

association between this and high clothing levels ($p < 0.01$) and gender culture ($p < 0.01$).

Conclusions CDD reports are associated with sport characteristics such as team structure, contact level, and presence of subjective judging. These may represent true risk factors for misconduct or a stronger culture of reporting. Implications for intentional injury (abuse) prevention are clear.

396 THE ASSOCIATION BETWEEN PRESEASON FITNESS LEVEL AND RISK OF INJURY OR ILLNESS – A PROSPECTIVE COHORT STUDY IN MALE ELITE ICE HOCKEY

^{1,2}Anine Nordström, ¹Roald Bahr, ^{1,3}Ben Clarsen, ^{2,4}Ove Talsnes. ¹Department of Sports Medicine, Oslo Sports Trauma Research Center, NO, Oslo, Norway; ²Innlandet Hospital Trust, Elverum, Norway; ³Disease Burden Norwegian Institute of Public Health, Bergen, Norway; ⁴University of Oslo, Oslo University Hospital, Oslo, Norway

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Background Little is known about the association between physical fitness and the risk of injury or illness in ice hockey.

Objective The aim of this study was to examine the association between pre-season fitness level and injury or illness risk among elite ice hockey players during the subsequent season.

Design Prospective cohort study.

Setting The GET League (the premier professional league in Norway).

Participants Male ice hockey players ($n = 133$).

Interventions (or Assessment of Risk Factors) The players reported all health problems, acute injuries, overuse injuries and illnesses, using the Oslo Sports Trauma Research Center Questionnaire on Health Problems weekly during the 2017/2018 competitive season (31 weeks), and completed eight different exercises (40 m sprint, countermovement jump, 3000 m run, squat, bench press, chins, brutal bench, and box jump) at the annual one-day, pre-season testing combine.

Main Outcome Measurements Number and severity of acute injuries, overuse injuries and illnesses.

Results The number of any health problem did not differ between fitness rank groups, except for all substantial health problems. There was no association between low physical fitness and the number of health problems, comparing the least fit tercile of the players to the rest of the cohort. The least fit players reported a greater cumulative burden of health problems, after adjusting for time on ice per game, position on ice and age.

Conclusions We found no association between low physical fitness and the number of health problems, comparing the least fit tercile of the players to the rest of the cohort. The least fit players reported a greater cumulative burden of health problems, after adjusting for time on ice per game, position on ice and age. Future research focusing on physical performance as risk factors for injury could consider including more specific performance tests on ice.

397 ABSTRACT WITHDRAWN

398 ARE IMUS SUFFICIENTLY ACCURATE TO MEASURE CHANGES IN 3D KNEE ANGLES AND VELOCITIES DURING THE 70 MS WEIGHT ACCEPTANCE PHASE OF A JUMP LANDING?

¹So Young Baek, ²Mirel Ajaroski, ¹Payam Mirshams Shahshahani, ¹Mélanie Beaulieu, ²Amanda Esquivel, ¹James Ashton-Miller. ¹University of Michigan, Ann Arbor, USA; ²University of Michigan, Dearborn, USA

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Background The accurate tracking of knee joint motions during maneuvers associated with non-contact ACL injury is important for identifying injury mechanisms.

Objective We tested the hypothesis that motion capture and inertial measurement unit (IMU) measures of 3D changes in tibiofemoral angle and velocity are interchangeable in the ~70 ms weight acceptance phase of a 3–4*BW dynamic jump landing movement involving knee flexion and tibial internal rotation.

Design Two APDM IMUs and NDI Certus marker triads were rigidly attached to the mid-tibial and -femoral bone of cadaver knees to record motions during simulated jump landings. The initial knee angle was 15 degrees maintained by preparatory quadriceps muscle forces and tensile stiffness for the landing. The Bland-Altman Limits of Agreement (LoA) was used to compare the 3D data from 852 trials.

Setting University biomechanics research laboratory.

Patients Nine cadaveric knees harvested from six male and three female adult human donors.

Main Outcome Measurements The 3D knee angle changes from motion capture system were considered the gold standard and compared to calculated IMU data from the fusion algorithm provided by APDM Opal. The 3D tibial and femoral angular velocity changes measured by the IMUs were considered the gold standard and compared to the differentiated Certus angular data.

Results Although the mean peak IMU knee angle changes were slightly underestimated in all three orthogonal planes, the LoA bands were large, ranging from 35.9% to 49.8%. Certus had acceptable accuracy in the camera plane for angular velocity changes, with LoAs of ± 54.9 %/sec and ± 32.5 %/sec, respectively, for the tibia and femur.

Conclusions These IMUs could not reliably measure the peak 3D knee angle changes. Certus measurements of tibiofemoral angular velocity changes were comparable to IMU measures in the camera plane, and when velocities were sufficiently large.

399 EPIDEMIOLOGY OF NON-CONTACT ACL INJURIES IN TEAM BALL-SPORTS: A SYSTEMATIC REVIEW WITH META-ANALYSIS AND META-REGRESSION OF 2748 INJURIES ACROSS 42 MILLION PLAYER-HOURS AND - EXPOSURES COMBINED

¹Lionel Chia, ²Daniilo De Oliveira Silva, ³Matthew Whalan, ⁴Fuller Colin, ¹Marnee McKay, ¹Justin Sullivan, ^{1,5}Pappas Evangelos. ¹The University of Sydney, NSW, Australia; ²La Trobe University, NSW, Australia; ³Football Australia, NSW, Australia; ⁴Colin Fuller Consultancy, NOTT, UK; ⁵University of Wollongong, NSW, Australia

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Background Not all ACL injuries are preventable. The epidemiology of non-contact ACL injuries is not known.

Objective To estimate the incidence and proportion of non-contact to total ACL injuries by sex, age, sport, participation level, and exposure type.

Design Systematic review, meta-analysis and meta-regression

Setting Team ball-sports (soccer, rugby, basketball, volleyball, American and Australian football, floorball, lacrosse, hockey, baseball, softball)

Participants Athletes participating in team ball-sports regardless of sex, age, and participation level

Interventions Six electronic databases were searched from inception to July 2020. Cohort studies of team ball-sports reporting number of knee injuries as a function of exposure and injury mechanism were included.

Main Outcome Measurements Proportion of non-contact to total ACL injuries and non-contact ACL injury incidence by unit of exposure, sex, age group, sport, participation level, and exposure type.

Results Forty-three studies covering 12 sports were included. The overall proportion of non-contact to total ACL injuries was 54% (95% CI 47–60%, $I^2=90%$; females: 62%, 95% CI 54–70%, $I^2=83%$; males: 47%, 95% CI 39–54%, $I^2=86%$). Injury incidence was higher in females (0.20 per 1000 player-hours, 95% CI 0.12–0.33, $I^2=92%$; 0.07 per 1000 player-exposures, 95% CI 0.04–0.14, $I^2=98%$) than males (0.08 per 1000 player-hours, 95% CI 0.04–0.14, $I^2=94%$; 0.05 per 1000 player-exposures, 95% CI 0.03–0.08, $I^2=97%$). Injury incidence during competition was much higher (0.53 per 1000 player-hours, 95% CI 0.35–0.81, $I^2=80%$; 0.35 per 1000 player-exposures, 95% CI 0.17–0.71, $I^2=96%$) than training (0.03 per 1000 player-hours (95% CI 0.02–0.05, $I^2=60%$; 0.02 per 1000 player-exposures, 95% CI 0.01–0.05, $I^2=86%$). Heterogeneity between studies was generally high.

Conclusions Non-contact ACL injuries represented over half of all ACL injuries sustained. The proportion of non-contact to total ACL injuries and injury incidence were higher in females than males. Injuries mostly occurred in competition settings. More research is required to fully understand the influence of sport, age group, and participation level on injury proportion and incidence. difficult.

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LONGITUDINAL CHANGES IN CUTTING KINEMATICS IN YOUNG FEMALE ATHLETES ACROSS PUBERTY

¹Lionel Chia, ²Timothy Hewett, ³Kevin Ford, ^{4,5}Gregory Myer, ¹Marnee McKay, ¹Justin Sullivan, ^{1,6}Pappas Evangelos. ¹Sydney School of Health Sciences, The University of Sydney, NSW, Australia; ²Hewett Global Consulting, MN, USA; ³Department of Physical Therapy, High Point University, NC, USA; ⁴Emory Sport Performance and Research Center, GA, USA; ⁵Emory University School of Medicine, GA, USA; ⁶University of Wollongong, NSW, Australia

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Background Young female athletes involved in high-speed cutting and change-of-direction sports are particularly susceptible to anterior cruciate ligament (ACL) injuries. Little is known if maturational changes in cutting technique contribute to the increased injury risk.

Objective To examine longitudinal changes in cutting kinematics in female athletes as they matured through puberty.

Design Longitudinal cohort study

Setting Biomechanics laboratory

Patients (or Participants) One-hundred and seventy-two healthy high-school athletes were tested while in at least two different pubertal stages (pre-, mid-, post-pubertal).

Interventions (or Assessment of Risk Factors) Trunk, hip, and knee sagittal, frontal and transverse plane range-of-motion, peak angles, and angles at initial-contact during an unanticipated 45° cut measured with a laboratory-based optoelectronic motion capture system. Pubertal stages were defined by Tanner Stages.

Main Outcome Measurements Changes in trunk, hip, and knee kinematics as girls mature across puberty (pre-to-midpubertal, pre-to-postpubertal, mid-to-postpubertal).

Results As girls matured through puberty, they displayed a decrease in sagittal-plane hip (1.6–4.4°, $p\leq 0.01$) and knee range-of-motion (ROM) (2.7–2.9°, $p\leq 0.01$), and decreased peak hip (2.9–3.2°, $p\leq 0.02$) and knee flexion angles (2.5–2.9°, $p\leq 0.01$), which is indicative of greater quadriceps dominance. Peak knee abduction angles also increased as girls progressed through puberty (0.9–1.4°, $p\leq 0.006$), suggesting greater ligament dominance. In terms of trunk dominance, there were mixed findings with a decrease in trunk frontal- (2.5–5.7°, $p< 0.01$) and sagittal-plane ROM (1.4–2.0°, $p\leq 0.05$), but an increase in trunk transverse-plane ROM (2.8–3.6°, $p\leq 0.01$) observed as girls mature. Other significant changes in cutting technique were decreased peak trunk flexion (3.8–7.8°, $p\leq 0.01$), and decreased hip flexion (2.9–3.3°, $p\leq 0.01$) and knee flexion angles (2.0–3.0°, $p\leq 0.02$) at initial contact, suggesting a more upright and stiffer cutting posture.

Conclusions As girls mature through puberty, they display a change in cutting strategy characterized by greater quadriceps and ligament dominance. Ameliorating these kinematic changes throughout maturation may further reduce ACL injuries in this high-risk group.

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BONE BRUISE PATTERN AND MECHANISM OF ANTERIOR CRUCIATE LIGAMENT INJURY IN PROFESSIONAL FOOTBALL PLAYERS: CORRELATION BETWEEN MRI AND VIDEO ANALYSIS

¹Pieter D'Hooghe, ²Alberto Grassi, ³Francesco Della Villa, ¹Khalid Alkhelaifi, ¹Emmanouil Papakostas, ²Filippo Tosarelli, ²Stefano Zaffagnini. ¹Aspetar Hospital, Doha, Qatar; ²IRCCS Istituto Ortopedico Rizzoli, Bologna, Italy; ³Isokinetic Group, Bologna, Italy

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Background The presence of bone bruises (BB), especially in the lateral compartment of the knee, is a common finding in the context of anterior cruciate ligament (ACL) injury. However, different patterns have been described and a precise correlation with mechanism of ACL injury has never been determined.

Objective To correlate the MRI features of ACL injuries with the exact injury mechanism obtained from video-analysis. Such investigation, which has never been performed up to now, provides relevant insights in the understanding ACL injury mechanism and in the genesis of intra-articular lesions such as bone bruises.

Design Fifteen professional football players sustaining an ACL injury (while playing during an official match of First League Championship) were included in the study. The video of injury was obtained from the Television broadcast. Knee Magnetic Resonance Imaging (MRI) was obtained within 7 days