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Using Interpretable Machine Learning to Predict Injury Risk Among Collegiate Male Basketball Players

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PURPOSE: Current predictive methodologies for injury risk are inadequate for the individualized management of athletes. This study introduces a machine learning (ML) framework tailored to evaluate injury risk among Chinese University Basketball Association (CUBA) participants.
METHOD: We conducted a longitudinal analysis of 681 CUBA athletes (average age: 19.75 ± 1.78 years) over three basketball seasons. Academy coaches and medical personnel undertook continuous surveillance of player exposure and injuries. We documented anthropometric measurements and physical tests assessing motor coordination and physical fitness attributes. Five ensemble learning algorithms including Random Forest (RF), Light Gradient Boosting Machine (LightGBM), categorical boosting (Catboost), Gradient Boosting Decision Tree (GBDT), and Extreme Gradient Boosting (XGBoost) were used to forecast and categorize injury risk based on its optimal performance.
RESULTS: The study identified that the XGBoost model provided the highest accuracy (0.7668). It showed the largest AUC value in the 10-fold cross-validation (0.8393; 95% CI: 0.8273-0.8512) and the smallest Brier score (0.1643; 95% CI: 0.1585-0.1700). Notably, SHAP value analysis revealed that sex, match location, sprint 30 m, age at PHV, and CMJ were significant predictors of evaluating the injury risk.
CONCLUSION: The ensemble learning model, particularly the XGBoost algorithm, demonstrates a robust capacity for predicting and classifying injuries in basketball players. These findings suggest that integrating ML models into athletic health management can significantly enhance injury surveillance and prevention strategies. The model's reliance on physical performance as predictors underscores the multifaceted nature of sports-related injuries.
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Comparing A Novel Smartphone Application To The Kinect V2 For Assessing ACL Injury Risk

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Screening for athletes at high risk for anterior cruciate ligament (ACL) tear who may optimally benefit from risk reduction programs remains a challenge. Initial coronal (IC), peak coronal (PC), and peak sagittal (PS) angles of a drop vertical jump (DVJ) measured by the Kinect v2 device (Microsoft) have been associated with ACL tear risk in collegiate varsity athletes. Development of a similar modality utilizing a smartphone application would improve simplicity, cost, and accessibility, allowing for widespread screening.
PURPOSE: To compare the DVJ tracking performance of a novel smartphone application to the previously validated Kinect v2 device.
METHODS: Two hundred fifty-two collegiate varsity athletes performed three DVJs that were recorded simultaneously with a novel smartphone application developed using the Google Mediapipe framework version 0.7 (Pixel 6; Google) and the Kinect v2. Agreement on IC, PC, and PS angles between the two devices was compared using intraclass correlation coefficient (ICC) tests (two-way mixed-effects model, consistency, single measures). High-risk athletes were identified based on published angle cutoffs for Kinect v2 measurements. Receiver operating characteristic (ROC) analysis was used to assess the accuracy of the smartphone application in identifying the same high-risk athletes.
RESULTS: ICC values for IC, PC, and PS angles were 0.696 (0.627 - 0.755, $P < 0.01$), 0.664 (0.589 - 0.728, $P < 0.01$), and 0.756 (0.697 - 0.804, $P < 0.01$), respectively, representing good agreement for IC and PC angles and excellent agreement for PS angles. Ninety-six (38%), 23 (9%), and 90 (36%) high-risk athletes were identified based on IC, PC, and PS angle cutoffs for the Kinect v2. ROC analysis demonstrated an area under the curve of 0.89 (0.85 - 0.93), 0.85 (0.77 - 0.93), and 0.89 (0.85 - 0.93) for identifying these high-risk athletes using the smartphone application, indicating excellent accuracy for all parameters. Smartphone application-derived IC, PC, and PS angle cutoffs of 0.74°, 2.20°, and 73.50° identified 83%, 78%, and 84% of high-risk athletes, respectively.
CONCLUSIONS: The novel smartphone application identifies athletes marked as high-risk for ACL tear from Kinect v2 cutoffs with excellent accuracy and shows potential for use in widespread screening.
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The Effects Of Anterior In-flight Perturbation On Lower Extremity Biomechanics During Drop Landings

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Landing after an athlete is airborne is a common situation associated with ACL injuries. We surmised that an unanticipated force applied to the trunk (about the longitudinal axis) would cause an undesirable body position and subsequently cause abnormal landing biomechanics.
PURPOSE: To determine the effects of in-flight perturbations applied to the trunk about the longitudinal axis of the body.
METHODS: Ten recreational female collegiate athletes (age: 20.4±1.3yr; mass: 64.2±10.3 kg; height: 169.6±8.4 cm) participated in this study and performed two blocks of testing. First, to serve as a baseline (BASE), participants performed five acceptable trials of natural double-leg drop landings (ht = 0.55m). In the second block of testing, trials consisted of drop landings with either an unexpected anteriorly-directed perturbation (PERT) or no perturbation (SHAM) with the testing sequence of PERT and SHAM trials randomly assigned. During the flight phase for PERT trials, the cable attached to a proprietary perturbing machine pulled on the participants' dominant side shoulder in an anterior direction. Three-dimensional lower extremity joint kinematic (240Hz) and ground reaction force (GRFs:1,200Hz) data were recorded for the landing phase. Paired-samples t-tests were used to detect differences between the BASE and PERT landing conditions ($p<.05$).
RESULTS: During the PERT condition, compared to the BASE condition, the following were greater: peak magnitudes of vertical (2.77±0.65 $N\cdot kg^{-1}$ and 2.25±0.57 $N\cdot kg^{-1}$) medial (0.34±0.08 $N\cdot kg^{-1}$and 0.27±0.08 $N\cdot kg^{-1}$), and posterior (1.15±0.27 $N\cdot kg^{-1}$and 0.95±0.23 $N\cdot kg^{-1}$) GRFs, and knee adduction (0.27±5.9° and -0.92±5.8°) and hip abduction (0.43±1.3° and 1.70±1.9°) displacements.