mood state and sleep quality in male freestyle wrestlers: A study from Sichuan Province, China. *Frontiers in Psychology, 15: 1445810, 2024.*

Objective: This study aims to investigate the changes in physiological performance, mental state and sleep quality during the weight reduction phase prior to competition in male freestyle wrestlers.

Methods: This study included 16 male freestyle wrestlers from Sichuan Province, China. Participants were evaluated at three time points: the first day of slow weight reduction (T1, March 26), the first day of rapid weight reduction (T2, April 26) and the day before the competition (T3, May 3), and measurements were taken for physiological performance, mood state and sleep quality.

Results: The most relevant findings indicated the following: Morning heart rate, creatine kinase and fatigue scores increased by 12.6, 64.6, and 19.0%, respectively, from T1 to T2 ($p < 0.05$), and decreased by 14.1, 36.6, and 16.8%, respectively, from T2 to T3 ($p < 0.05$). Hemoglobin and testosterone levels decreased by 3.0 and 16.8%, respectively, from T1 to T3 ($p < 0.05$), and by 2.9 and 18.2%, respectively, from T2 to T3 ($p < 0.05$); The secondary findings revealed the following: The total mood disturbance scores decreased by 3.8% from T2 to T3 ($p = 0.072$), positive mood scores decreased by 9.0% from T1 to T2 ($p = 0.090$), the Pittsburgh Sleep Quality Index total scores increased by 14.4% from T1 to T2 ($p = 0.323$) and total work output and average power output decreased by 7.3 and 7.8%, respectively, from T1 to T3 ($p = 0.067$, $p = 0.052$); Regression analyses predicted negative mood ($Y_1 = 62.306 - 0.018 \times \text{maximum power output}$) and sleep quality ($Y_2 = 2.527 + 0.278 \times \text{Immunoglobulin G}$) during the weight reduction period.

Conclusion: The combined slow and rapid weight reduction approach effectively minimized body fat in athletes with limited effect on their physiological performance and sleep quality. However, the effects were adverse on certain health variables and anaerobic power in Chinese male freestyle wrestlers. The identified correlations between negative mood and maximum power, and between sleep quality and immunoglobulin G, shed new light on factors influencing athletes' well-being during weight reduction, and underscored the need for careful monitoring of physiological variables in future weight management strategies.



Performance Research Reviews

Rapid Weight Changes and Competitive Outcomes in Muay Thai and Mixed Martial Arts: A 14-Month Study of 24 Combat Sports Events. Sports, 12: 280, 2024.

Abstract - This study investigates the rapid weight loss (RWL) and rapid weight gain (RWG) of contest winners and losers from Muay Thai (MT) and mixed martial arts (MMA) events. The relationship between rapid weight change variables of males and females, and competitive success is also examined. Data from a weight management questionnaire was collected one day post-competition from 185 participants across 24 fight events, resulting in 263 responses (MMA: n = 78, MT: n = 185). Official and secondary weigh-in data were provided by the Combat Sports Commission. The results show that in MT, contest winners compared to losers had significantly greater RWL-7 days ($5.9 \pm 2.6\%$ vs. $4.6 \pm 2.7\%$, $p = 0.01$), RWG ($6.2 \pm 2.9\%$ vs. $4.7 \pm 2.8\%$, $p = 0.003$), and RWG/RWL ratio (108% [86–132%] vs. 86% [60–119%], $p = 0.038$), while no significant differences were observed for MMA. Mixed logistic regression models that controlled for age showed that a 1% increase in female RWL-24 h ([OR = 1.57, R² = 0.105, $p = 0.001$]) was associated with a 1.6 times higher likelihood of winning compared to female athletes without this increase. We emphasize that associations do not imply causation, and it is possible that other factors which align with rapid weight change practices may impact the observed relationship. Nonetheless, MT contest winners show greater RWL, RWG, and RWG/RWL ratio than losers, and female rapid weight changes appear to be associated with competitive success in this cohort.

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