



Performance Research Reviews

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Baseball

AI-assisted umpire evaluation in baseball: A data-driven approach to assessing ball-strike decisions. Journal of Sports Engineering and Technology, Ahead of Print: 1-12, 2025.

Abstract - Ball-strike judgments in Major League Baseball (MLB) remain susceptible to human error, potentially affecting game outcomes and competitive fairness. This study develops an AI umpire using deep learning to assess the consistency of human umpire decisions. A deep neural network trained on 362,734 pitches from the 2019 MLB season achieved an accuracy of 93%. The AI umpire's high-confidence predictions (probability >0.9 or <0.1) were compared against actual umpire calls to identify systematic discrepancies. Results indicate that these discrepancies were not randomly distributed but concentrated in specific game contexts—particularly early innings and first-pitch situations—suggesting situational influences on judgment. Moreover, some umpires exhibited spatial biases by consistently expanding or contracting the strike zone relative to the AI model's zone. These findings suggest that umpire decisions are shaped by game dynamics rather than being solely rule-bound. This study proposes a novel AI-based evaluation framework for officiating consistency, illustrating the potential of AI to support more objective and reliable assessments than human umpires.

"Can We Trust Them?"- An Expert Evaluation of Large Language Models to Provide Sleep and Jet Lag Recommendations for Athletes. Sports Medicine, Sports Medicine, Ahead of Print: 1-14, 2025.

Background: With the increasing use of artificial intelligence in healthcare and sports science, large language models (LLMs) are being explored as tools for delivering personalized, evidence-based guidance to athletes.

Objective: This study evaluated the capabilities of LLMs (ChatGPT-3.5, ChatGPT-4, and Google Bard) to deliver evidence-based advice on sleep and jet lag for athletes.

Methods: Conducted in two phases between January and June 2024, the study first identified ten frequently asked questions on these topics with input from experts and LLMs. In the second phase, 20 experts (mean age 43.9 ± 9.0 years; ten females, ten males) assessed LLM responses using Google Forms surveys administered at two intervals (T1 and T2). Inter-rater reliability was evaluated using Fleiss' Kappa, and intra-rater agreement using the Jaccard Similarity Index (JSI),



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and content validity through the content validity ratio (CVR). Differences among LLMs were analyzed using Friedman and Chi-square tests.

Results: Experts' response rates were high (100% at T1 and 95% at T2). Inter-rater reliability was minimal (Fleiss' Kappa: 0.21-0.39), while intra-rater agreement was high, with 53% of experts achieving a JSI ≥ 0.75 . ChatGPT-4 had the highest CVR for sleep (0.67) and was the only model with a valid CVR for jet lag (0.68). Google Bard showed the lowest CVR for jet lag (0%), with significant differences compared to ChatGPT-3.5 ($p = 0.0073$) and ChatGPT-4 ($p < 0.0001$). Reasons for inappropriate responses varied significantly for jet lag ($p < 0.0001$), with Google Bard criticized for insufficient information and frequent errors. ChatGPT-4 outperformed other models overall.

Conclusions: This study highlights the potential of LLMs, particularly ChatGPT-4, to provide evidence-based advice on sleep but underscores the need for improved accuracy and validation for jet lag recommendations.

Data visualization and K-means clustering in MLB: Uncovering performance trends, payroll impact, and strategic insights. Managing Sport and Leisure, Ahead of Print: 1-21, 2025.

Abstract - This study uses data visualization and K-means clustering to analyze 23 years of Major League Baseball data from sources including Baseball Savant, Baseball Reference, and Spotrac Visualizations. Key trends examined include Launch Angle, Exit Velocity, League Slash Line, and Three True Outcomes. Analyses identified the top 30 hitters by OPS, Launch Angle, and Strikeout Percentage, the top defensive players by Outs Above Average (OAA) for 2023 and a positive correlation between Exit Velocity and Slugging Percentage. The relationship between team payrolls and Wins Above Replacement (WAR) was explored, uncovering insights into financial investment and performance. K-means clustering assessed individual player values to reach the overall aim of this work, which is to contribute machine learning tactics to aid in team construction, decision making, and further the world of baseball analytics.

Development of strategic pitching skill items in professional baseball games. Journal of Physical Education and Sport, 25(8): 1742-1751, 2025.

Introduction: Strategic decision-making in pitching is a crucial factor in baseball performance, yet traditional metrics like earned run average and even advanced sabermetrics such as fielding independent pitching (FIP) and strikeout-to-walk ratio (K/BB) fail to directly measure how pitchers adapt their pitch selection in response to situational demands. Relatedly, although sports science has explored biomechanical and physiological aspects of pitching, little attention has



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been paid to the intentional structure of pitching strategy. This study addresses this critical gap by developing and validating a measurement model of strategic pitching skills based on pitch-by-pitch data.

Materials and Methods: Using data from Nippon Professional Baseball (NPB), the study analyzed 28,222 plate appearances. A causal-effect analysis with the Delphi method was conducted with expert input to define two main domains of strategic pitching skill: pitch velocity skill and pitch location skill. Sub-skills included off-speed variation (velocity) and vertical, horizontal, and diagonal skills. A total of 20 items were initially created based on differences in pitch characteristics relative to the context (e.g., pitch count, previous pitch). Exploratory and confirmatory factor analyses were conducted to test the construct validity, followed by structural equation modeling (SEM) to examine criterion-related validity using FIP and K/BB as external indicators.

Results and Discussion: After the exploratory analysis, 18 items remained, yielding a four-factor model that explained 70% of the variance. A confirmatory factor analysis further supported this model, and both horizontal and off-speed skills showed significant associations with improved performance, reflected in lower FIP (-0.51 and -0.39, respectively) and higher K/BB (0.76 for horizontal skill). These results confirm that the developed items are not only statistically valid but also practically meaningful. This model provides a novel framework for evaluating strategic pitching skills and has potential applications in individualized coaching, performance analysis, and AI-based scouting systems.

Conclusions: This study developed and validated a set of strategic pitching skill items based on pitch-by-pitch data from NPB. The resulting model consists of two domains—pitch velocity skill and pitch location skill—comprising four sub-skills. Construct and criterion related validity were confirmed, particularly for horizontal and off-speed skills. These skills offer practical value as measurable indicators for coaching, scouting, and player development.

Basketball

Anterior cruciate ligament injury is rarely the last dance for professional basketball players: High return to play with longer recovery time. A systematic review and meta-analysis. Journal of ISAKOS, 15: 101023, 2025.

Importance: Anterior cruciate ligament (ACL) injuries are considered one of the most serious setbacks for professional basketball players. While return to play (RTP) is commonly achieved in other sports, the impact of ACL reconstruction (ACLR) on RTP rate, timing, and re-rupture in elite basketball remains unclear.



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Aim: To evaluate the rate, timing, and level of RTP, as well as re-rupture rates, in professional basketball players following ACL reconstruction, and to assess whether these outcomes have changed over time. We hypothesized that while overall RTP rates would remain high, time to RTP may have increased over the past decade, reflecting evolving rehabilitation protocols and return to sport criteria.

Evidence review: A comprehensive search of PubMed, Embase, and Cochrane Library was performed (last updated July 2025) following preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. Studies were included if they reported RTP outcomes in skeletally mature professional basketball players after primary ACLR. Four distinct outcome measures were extracted and documented: RTP, time to RTP, level of RTP, and ACL re-rupture. Meta-regression was performed based on the publication period (before 2016, 2016-2020, after 2020).

Findings: Eight studies were included. The pooled RTP rate was 86.8% (95% confidence interval [CI], 79.5-92.8%), with 97.2% (95% CI, 86.9-100.0%) of players returning to their pre-injury level. The mean time to RTP was 367 days (95% CI, 357-376), increasing significantly in recent years ($p = 0.012$). The overall ACL re-rupture rate was 1.8% (95% CI, 0.2-4.6%). No significant differences were observed in RTP or re-rupture rates across time periods, but a progressive increase in time to RTP was noted.

Conclusion: Professional basketball players achieve high rates of RTP after ACLR, with most returning to their pre-injury level. Re-rupture rates are low; however, time to RTP has increased in recent years, likely reflecting more conservative, criteria-based rehabilitation strategies. ACL injury is no longer a career-ending event in elite basketball but a longer and more complex recovery may be required.

Level of evidence: Level IV.

Assessing the relationship and convergent validity of player load and dynamic stress load in basketball: A multivariable regression analysis. International Journal of Sports Physiology and Performance, Ahead of Print: 1-9, 2025.

Purpose: This study aimed to assess the strength of the relationship between Player Load and dynamic stress load (DSL); to evaluate the convergent validity between Player Load, DSL, and other external-load parameters in basketball; and to develop multiple-regression models to explain the relative importance of different external-load parameters to Player Load and DSL.



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Methods: Thirteen male basketball players less than 18 years old (age: 16.9 y, height: 198.1 cm, and body mass: 80.2 kg) participated in this study during the 2023–24 season. Players' physical demands were monitored with a local positioning system that was combined with inertial microsenors (WIMU PRO, RealTrack Systems SL). The accelerometer-derived metrics analyzed in this study were Player Load and DSL and other external-load metrics.

Results: Player Load and DSL showed a very large repeated-measure relationship, $rm_corr = .781$. Player Load showed a relationship with total distance (.967, almost perfect), high-speed running (.687, large), acceleration distance (.680, large), and deceleration distance (.661, large). Dynamic stress load showed a significant relationship with total distance (.662, large), high-speed running (.663, large), acceleration distance (.426, moderate), and deceleration distance (.412, moderate).

Conclusions: Player Load and DSL are correlated but not interchangeable. Player Load correlates at least moderately with all external-load measures monitored, with total distance and step count being almost perfect. Although DSL is correlated well with impacts, step count, and jump count over 3 gravitational forces, it correlates to a lesser extent with all metrics. Finally, this study developed 2 multiple-regression models to explain the relative importance of external-load parameters.

Beyond the box score: Clustering offensive play types to reveal game styles in professional basketball. Journal of Sports Sciences, Ahead of Print: 1-16, 2025.

Abstract - This study examined offensive tactical patterns in professional basketball and their relationships with scoring performance under varying contextual factors. Data from 982 games in the 2023–2024 Chinese Basketball Association regular season were analyzed. A k-means clustering procedure identified three offensive archetypes: Individual Creation Style (ICS), Pick-and-Roll Variation Style (PNRS), and Screen-Post Synergy Style (SPSS); random forest classifiers with Shapley Additive exPlanations confirmed cluster separations. Correlation analyses showed that isolations and pick-and-roll (PnR) handler plays in ICS were moderately associated with two-point shots made ($r = 0.31$) and accuracy ($r = 0.30$); hand-off actions in PNRS weakly correlated with two-point shot accuracy ($r = 0.12$); and off-ball screens in SPSS were moderately related to three-point shots made ($r = 0.31$). Poisson regression models revealed contextual effects. Specifically, PnR handler plays increased against stronger opponents ($p < 0.001$), isolations occurred more frequently in faster-paced games ($p = 0.002$); hand-off completions were greater in wins ($p = 0.034$) and against stronger than weaker opponents ($p = 0.034$); and off-ball screens increased against medium-level opponents ($p = 0.011$) and after longer travel



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distances ($p = 0.033$). These findings provide a scalable analytical framework connecting tactical structures, scoring outcomes, and situational constraints in professional basketball.

Biochemical and perceptual markers of physiological stress during acute exercise overload in U20 elite basketball players. Stresses, 5: 52, 2025.

Abstract - The allostatic load index (ALindex) measures the cumulative physiological burden on the body due to stress. This prospective cohort study examined the relationships between certain molecular biomarkers, physical variables, and psychometric variables during deload and overload microcycles to contribute to developing an ALindex in professional team-sport athletes. Twelve elite male basketball players (18.3 [0.9] years; 77.2 [5.7] kg; 185 [9.0] cm) were monitored during two microcycles (deload and overload). Blood creatine kinase (CK) and urea levels, countermovement jump (CMJ), session-RPE ($\text{RPE} \times \text{session duration [min]}$, its exponentially weighted moving average [EWMA]), and a cumulative wellness score (sleep, stress, fatigue, muscle soreness, and mood) were assessed at different time points. Bayesian and robust statistics (Cohen's ξ) were employed. CK rose from 222 U/L (deload) to 439 U/L (overload; +98%, large effect $\xi = 0.65$), while session-RPE load more than doubled (270 [269] AU to 733 [406] AU, $\xi > 0.8$). No difference was found in urea and wellness scores (cumulative or other components). CK levels showed moderate positive correlations with both EWMA of session-RPE ($\rho = 0.346$, $p = 0.002$) and reduced sleep quality ($\rho = 0.25$, $p = 0.018$). Bayesian modeling identified the EWMA of session-RPE as the strongest predictor of jump-defined fatigue ($\beta = 0.012$, 95% HDI [0.004, 0.021]), while CK demonstrated a small negative association ($\beta = -0.009$, HDI [-0.016, -0.001]). Finally, a principal component analysis (PCA) revealed that CK and the EWMA of session-RPE were robust indicators of physiological stress. A parsimonious index based on PCA loadings ($[0.823 \times \text{CK}] + [0.652 \times \text{EWMA of session-RPE}]$) demonstrated strong discriminative validity between microcycle phases (overload: 515, 95% HDI [442, 587] versus deload: 250, 95% HDI [218, 283], $\text{BF}_{10} > 100,000$). CK and session-RPE may serve as sensitive biomarkers for inclusion in the ALindex for team sport athletes.

Definition and influencing factors of basketball shoes 'court feel': A Delphi study. Footwear Science, Ahead of Print: 1-11, 2025.

Abstract - The term of basketball shoes 'court feel' is frequently mentioned by basketball enthusiasts and sneaker bloggers. It is a comprehensive description of the interaction among wearers, basketball shoes, and courts, which might



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be a better evaluation factor than fit and comfort for basketball shoes. Yet it lacks a clear definition. This study aims to define court feel and identify its influencing factors through three Delphi rounds with 29 basketball experts. Ultimately, 88% (23/26) of the experts agreed that court feel refers to the subjective sensations of the wearer provided by the basketball shoes during basketball. Additionally, three main influencing factors were identified as traction, proprioception, and lateral stability. Establishing a clear definition and identifying these influencing factors of court feel might guide wearers in selecting suitable basketball shoes and assist footwear manufacturers in evaluating and designing basketball shoes.

Football

Circadian variation in coaches' decision-making in the National Football League's evening games. Chronobiology International: The Journal of Biological and Medical Rhythm Research, Ahead of Print: 1-8, 2024.

Abstract - The aim of this study was to explore whether National Football League (NFL) coaches show variation in their decision-making on fourth down when traveling through time zones. Data from visiting teams in games from 20 seasons (2000–2020) of the NFL were retrieved from online sources (n = 5360 games). Decision-making was measured with the percentage of offensive plays on fourth down. A factorial ANCOVA was done to verify whether travel direction had an impact on fourth downs in evening games, while controlling for the seasons. A moderation analysis was computed to verify whether the time of game moderates the relationship between longitudinal distance traveled and decisions on fourth downs. Results showed that in evening games, coaches in teams traveling westward called more offensive plays on fourth down, compared to when they traveled in any other direction. Results from the moderation analysis showed that only in evening games, further westward longitudinal degrees traveled predict more fourth downs. For the first time, this study offers insight that circadian misalignment may not only affect player performance but also influence coaching decisions in professional sports. These results beg the question whether other aspects of coaching or staff decisions show circadian variations in professional sports.



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Lower extremity injury rates on artificial turf versus natural grass surfaces in the National Football League during the 2021 and 2022 seasons. The Orthopaedic Journal of Sports Medicine, 12(8): 1-6, 2024.

Background: It has been argued that the use of artificial turf football fields in the National Football League (NFL) increases player injury risk compared with natural grass surfaces.

Purpose/hypothesis: The purpose of this study was to quantify the rate of lower extremity injuries occurring in NFL players on artificial turf compared with natural grass surfaces and characterize the time missed due to injury and proportion of injuries requiring surgery. It was hypothesized that lower extremity injuries requiring surgical intervention would occur at a higher rate on artificial turf than on natural grass.

Study design: Descriptive epidemiology study.

Methods: Lower extremity injury data for the 2021 and 2022 NFL seasons were obtained using publicly available records. Data collected included injury type, player position, player age, playing surface, weeks missed due to injury, and whether the patient underwent season-ending or minor surgery. Multivariable logistic regression was performed to determine the risk of season-ending surgery according to playing surface.

Results: When combining injuries for the 2021 and 2022 seasons (N = 718 injuries), the incidence rate of lower extremity injury was 1.22 injuries/game for natural grass and 1.42 injuries/game for artificial turf. The odds of a season-ending surgery were found to be significantly higher on artificial turf compared with natural grass (odds ratio = 1.60; 95% CI, 1.28-1.99; $P < .05$), while additional variables, including weather, age, position, week of injury occurrence, and history of prior injury, did not influence the odds of season-ending surgery.

Conclusion: The 2021 and 2022 NFL seasons of our analysis demonstrated a higher incidence rate of injuries on artificial turf surfaces compared with natural grass surfaces. In addition, the odds of injury requiring season-ending surgery were found to be significantly higher on artificial turf compared with natural grass.



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Observation of risk for concussion following 'lowering the helmet to initiate contact' penalties in the NFL. Journal of Orthopaedic Reports, 3: 100347, 2024.

Objective: This observational study examines the associated risk for concussion following 'lowering the helmet to initiate contact' penalties in the National Football League.

Methods: Using officially published injury data on the National Football League (NFL) website, the authors reviewed NFL Players diagnosed with a concussion from 2015 to 2022 and who received a 'lowering the helmet to initiate contact' penalty from 2018 to 2020. Reported concussions were evaluated for association with 'lowering the helmet to initiate contact' penalties. The Friedman test assessed overall differences between the years. Pairwise comparisons were performed using the Wilcoxon signed-rank test with a Bonferroni correction to adjust for multiple comparisons.

Results: The average incidence of all concussions per play was 0.45% for regular-season games. From 2018 to 2020, 86 lowering the helmet to initiate contact penalties were called. Three of 86 penalties resulted in concussions, with a 3.5% incidence. The Friedman test indicated significant differences in concussion trends across the years ($\chi^2 = 16.0$, $p = 0.0003$). Pairwise analysis with the Wilcoxon signed-rank test and adjusted for multiple comparisons with a Bonferroni correction ($\alpha = 0.05/28 = 0.0018$) showed no statistically significant differences between years. There was a significant negative correlation of overall concussion incidence per year.

Conclusions: The incidence of concussion with players penalized for lowering the helmet to initiate contact is greater than the overall incidence of concussions in all plays. While there is no difference in total concussions that occur, the concussion rate has a significant negative trend between 2015 and 2022. However, it is difficult to analyze the nonimmediate effects of this penalty on players' intended play and practice, which may further decrease concussions.

Position-specific differences in speed profiles among National Football League Scouting Combine participants. Journal of Strength and Conditioning Research, Ahead of Print: 1-8, 2024.

Abstract - This study examined the relationships between speed profiles and athletic performance measurements from the National Football League (NFL) Scouting Combine, and position-specific differences in speed profiles. Subjects included NFL Scouting Combines participants with valid scores for the 40-yard dash, as well as the 10- and 20-yard splits of the 40-yard dash ($n = 2,156$). Subjects were divided into the following position groups: defensive backs (DBs, $n = 421$),

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defensive linemen (DL, $n = 356$), linebackers (LBs, $n = 261$), offensive linemen (OL, $n = 354$), running backs (RBs, $n = 217$), tight ends (TEs, $n = 122$), quarterbacks (QBs, $n = 108$), and wide receivers (WRs, $n = 317$). Performance measures included 40-yard dash time (with 10- and 20-yard split times), bench press repetitions to failure, vertical jump height, broad jump distance, pro-agility time, and L-cone drill time. The 40-yard dash and its splits calculated v_{max} , τ , and a_{max} to reflect speed profiles. One-way analysis of variances examined position-related differences. Pearson's product moment correlation coefficients examined relationships between performance measures and speed profile variables. Skill positions (DB and WR) had the greatest v_{max} and a_{max} , and lowest τ , followed by big skill positions (LB, RB, TE, QB), followed by DL, then OL with the lowest v_{max} and a_{max} , and highest τ . For skill and big skill positions, v_{max} , τ , and a_{max} exhibited greater relationships with combine measures, whereas OL generally had the lowest relationships. The position-specific differences in this study demonstrate potential areas of strength and weakness for certain positions. This may help guide strength and conditioning coaches desiring to improve position-specific speed and acceleration capabilities for American football players.

Practical Applications - Although the goal of athletic performance combines is to assess the potential for on-field performance for a given sport, simply assessing the raw outcome variables may yield in complete information. Specifically, in American football, maximal speed and acceleration are vital requisite performance characteristics that ultimately aid on-field performance. Therefore, calculating v_{max} , t , and a_{max} from the 40 yd dash and associated splits may provide practical relevance for strength and conditioning coaches regarding sprinting and acceleration capabilities. Furthermore, the position-specific differences in this study demonstrate potential areas of strength and weakness for certain positions. Specifically, it appears that positions who are generally faster have greater acceleration profiles and achieve a higher percentage of their maximum velocity in a shorter amount of time. This may speak to the need of strength and conditioning coaches to prioritize training maximum speed, acceleration, or both depending on the results of the specific team.

Practice patterns and return to sports timing of National Football League head team physicians for ACL reconstruction. The Orthopaedic Journal of Sports Medicine, 12(10): 1-4, 2024.

Background: Previous surveys of the practice patterns for anterior cruciate ligament (ACL) reconstruction in collegiate and professional team physicians have shown bone–patellar tendon–bone (BPTB) autograft being the most common graft, with variable return-to-sports timing.



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Purpose: To evaluate the current practice patterns and return-to-sports timing of National Football League (NFL) head team physicians for ACL reconstruction.

Study Design: Cross-sectional study.

Method: All 32 NFL head team orthopaedic surgeons were surveyed and asked their primary ACL graft preference, revision ACL graft preference, use of lateral extra-articular tenodesis (LET) or anterolateral ligament reconstruction (ALL), use of suture brace augmentation, return-to-sport timing, and whether functional testing was utilized in determining readiness of return to play. The years of experience of the physician were also evaluated.

Results: All 32 head team physicians responded, with 31 (97%) using ipsilateral BPTB autograft in the primary setting and 1 using ipsilateral quadriceps autograft. In the revision setting, 24 (75%) physicians preferred a contralateral BPTB autograft, while 5 (16%) used an ipsilateral quadriceps autograft, 1 (3%) used a contralateral quadriceps autograft, and 2 (6%) used a BPTB allograft. One respondent (3%) used suture brace augmentation “most of the time” in the primary setting and always in the revision setting. No respondents utilized an ALL or LET in the primary setting and 2 (6%) respondents always performed an LET in revisions. Five others (16%) have performed at least 1 ALL or LET in an NFL athlete. Mean return to sports was at 9 months postoperatively, with no physicians allowing players to return before 7 months. All but 1 respondent used functional testing in return-to-sports decision-making.

Conclusion: All but 1 of the 32 NFL head team physicians used BPTB autograft in primary ACL reconstruction. The majority preferred contralateral BPTB autograft in revisions, with a few considering extra-articular procedures or suture bracing in addition. On average, head team physicians allowed players to return at 9 months postoperatively, with none allowing return before 7 months. Nearly all utilized functional testing to aid in return-to-play decision-making. These homogenous findings in this high-risk and public athletic cohort aid in patient education and clinical decision-making for best treatment of ACL injuries, particularly in contact athletes.

Gymnastics

A review of training approaches for floor gymnastics performance. BIO Web of Conferences, 217: 01008, 2026.

Abstract - This study is a systematic literature review aimed at evaluating ten evidence-based training approaches used to enhance floor gymnastics performance. The review includes ten verified scientific articles published between 2013 and 2025, covering core strength development, neuromuscular training, flexibility enhancement, rhythm coordination



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through music, nutritional strategies, and audiovisual learning tools. The findings indicate that multidimensional training approaches significantly improve technical, physical, and artistic aspects of floor routines. The review highlights the importance of structured, progressive, and evidence-based training to support athlete performance and safety.

Effects of instruction-guided attentional focus on jump performance in women's artistic gymnastics. European Journal of Sport Science, 26: e70112, 2026.

Abstract - Instructions are a common part of training in many sports. The content of the instructions and how they are formulated is relevant for the effect on performance. For motor learning and skill development, instructions that initiate an external focus of attention are predominantly described as beneficial in the literature. We assume that an instruction-guided attentional focus causes an effect on jump performance depending on whether the instruction matches the imagery type. Twenty-nine female participants ($M_{age} = 19.55 \pm 3.01$ years) with artistic gymnastics expertise ($M = 11.38 \pm 4.24$ years) completed an online questionnaire, the Vividness of Movement Imagery Questionnaire (VMIQ-2) and performed stretched jumps with a 450° longitudinal axis (LA) turn in a laboratory setting. Crucial gymnastic-specific performance criteria such as jump height, body position and landing details were recorded and analysed. ANOVA results indicate no significant differences in performance between three instruction groups. Results of linear mixed models analyses show differences between baseline performance and the instruction phases for five variables. There seems to be a disruptive effect on performance when attention is consciously directed. The effect of an instruction-guided attentional focus on performance appears to be independent of the imagery type.

Golf

Hex bar deadlift as a post activation performance enhancement warm-up strategy for golf club head speed. International Journal of Strength and Conditioning, 4(1): 1-7, 2025.

Abstract - Club head speed (CHS) is a key determinate of golf ball carry distance. Greater carry distance correlates with greater skill. The aim of the present study is to investigate the acute effects of using the hex - bar deadlift as a post activation potentiation enhancement for improving CHS in collegiate golfers. Sixteen ($n=8$ females, age: 19.5 ± 2 years, weight $68.66 \text{ kg} \pm 8.6 \text{ kg}$, height $168.4 \text{ cm} \pm 12.7 \text{ cm}$, $n=8$ males, age: 19.75 ± 2 years, weight $70.0 \text{ kg} \pm 9.5 \text{ kg}$, height $178.1 \text{ cm} \pm 12.7 \text{ cm}$) division 2 collegiate golfers participated in this randomized crossover study during the off-season. The study was divided into 3 sessions on 3 separate days. Players reported to the training facility and completed a one-



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repetition maximum (1RM) hex- bar deadlift on day one. Sessions 2 and 3 included two CHS assessments, one with the PAPE protocol and one without. Each session was 5-7 days apart. One CHS test was preceded by a standardized warm-up, while the other was preceded by the same standardized warm-up with the inclusion of the hex - bar deadlift PAPE strategy (3 reps at 60%, 3 reps at 70%, and 3 reps at 85% of 1RM). A paired two-sided t-test revealed an increase in CHS with the PAPE strategy resulting in a mean difference in CHS of +0.8325 mph ($p = 0.02447$, $d = 0.625$). In conclusion, the hex- bar deadlift was shown to provide enough stimulus to elicit a PAPE effect and increase CHS in collegiate golfers.

Ground reaction force and centre of pressure during the golf swing and associations with clubhead speed and skill level: A systematic review. Sports Medicine, Ahead of Print: 1-22, 2026.

Background: Optimising performance with a driver, fairway woods and long irons is a key focus for many golfers, with the primary goal of hitting the ball as far as possible while maintaining the ball in play. As such, recent years have seen a strong focus in the golf literature on how to maximise performance off the tee by investigating the factors that lead to the increase in clubhead speed (CHS). These factors include: (i) effective use of ground reaction force (GRF) during the swing and (ii) the path followed by the centre of pressure (CoP).

Objectives: The primary purpose of this systematic review was to investigate GRF and CoP within golf research and to identify what associations they have with CHS and skill level.

Methods: This systematic review followed the most recent Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. In total, 129 studies were initially retrieved from SPORTDiscus, Medline and CINAHL databases, with studies meeting the inclusion criteria being subject to Newcastle-Ottawa's quality assessment criteria (with a maximum score of 9 being possible).

Results: A total of 24 studies met the inclusion criteria for this review. Nine empirical investigations showed moderate-to-strong relationships between either: (i) CoP and CHS or (ii) GRF and CHS. In addition, more skilled golfers tended to exhibit higher GRF and superior CHS than less skilled golfers. From a quality assessment standpoint, all 24 studies scored either a 7 or 8.



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Conclusions: Changes in both CoP and GRF represent important factors which contribute to superior golf performance, as defined by increases in CHS or reduced handicaps. Clearly defined methods for assessing force during the golf swing and universal terminology regarding GRF and CoP metrics are recommended for further research.

Hockey

Did the implementation of a bye week decrease injury rates in the National Hockey League?
The Orthopaedic Journal of Sports Medicine, 14(2): 1-5, 2026.

Background: In the 2016-2017 National Hockey League (NHL) season, a bye week was introduced to give players rest in the middle of the season. Bye weeks and midseason breaks are a common practice in other sports such as football and soccer.

Purpose: To compare the rates of different types of injuries, games missed due to injury, and number of multiple injuries by players between previous uninterrupted seasons and the succeeding seasons with bye weeks scheduled.

Study design: Descriptive epidemiology study.

Methods: This study retrospectively looked at NHL injuries from 2000 to 2023. Injured players were identified from publicly available online databases: tsn.ca, cbssports.com, and sportsforecaster.com. Detailed information regarding the number and characteristics of the injuries was categorized according to different types of injuries for each season. Injury rates were compared before and after bye weeks were introduced. To evaluate the effect of bye weeks on injuries, multivariate regression models were used adjusting for position.

Results: There was a significant difference in overall injury rates per season before and after the implementation of a bye week, from 763.7 to 646.7 injuries ($P = .005$). Among all players, defensemen saw a significant decrease in proportion of injuries after a bye week was introduced ($P < .001$). After adjusting for position, there were significantly decreased odds of muscle injuries (OR, 0.26; 95% CI, 0.22-0.29; $P < .001$), knee injuries (OR, 0.41; 95% CI, 0.35-0.48; $P < .001$), and arm and shoulder injuries (OR, 0.39; 95% CI, 0.33-0.46; $P < .001$) sustained by players after the implementation of a bye week. These injuries resulted in a mean of 9.02 games missed before bye week implementation and 10.53 after ($P < .001$).

Conclusion: This study showed that the introduction of a bye week in the NHL was associated with lower overall injury rates and reductions in several injury types, indicating a potential relationship between scheduled breaks and observed injury patterns.



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Travel-induced circadian shift between teams influences penalties in the National Hockey League. Chronobiology International, Ahead of Print: 1-6, 2026.

Abstract - There is a growing recognition of the impact of circadian rhythms on athletic performance, when teams crossing multiple time zones play at a different circadian alignment than their opponents. This study aimed to examine the association between circadian differences between NHL teams and increased penalty behavior. Data from NHL games played between 2009 and 2021 ($n = 27,642$) were analysed. A travel-adjusted time zone was computed for both teams, from which a Difference in alignment between teams was calculated: Ahead, same as, and behind opponent. A one-way ANOVA was done with the Difference in alignment on the number and minutes of penalties and results were significant for both variables. Post-hoc analyses revealed that teams behind received significantly fewer penalties ($p < 0.001$) than teams ahead or in the same time zone as their opponents ($p < 0.001$) and had fewer penalty minutes than teams who were in the same time zone as their opponent ($p = 0.002$). These results suggest that teams playing at a later point in their circadian cycle than their opponents were given more penalties, which highlights the importance of professional organisations understanding the potential influence of circadian rhythms and travel on behavior and performance outcomes during games.

Lacrosse/Field Hockey

Comparison of Sprint Deceleration Capacity in Front- and Side-Facing End Stances in Multidirectional Team Sport Athletes. European Journal of Sport Science, 26: e70143, 2026.

Abstract - Deceleration is a crucial task in multidirectional team sports. However, no research has explored how different end stances impact deceleration performance. This is important due to the multidirectional nature and variance of these directional changes in such sports. This study aimed to compare sprint deceleration capacity between front-facing (FF) and side-facing (SF) end stances using a deceleration threshold methodology to standardize the start point of deceleration. 20 team-sport athletes completed three maximal sprint deceleration trials in three conditions: FF and SF with both preferred leg stance (SF_{PREF}) and nonpreferred leg stance (SF_{NON-PREF}). Key metrics of time-to-stop (TTS), distance-to-stop (DTS), average deceleration (DEC_{ave}), and maximum deceleration (DEC_{max}) were analyzed using linear mixed models. Results indicated significantly different deceleration profiles between FF and SF conditions with FF decelerations exhibiting greater TTS and DTS but lower DEC_{ave} and DEC_{max} compared to SF tasks ($p < 0.05$). No significant differences were determined between SF_{PREF} and SF_{NON-PREF} task conditions ($p = 0.64-1.00$). Correlation analysis demonstrated high similarity in DTS across tasks ($r = 0.87-0.92$) but greater divergence in TTS and DEC_{ave} ($r = 0.55-0.88$).



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These findings suggest that deceleration mechanics are task dependent with SF tasks eliciting greater braking demands. Practitioners should consider sport-specific deceleration requirements when designing training interventions.

Concussion recovery time, return to play protocols, and mandated sit-out periods among adult amateur contact field sports: A systematic review. Irish Journal of Medical Science, Ahead of Print: 1-13, 2026.

Background: Field-based contact sports, including American football and rugby are among those with the highest sport-related concussion (SRC) rates. Regarding SRC treatment, gradual return-to-play (RTP) protocols are commonly used, however variability in RTP protocols between sporting bodies and scholastic institutions makes accurately interpreting published SRC severity data difficult.

Aims: Compare SRC recovery times, RTP protocols, and mandated sit-out period duration among adult amateur contact field sports.

Methods: MEDLINE, CINAHL Complete, SPORTDiscus, APA PsycInfo, and APA PsycArticles were searched on May 13th, 2024. Eligibility criteria included (1) published in English in a peer-reviewed journal from 2015 to 2024, (2) adult population, (3) amateur, field-based contact sport athlete population, (4) diagnosed and/or suspected SRC, and (5) recovery time (days/weeks) data available.

Results: 19/6085 (< 1%) studies comprising 58 datasets met all inclusion criteria. The studies comprised American football (10/19, 52.6%), field-hockey (5/19, 26.3%), lacrosse (9/19, 47.4%), ladies gaelic football (1/19, 5.3%), rugby (8/19, 42.1%), soccer (10/19, 52.6%), and sprint football (1/19, 5.2%). Mandated sit-out periods ranged from 0 to 21 days across sports, and RTP protocol durations ranged from 5 to 21 days. The most common RTP protocol duration was 7 days (n = 31/58), and mandated sit-out period was no same-day return (n = 25/58). Field hockey had the longest reported SRC recovery duration (34 days), and rugby had the longest mandated sit-out period (21 days).

Conclusion: Recovery time following concussion in contact sports should be interpreted in light of sport type, mandated sit-out policies, and RTP protocols. Empirical evidence should drive decisions in RTP protocols and sit-out periods, which are currently inconsistent between sports.



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Soccer

Subjective monitoring in under-20 soccer athletes: Affective, load, monotony, and sleep variations throughout a competitive cycle. Clinical Practice & Epidemiology in Mental Health: 21: 1-12, 2025.

Introduction: The physical and mental demands of competitive soccer, combined with a high density of matches and training sessions, impose substantial psychophysiological stress on athletes. In this context, subjective variables, such as affective responses, perceived exertion, and sleep, emerge as important indicators, offering additional insights into players' readiness and recovery. However, few studies have examined these variables in an integrated manner over extended periods of preparation and competition.

Objective: This study aimed to investigate the effects of soccer training sessions and matches on affective responses (valence and arousal), perceived exertion, and sleep duration in under-20 soccer athletes. Additionally, the objective of this study was to assess correlations between affective responses and traditional internal load variables (RPE), monotony, strain, and self-reported sleep duration.

Methods: This observational study was conducted with 21 under-20 athletes from a Brazilian elite soccer team over 11 weeks encompassing training sessions, friendly matches, and official competition. Affective responses were assessed before and 30 minutes after each session using the Feeling Scale (FS) and the Felt Arousal Scale (FAS). Perceived exertion (RPE), sleep duration, monotony, and strain were recorded daily. Two-way ANOVA was applied for FS and FAS, while one-way ANOVA was used for weekly training load, sleep, monotony, and strain. Mann-Whitney tests (match vs. training) were also performed. Pearson's correlation coefficients were calculated between variables. The significance level was set at $p < 0.05$.

Results: There were significant main effects of week and moment (pre/post) for both FS and FAS, with a notable decrease in affective responses after sessions ($p < 0.0001$). Sleep duration progressively increased from the seventh week onward ($p < 0.05$), whereas training load, monotony, and strain fluctuated across the weeks, with significant declines toward the end of the cycle. Significant differences between matches and training sessions were found for training load ($p = 0.0333$) and sleep duration ($p < 0.0001$), but not for affective scales. On an individual level, 71% of athletes showed a reduction in affective responses post-session. Correlations between affective and the other variables were trivial to small (ranging from $r = 0.11$ to $r = 0.24$), with slightly more consistent associations for sleep and RPE.



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Conclusion: There was a significant reduction in FS over the weeks. Fluctuations in FS were observed across weeks in line with accumulated load and competition demands. Seventy-one percent of athletes showed a decrease in FS post-activity. The monotony and strain showed a declining trend over the competitive cycle, particularly in the latter weeks, indicating a reduction in training variability and cumulative load. These reductions coincided with an increase in self-reported sleep duration, suggesting a favorable shift in the balance between training stress and recovery. Finally, FS displayed weak correlations with perceived exertion, monotony, strain, and sleep duration.

Return to high-speed running after a hamstring injury in soccer: A scoping review about criteria and management of on-field rehabilitation. Strength and Conditioning Journal: Ahead of Print: 1-10, 2026.

Abstract - The importance of criteria for rehabilitation progression in hamstring injuries is well-known, particularly regarding the return to high-speed running (HSR). No previous reviews have compiled the existing evidence on HSR progression criteria or the protocols used to manage the on-field exposure in soccer players. The aims of this review are to summarize the available literature on criteria for progressing to HSR exposure and synthesize the available literature regarding the management of on-field HSR exposure during hamstring injury rehabilitation in soccer. The following electronic databases were searched until December 2024: PubMed, Web of science, Scopus, and SPORTDiscus. All types of studies in English describing the criteria for assessing return to HSR and how to manage the exposure to HSR during an on-field rehabilitation progression were included. Eight studies met the inclusion criteria. Practitioners should consider the absence of pain, hamstring strength, and imaging when determining a player's readiness for return to HSR. On-field rehabilitation is an essential part of the return to play process, and practitioners should carefully plan the progression of running load, the difficulty of the proposed drills, the movement skills, and the soccer-specific actions.

Energy requirements of injured soccer players: A doubly labelled water case series from the English Premier League. Performance Nutrition, 2:2, 2026.

Abstract - Accurate estimation of energy requirements is essential for optimising nutritional strategies during injury rehabilitation in professional soccer. This case series examined total daily energy expenditure (TDEE) via doubly labelled water (DLW), energy intake (EI), and body composition across two rehabilitation phases in English Premier League (EPL)



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players. Case Study 1 (22 years-old, 193 cm, 93.7 kg) involved early-stage hamstring rehabilitation, while Case Study 2 (21 years-old, 186 cm, 88.7 kg) captured the transition from partial (PWB) to full weightbearing (FWB) during rectus femoris rehabilitation. EI was measured via remote food photography method and 24-hour recalls on two non-consecutive days per case. Body composition was measured via dual-energy X-ray absorptiometry in Case Study 1 at baseline and Day 14. In Case Study 1, TDEE increased by 1013 kcal·day⁻¹ (Week 1: 3143 kcal·day⁻¹ ; Week 2: 4156 kcal·day⁻¹), accompanied with an increased DLW-estimated EI (Week 1: 2911 kcal·day⁻¹ ; Week 2: 4343 kcal·day⁻¹). Body mass (BM) remained stable (+0.10 kg), but fat-free soft-tissue mass (FFSTM) decreased (-0.50 kg), primarily in the trunk and non-injured leg, while FFSTM in the injured leg was preserved (+0.07 kg). In Case Study 2, TDEE increased by 538 kcal·day⁻¹ (PWB :3175 kcal·day⁻¹ ; FWB: 3713 kcal·day⁻¹) but remained below pre-injury levels (4546 kcal·day⁻¹). BM reduced in both PWB (-0.3 kg) and FWB phases (-1.2 kg). DLW-estimated EI indicated energy deficits in both phases (PWB: 139 kcal·day⁻¹ ; FWB: 557 kcal·day⁻¹). These findings highlight that energy requirements of EPL players fluctuate across rehabilitation phases, emphasising the importance of individualised nutritional support during rehabilitation.

Contextual factors and running demands in elite female soccer: A comparison between starters and non-starters. Research Quarterly for Exercise and Sport, Ahead of Print: 1-14, 2025.

Abstract - This study examined how contextual factors influence match-running performance in elite women's soccer, with a focus on differences between starters (i.e. players who began the match) and nonstarters (i.e. players who entered the match as substitutes and played for at least 5 minutes). A total of 95 women's players from four teams competing in the Brazilian Women's First Division were monitored across 60 matches using 10-Hz GPS devices. Running performance was analyzed in both absolute and relative terms (m·min⁻¹) across five speed zones, PlayerLoad, accelerations, and decelerations metrics. The contextual variables examined included opponent level, match location, number of days between matches, and the momentary point-difference. Starters covered greater absolute distances, while nonstarters exhibited higher relative demands in moderate- to high intensity zones and accelerations. Starters displayed higher relative distances in low intensity running. As part of the positional comparison, midfielders covered the greatest total distance, while external defenders and forwards performed more high-intensity actions. Central defenders had the lowest physical demands across all metrics. Nonstarters showed greater sprinting distances in matches against stronger opponents when playing at home. The momentary point-difference also influenced physical performance, with more balanced matches associated with reduced running outputs across positions and roles. Additionally, greater running outputs were observed in matches with ≤4 days of recovery, especially in low-to-moderate



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intensity zones. Performance staff should adopt role-specific and context-approach training strategies, considering starter status and match contextual demands to prescribe compensatory training loads in elite women's soccer.

Softball

Influence of humeral retrotorsion on glenohumeral range of motion in health collegiate softball players. International Journal of Sports Physical Therapy, 21(2): 124-134, 2026.

Background: Anatomic humeral retrotorsion (aHRT) influences objective measures of glenohumeral external (GER) and internal rotation (GIR) range of motion (ROM) in baseball players. Baseball players often display GER deficits within the context of aHRT; however, this has yet to be studied in a softball population. Hypothesis/Purpose: 1) To determine if there are differences in GER ROM, GIR ROM, total range of motion (TROM), aHRT, relative humeral retrotorsion (rHRT), and HRT-corrected motion between collegiate softball position players and pitchers, 2) to determine if differences exist between GER and HRT-corrected GER and GIR and HRT-corrected GIR in collegiate softball players, regardless of position.

Study design: Retrospective Descriptive Study.

Methods: Sixty-three healthy Division I softball players participated. Objective measures of GER, GIR, and aHRT on the throwing arm and non-throwing were collected using a digital inclinometer at various timepoints during the 2023-2024 seasons. TROM, rHRT, and HRT-corrected motions were calculated from objective measurements on the throwing arm and non-throwing arm. Independent *t*-tests were used to determine differences in objective ROM and HRT measures between position. Paired *t*-tests were used to determine differences between objective ROM and HRT-corrected ROM in both the pitching and position player cohorts. Effect sizes were calculated.

Results: There were no significant differences in GER, GIR, TROM, aHRT, rHRT, HRT-corrected GER, and HRT-corrected GIR by player position ($p > 0.05$). Effect sizes ranged from -0.27-0.57. There were differences in position players between GER ($5 \pm 8^\circ$) and HRT-corrected GER ($-11 \pm 14^\circ$) ($p < 0.001$) and GIR ($-10 \pm 10^\circ$) and HRT-corrected GIR ($6 \pm 12^\circ$) ($p < 0.001$). There were differences in pitchers between GER ($1 \pm 8^\circ$) and HRT-corrected GER ($-11 \pm 11^\circ$) ($p < 0.001$) and GIR ($-7 \pm 9^\circ$) and HRT-corrected GIR ($5 \pm 10^\circ$) ($p < 0.001$).

Conclusion: When glenohumeral ROM is interpreted within the context of rHRT, GIR deficits are not common in softball players. Based on the current findings, it is imperative that rHRT be assessed in all softball players as this information will aid in the identification of true motion restrictions.



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Level of evidence: 3.

Prevalence of hamstring injuries in collegiate softball players and comparison to collegiate baseball players. International Journal of Sports Physical Therapy, 21(1): 66-78, 2026.

Background: Hamstring strain injuries (HSIs) are common among collegiate athletes resulting in meaningful time lost from play and high rates of recurrence. There is a paucity of literature regarding the prevalence and characteristics of HSIs in both softball and baseball athletes, with notable underrepresentation of the female athlete.

Hypothesis/purpose: To determine the Hamstring Outcome Score (HaOS) scores, and the self-reported prevalence, recurrence, and time lost from play due to HSI in collegiate softball athletes and to compare these findings to previously collected data on baseball players. Based on the overall similarity of the sports, the null hypothesis was that there would be no difference in scores between the groups.

Design: Cross-Sectional Observational Study.

Method: Prior to the beginning of the 2021-2024 collegiate softball seasons, 16 different colleges or universities were approached asking permission to have their players complete a questionnaire regarding their self-reported history of hamstring injury and/or posterior thigh pain. The questionnaire and rationale for the study were presented to athletes from each team by study personnel or certified athletic trainers associated with teams at initial pre-season team meetings. Players used their cell phone and completed the questionnaire using a digitized, validated HaOS assessing history, prevalence, recurrence, time lost from play and functional impact of hamstring injury (HSI) and posterior thigh pain. Participation was voluntary and no players were excluded from the study unless they chose not to complete the questionnaire. A mixed effects linear regression model was fit to examine differences in HaOS between injured and uninjured athletes. Additionally, prior published data on baseball players collected using the same survey was used for comparing HSI and HaOS scores between sports and positions.

Results: Responses were received from 12 of the 16 teams initially asked to participate in this study. Of the 264 softball athletes associated with these 12 teams, 156 softball athletes (mean age 19.5 +/- 2.1 years) chose to participate in this self-reported survey study by agreeing to complete the survey (59% completion rate). Of the 156 athletes who responded, 100 (64%) were from Division I programs and 56 (36%) were from Division III programs. HaOS scores were significantly different in all areas and total score between injured and non-injured softball athletes ($p < 0.001$ to 0.039) with the exception of "soreness" ($p = 0.092$). Forty-seven softball athletes (30.1%) reported a history of HSI. Of those

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softball players who reported HSI, 82% returned to play in less than seven days. By position, 44% of all catchers reported a history of HSI, while HSI reported by other position players ranged from 26-30%. Fifteen players (32%) reported recurrent and/or bilateral injuries. Self-reported HSI was higher in softball athletes (30.1%) than in baseball athletes (22.4%), though the difference did not reach statistical significance ($p=0.097$). However, when comparing athletes by position, a significant difference between the sports was observed in pitchers, with 27% of softball pitchers reporting HSI compared to 12% of baseball pitchers ($p=0.041$). Among softball players, only 18% missed greater than one week of sports participation versus 47% of baseball players ($p=0.009$). Recurrence rates were not significantly different between the two groups of athletes ($p=0.753$). Softball players reported significantly worse overall hamstring health and function compared to baseball players, whether injured or not, based upon the five domains and total scores of the HaOS ($p < 0.001$ to 0.033), with the exception of "soreness" between injured and non-injured players ($p=0.172$).

Conclusion: Softball pitchers self-report significantly more hamstring injuries than baseball pitchers while there was no significant difference reported between other positions. The HaOS demonstrated that collegiate softball players reported significantly poorer overall hamstring health, function and hamstring confidence than baseball players. Despite this, softball athletes lost less time from practice and competition after injury than their baseball counterparts.

Level of evidence: 3.

Swimming

Higher lactate for better performance? A longitudinal case study of a highly trained female swimmer. International Journal of Sports Physiology and Performance, Ahead of Print: 1-3, 2026.

Purpose: To longitudinally investigate the relationship of blood lactate concentration (BLC) and performance in the 50- and 100-m backstroke swimming events of a highly trained female swimmer.

Methods: We gathered BLC and performance data from 18 50-m and 24 100-m backstroke races of a highly trained national-level female swimmer over 6 years (age 14-20). We measured BLC with a portable analyzer and calculated swimming speed from the official results. We checked the data distribution with the Shapiro-Wilk test and performed Pearson correlation analysis, followed by partial correlation analysis. We used Student t test for independent observations to compare BLC between the 2 events. Statistical significance was declared at $P < .05$.



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Results: The BLC was 15.5 (2.7) mmol·L⁻¹ (mean [SD] throughout) after the 50-m races and 16.5 (1.8) mmol·L⁻¹ after the 100-m races. No significant difference was found in BLC between the 2 events ($P = .127$). We found a significant correlation between BLC and swimming speed at both 50 m ($P = .018$, $r = .548$) and 100 m ($P = .012$, $r = .503$), as well as between age and speed at 50 m ($P = .001$, $r = .721$) and between age and BLC at 100 m ($P = .039$, $r = .424$). When controlling for age, BLC and speed correlated significantly at 100 m ($P = .034$, $r = .444$) but not at 50 m ($P = .113$, $r = .399$).

Discussion: High BLC favored the performance of the highly trained female swimmer, especially in the 100-m event. Thus, training to promote anaerobic metabolism may enhance performance in short-distance swimming races, whereas the BLC may partly explain performance in such events.

Relationship between anaerobic power and start performance parameters in adolescent swimmers. BMC Sports Science, Medicine and Rehabilitation, Ahead of Print: 1-20, 2026.

Background: Start performance is a critical determinant of success in competitive swimming. This study investigated the relationships between anaerobic power (AP), vertical jump height (VJ), and flight distance (FD) in adolescent swimmers.

Methods: Fifty-four Tier 2 adolescent swimmers (32 males, 22 females; age: 13.57 ± 1.31 years) participated in the study. Anaerobic power was calculated using the Lewis formula, and FD was measured via video analysis with Kinovea software. Statistical analyses included independent samples t-tests, Pearson correlations, and multiple regression models to identify performance predictors.

Results: Significant gender differences were observed in body height, weight, VJ, FD, and AP (all $p < 0.05$), with males outperforming females, while training experience was similar. FD showed a significant positive correlation with AP ($r = 0.51$, $p < 0.001$), representing a moderate effect size. Multiple regression analysis further revealed that Age ($\beta = 0.65$, $p < 0.001$) and Gender ($\beta = 0.32$, $p = 0.003$) were the primary predictors of FD, while AP did not emerge as an independent predictor in the final model.

Conclusion: Although anaerobic power is associated with start performance, age and gender are the strongest predictors of flight distance in adolescent swimmers. These findings add to previous research by highlighting the importance of maturational and technical development for optimizing start efficiency during early specialization.



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Tennis

The effects of a strategic instructional self-talk intervention on performance in a complex tennis rally. Behavioral Sciences, 16: 87, 2026.

Abstract - The purpose of the present study was to examine the effects of a strategic self-talk intervention on a complex tennis performance test through the use of a narrow internal instructional self-talk plan. Fifty young beginner tennis players from two tennis academies were assigned into intervention and control groups. A pre/post quasi-experimental design was implemented, including baseline assessment, training intervention, and final assessment. The intervention lasted five weeks, during which all participants underwent the same training, with the experimental group using strategic self-talk. Repeated measures MANOVA revealed a significant time by group interaction for all tennis strokes; pairwise comparisons showed that the all strokes performance of the self-talk group improved from initial to final assessment and was better than the performance of the control group at final assessment. In addition, repeated measures ANOVA examining the overall performance of the rally showed that the intervention group achieved higher total rally scores than the control group. The effectiveness of the intervention in this multi-stroke task suggests that strategic self-talk facilitated movement sequences, possibly through an efficient shifting of attention. Accordingly, practitioners are encouraged to explore the potential of strategic self-talk for tasks requiring such attentional demands.

Analyzing tie-break performance of different types of male and female tennis players in Grand Slam matches. International Journal of Performance Analysis in Sport, Ahead of Print: 1-25, 2026.

Abstract - In professional tennis, tiebreaks are critical, high-stakes situations where technical and tactical factors determine point outcomes. However, the interaction between player archetypes and Score context in Grand Slam events remains underexplored, hindering the development of personalised strategies and performance optimisation. This study by classifying 6458 male and 2236 female players two-step clustering, incorporating height, weight, age, ranking, professional experience, handedness, and backhand style. Retrospective analysis examined 4347 tiebreaks (51,665 points) from 2011–2024, utilising Hawk-Eye/radar data on serve/return performance, rally structures, net approaches, and winner/error ratios; methods included Pearson chi-square tests with Cramér's V and CHAID decision trees for point-winning probabilities. Score context proved the primary predictor in men ($V = 0.454$, $p < 0.001$), followed



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by server identity and net play, with probabilities ranging from approximately 11% to over 90% across player types, scorelines, and roles. Power-oriented male player types (Big-sized Balanced; Tall-Heavy) had higher first-serve speeds but were more vulnerable to agile baseliners under net pressure. Female Big-sized Balanced players performed best when serving with a lead, while baseline-oriented types were more consistent but less successful when trailing. Left-handed specialists showed no consistent advantage ($V < 0.10$). These findings provide support coaches with data-driven tools for targeted preparation and tactical adjustments, enhancing competitive outcomes in tennis.

Volleyball

Field-based tests for assessing motor abilities in young volleyball players: Normative values and age group differences. BMC Sports Science, Medicine, and Rehabilitation, Ahead of Print: 1-36, 2026.

Abstract - The aim of this cross-sectional study was to establish age and sex-specific normative values for strength, power, agility and flexibility assessed by field-based tests in young volleyball players aged 10–18 years who were actively training and competing in volleyball, and to examine differences across age groups. The sample consisted of 3,337 boys and girls aged 10 to 18 years. All participants were actively involved in volleyball. The following field-based tests were applied: Standing Long Jump (SLJ), Standing Medicine Overhead Throw (SMOT), Modified X Test (X test), Sit and Reach (SR), and Shoulder Stick Test (SST). To establish normative values for field-based tests assessing motor abilities in young volleyball players and to determine age group differences, basic descriptive statistics (Mean, SD), along with one-way MANOVA and ANOVA, were used. Significant differences were observed across all implemented motor ability tests in both males and females (ANOVA: $F = 106.9$, $p < 0.001$, $\eta^2 = 0.353$, on average), except for the SST test in females. Overall, performance in strength, power, and agility tests improved with increasing age, whereas flexibility showed smaller or more stable age-related changes, particularly in girls. These results reflect the interplay between biological maturation, volleyball-specific demands and training exposure. The normative data provided may offer useful reference values for contextualizing physical development in youth volleyball within long-term athlete development frameworks.



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The association between spike technique and injuries in competitive volleyball players - A pilot study. *Frontiers in Sports and Active Living*, 8: 1737436, 2026.

Background: Different spike techniques in volleyball may vary in performance and shoulder loading, potentially influencing injury risk. However, no previous study has systematically examined the association between spike technique and shoulder injuries in competitive volleyball players.

Methods: An online questionnaire was distributed via coaches to competitive volleyball players from Austria, Brazil, Germany, Greece, Portugal, and the USA between December 2024 and February 2025. The survey collected demographic data, spike technique (bow & arrow or circular), self-reported shoulder injuries or symptoms, and related treatments. Coaches classified players' spike techniques based on provided descriptions. Group differences were analyzed using Chi-square tests ($p < 0.05$).

Results: A total of 175 players (90 females, 85 males; mean age 24.3 ± 9.4 years) participated in the study. The bow & arrow technique was most common (71.4%), followed by circular (25.7%). Overall, 32% of the players reported shoulder injuries and 44.7% reported shoulder symptoms. No significant differences in injury or symptom frequency were found between techniques, either overall or within genders ($p > 0.05$). In females, the circular technique showed lower injury (18.2% vs. 31.2%) and symptom (36.4% vs. 51.6%) rates descriptively compared to bow & arrow, but without statistical significance. Males showed very similar rates for the techniques (injury: 39.1% vs. 34.4%; symptoms: 39.1% vs. 42.6%).

Conclusion: The present data do not demonstrate a clear advantage of either spike technique with respect to shoulder injuries or symptoms. Gender-specific trends towards a greater injury risk for women using bow & arrow technique warrant further investigations. Future studies should increase sample size, include a broader range of competitive levels, and also integrate objective biomechanical and medical assessments.

Wrestling/Combat Sports

The effect of sodium bicarbonate supplementation on wrestling specific performance and fatigue markers. *The Online Journal of Recreation and Sports*, 15(1): 1-7, 2026.

Abstract - The aim of this study was to evaluate the effects of a five-day sodium bicarbonate supplementation regimen on wrestling-specific anaerobic performance and fatigue markers. Fifteen male wrestlers, aged between the mean age of 18.53 ± 0.74 , and all actively engaged in wrestling, participated in the study. Wrestlers received sodium bicarbonate supplementation at a dose of 0.3 g.kg⁻¹ for five consecutive days. Performance was assessed before and after



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supplementation using a wrestling-specific suplex throw test. Additionally, lactate and blood gas parameters were analyzed from fingertips and intravenous blood samples. Lactate levels significantly increased post-exercise; however, no significant difference was found between pre- and post-supplementation levels ($p>0.05$). On the other hand, dummy throw performance significantly improved ($p<0.05$). Blood gas analysis revealed statistically significant changes in pH, $p\text{CO}_2$, HCO_3^- , sO_2 , and FO_2Hb parameters. These findings suggest that the supplementation contributed to performance enhancement by inducing a state of metabolic alkalosis. This study demonstrated that five days of sodium bicarbonate supplementation may enhance performance in sports like wrestling, which involve short-duration, high-intensity efforts. Although no significant changes in lactate levels were observed, the performance improvement is thought to result from the buffering of hydrogen ions and the maintenance of acid-base balance.

Effects of rapid weight loss on the immune system in combat sports athletes: A systematic review. International Journal of Molecular Sciences, 27: 508, 2026.

Abstract - Rapid weight loss (RWL) is a common strategy among combat sports athletes aiming for a competitive advantage. However, it imposes significant immunological stress that compromises both innate and adaptive immune defenses. This systematic review synthesizes current experimental and mechanistic evidence on the effects of RWL in combat sports, focusing on cellular immunity, neuroendocrine regulation, and inflammatory pathways. Acute RWL activates the hypothalamic–pituitary–adrenal axis, elevating plasma cortisol and suppressing lymphocyte proliferation, T-cell function, and natural killer cell cytotoxicity. Although neutrophil counts increase, their phagocytic and oxidative burst capacities decline, reflecting impaired host defense. Monocyte and macrophage systems shift toward proinflammatory phenotypes, while mucosal immunity is weakened by reductions in secretory immunoglobulin A, leading to increased upper respiratory tract infection risk. The magnitude and speed of weight loss are critical determinants of immune dysfunction, with reductions exceeding 5% of body mass producing particularly severe consequences. Evidence-based intervention strategies—including gradual weight management, nutritional optimization, and biomarker monitoring—are essential to mitigate immunosuppression and safeguard athlete health. This review highlights key gaps in combat sports-specific protocols and proposes integrated approaches to preserve immune competence and optimize performance.

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**COMPLIANCE WITH INTERASSOCIATION RECOMMENDATIONS
FOR STRENGTH AND CONDITIONING PROFESSIONALS**

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