

VNATA 2020 Free Comm Abstracts

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208402MD

A Comparison of Hardiness Between Athletes and Non-Athletes in a Collegiate Setting

Leah M Kilchrist, James Lee Farnsworth, Lindsay E. Kipp, Junhyoung Kim

Context: Hardiness is a personality trait composed of 3 parts: commitment, control, and challenge. This trait can allow individuals to better cope with stressful situations or obstacles. Despite stressful challenges, they stay engaged, have belief that they can affect the situation, and that it is an opportunity for improvement. High hardiness has been shown to moderate stress and decrease mental health issues. Elite athletes have higher hardiness than athletes at lower competitive levels, and it would seem that athletes have more opportunities to develop hardiness than non-athletes. Athletes may be better equipped to deal with stress and challenges than non-athletes, which could leave them more vulnerable to mental health issues than hardier individuals. The purpose of this study was to determine if hardiness is higher in athletes than in non-athletes in a collegiate setting. It was hypothesized that athletes would have higher hardiness than non-athletes.

Methods: This study used a cross-sectional survey design. Students and student-athletes at a division I university were recruited using convenience sampling methods (e.g., email, flyer, class recruitment). All participants were sent an email link to fill out a brief demographic questionnaire (age, sex, academic classification, athlete classification), and the Dispositional Resilience Scale-15 (DRS-15). The DRS-15 measures hardiness and has 15 items that are rated on a 4-point Likert scale (0-3). Scores can range from 0-45 with a higher score indicating higher hardiness. It has been validated and has good reliability in college students. The survey instruments were combined and hosted online using Qualtrics. To enable comparisons between athletes and non-athletes all participants were asked to indicate whether they considered themselves to be an athlete or non-athlete. An independent-samples t-test was calculated to determine if hardiness scores, as measured by the DRS15, were significantly different between athletes and non-athletes

Results: A total of 62 students and student-athletes participated in this study (Mean Age = 20.74 ± 1.62 ; Male = 50.7%; Freshman = 4, Sophomore = 17, Junior = 11, & Senior = 24, Graduate = 6). Twenty-three (34.3%) of the participants identified themselves as athletes. No significant differences ($t_{55} = -0.53$; $p = 0.60$) were found between the average DRS15 score for athletes (29.14 ± 4.53) and non-athletes (29.74 ± 4.02). Both groups reported moderate-to-high hardiness.

Conclusions: Hardiness is developed through overcoming challenges and difficult life experiences. Participation in sport is believed to enhance development of hardiness through increased exposure to daily challenges. In this study, however, there were no differences found in hardiness between students and student-athletes. High variability in hardiness for both groups suggests that hardiness may be more individualistic and can be enhanced by a variety of factors, particularly in students who often face challenges with balancing academic, work, and social schedules.

Total Word Count: 445

209244MD

A Dyadic Analysis of Parent's Competitiveness and High School Athlete's Sport Specialization

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Context: Sport specialization has become an important topic for its relationship to increased injury and negative psychosocial effects on young athletes. Several studies have suggested that parents play a role in the athlete's decision to specialize, yet this dynamic has not been explored by a study including both parents and athletes and employing dyadic data analysis methods. The purpose of this dyadic study is to explore the role of parent competitiveness on the athlete's specialization decision.

Methods: 1,070 parents and their high-school athletes (i.e., dyads) completed an online survey with Survey Sampling International. Parents (75% mothers; age mean=47.1;s.d.=8.864) responded first. Their high-school athletes (51% female; age mean=16.7;s.d.=1.889) completed a separate survey. Measures included the previously published sport-specialization categorization (low, medium, high) and the established competitiveness index (enjoyment of competition and contentiousness [i.e., an inclination to fight or quarrel]). Descriptive analyses revealed the prevalence of sport specialization. Actor-partner interdependence models (APIM) examined the influence of the partner's competitiveness on the actor's specialization categorization. With the athlete's report of specialization, the parent's competitiveness is the partner effect for the athlete. With the parent's report of specialization athlete's competitiveness is the partner effect for the parent.

Results: The athlete's and parent's competitiveness were significantly correlated ($R = .463, p < .001$). Among athletes, 52.9% were low, 29.3% were medium, and 17.8% were high. Among high-specialization athletes, 64% of their parents agreed with their categorization. Significant actor/partner effects were found between sport specialization and competitiveness (enjoyment of competition [Actor Effect = $.012, p < .001$; Partner Effect = $.008, p = .032$]; contentiousness [Actor Effect = $-.031, p < .001$; Partner Effect = $-.019, p < .001$]). APIM analysis revealed that athlete's competitiveness was significantly associated with their sport specialization categorization (Athlete Actor Effect for Enjoyment of Competition = $.020, p = .001$; Athlete Actor Effect for Contentiousness = $-.046, p < .001$) while the parent's level of competitiveness was not related to the athlete's report of sport specialization level (Parent Partner Effect for Enjoyment of Competition = $.005, p = .453$; Parent Partner Effect for Contentiousness = $-.011, p = .211$). Figure 1 illustrates these results. A significant partner effect was observed for the athlete's contentiousness on the parent's report (Athlete Partner Effect for Contentiousness = $-.028, p = .001$).

Conclusions: With high school athletes, the parent's competitiveness does not have a significant effect on the athlete's specialization. Instead, it is the athlete's competitiveness that drives sport specialization. Being an argumentative contrarian may predispose athletes to lower levels of sport specialization which may be driven by the association between contentiousness and a need for approval/power. In comparison, enjoying competition (seeking to outperform others) is associated with higher levels of specialization.

Total Word Count: 444

207861ED

A Non-Contact Femur Fracture in a High School Football Player: A Case Study

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Background: This case involves a seventeen-year-old male running back who presented with an obvious thigh deformity. During a high school football game, the patient stepped out of bounds to avoid a tackle and fell onto the ground on his left side. He reported that his main symptoms were an immediate burning sensation and pain down his leg, followed by his whole leg going numb. The athletic trainer observed an obvious deformity in the patient's right thigh and noted that his foot was pointing in the opposite direction. The athletic trainer reported to the on-site team physician who immediately suspected a femur fracture, and Emergency Medical Services was waived onto the field. The patient was placed in a femoral traction splint with distal sensation, motor, and circulation intact and was transported to the Emergency Department. The patient reported no history of lower extremity injuries and no medical, surgical, or family history that would predispose him to a fracture.

Differential Diagnosis: Femoral head fracture, pelvic fracture, femoral stress fracture, osteoporosis, hip pointer, quadriceps strain, or iliopsoas strain.

Intervention & Treatment: At the emergency department, physicians noted that the patient was point tender over his proximal right femur. A radiograph was taken, diagnosing an isolated proximal shaft femur fracture. The patient's vital signs and neovascularity were determined to be normal. Laboratory tests demonstrated normal levels of vitamin D, calcium, and vitamin A. The patient had no signs or symptoms of osteoporosis and no imaging hot spots indicating a stress fracture or other indications of lack of bone health or weakness. The doctor ruled the injury as an idiopathic fracture. The patient underwent an antegrade intramedullary nailing open reduction and internal fixation procedure the morning after the injury. Following the surgery, the patient stayed in the hospital for two days where he started ambulating with crutches and began active-assisted range of motion exercises for the hip and knee. Upon release, he was placed on bed rest for a week and then began working with his athletic trainer. He slowly progressed into active range of motion and strengthening exercises such as heel slides, quadriceps sets, single-leg raises, and hamstring curls. After a month, he started walking on his own without crutches. He progressed into neuromuscular control and balance exercises, which were the most challenging for him. Although not yet released to begin running progressions, two months after the injury, the patient ran for the first time which resulted in pain and reduced mobility. The patient perceived this as a set-back which reduced his motivation for rehabilitation and his desire to return to football. However, with continued rehabilitation, he was cleared to return to football four months after the injury but chose not to citing continued discomfort and fear of re-injury as his reasons.

Uniqueness: The femur is a strong, dense bone, therefore, fractures are rare, especially in sports. The leading cause of femur fractures is car accidents or falls in elderly individuals. The patient had a non-contact mechanism of injury, which most typically results from a pathologic cause, however, that was not found in this case.

Conclusions: Femur fractures are rarely recorded in sports, so it is not a usual injury for athletic trainers to treat. Athletes affected by a femur fracture can recover from the injury, but they may never be at the same performance level as before the injury. The traumatic injury can lead to many deficiencies, psychological concerns, and prolonged discomfort for many years, which illustrates the importance of athletic trainers being educated about this injury and developing effective rehabilitation protocols, which include psychological interventions.

Total Word Count: 591

205545CB

A Prospective Study of the Impact of Concussions on Health Outcomes in High School Football Players

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Context: Football is the most popular sport among US high school students and is among the highest for sport-related concussion (SRC) incidence. There is limited data detailing how SRCs impact a high school football player's psychosocial health beyond their short-term injury recovery and return to play. The purpose of this study was to longitudinally assess the impact of SRCs on concussion related symptoms, health-related quality of life (HRQoL) and depression in high school football players through 12 months post-SRC.

Methods: Participants in this prospective study included 1,176 interscholastic football players (16.0±1.2 years) from 31 Wisconsin high schools. At enrollment, each player completed the Symptom Scale (PCSS) from the SCAT3 to assess their concussion related symptoms and symptom severity, the Pediatric Quality of Life Inventory 4.0 (PedsQL) for Physical, Psychosocial and Total HRQoL and the Patient Health Questionnaire-9 (PHQ-9) for depression. Athletic Trainers (ATs) recorded the onset and resolution characteristics for each SRC. Injured players were asked to repeat each measure within 72 hours of their SRC (Onset), 7 days (D7), at return to play (RTP), as well as 3 months (M3), 6 months (M6) and 12 months (M12) post SRC. An increase in the number of PCSS symptoms, PCSS severity score or higher PHQ-9 scores indicated increased disablement while a decrease in the PedsQL scores indicated increased disablement from baseline. Scores at each time point were compared to the subjects' own baseline with linear mixed models for repeated measures controlling for age, and previous SRC with subject as a random effect.

Results: Sixty-two subjects (5.2%) sustained an SRC. Compared to baseline, the change (mean change, (95%CI), p value) in the PCSS symptom scores were increased at Onset (6.3, (5.2, 7.5) $p < 0.001$) and D7 (1.8, (0.6, 2.9) $p = 0.002$) but decreased or were not changed at RTP, M3, M6 and M12. The mean change in the PCSS symptom severity scores was increased at Onset (15.5, (12.0, 19.0) $p < 0.001$) and D7 (4.3, (0.9, 7.8) $p = 0.015$) while no change was detected at RTP, M3, M6 and M12. The PedsQL Physical summary scores were decreased at Onset (-6.7, (-10.4, -2.9) $p = 0.001$) and D7 (-7.2, (-11.0, -3.4) $p < 0.001$), but increased or not changed at RTP, M3, M6 or M12. Both the PedsQL Psychosocial summary and PedsQL total scores increased or not changed at any time point through M12. No differences or d

Conclusions: Football players who sustained an SRC reported no prolonged adverse psychosocial health outcomes (increased PCSS symptoms or symptom severity, increased depression, or lower HRQoL) following their return to play through the 12 months post injury.

Total Word Count: 425

209303MA

A Systematic Dry Needling Treatment Supports Recovery Post-Training for Division I Ice Hockey Athletes: Level 2 Exploration Case Series

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Background: The collegiate hockey season has an intense schedule, producing significant demand on physical and mental health. Recovery is essential to assist in decreasing soreness, inflammation, and fatigue. Dry needling (DN) is an emerging therapeutic technique in athletic healthcare with some evidence suggesting benefits that promote the recovery process post-activity. Athlete Self-Reported Measures (ASRM) of patient post-DN would help inform whether DN treatments contribute to patient perceived improvement in recovery stress cycle. Therefore, the purpose of this case-series was to explore a systematic DN lower extremity recovery protocol in healthy ice hockey athlete's post-exercise using the Active Recovery Stress Scale (ARSS).

Patient: 4 student-athletes (aged 20 to 22 years old) participating in NCAA Division I ice hockey served as cases. Cases were free of injury, engaged in pre-season ice hockey practice, and participated in all team activities without restrictions. All cases had decreased ARSS scores compared to their baseline at the time of DN treatment.

Intervention & Treatment: Athletic Trainer performed DN lower extremity recovery protocol on all cases during a single session. The DN approach was to stimulate the pathways for pain control, autonomic nervous system regulation, and cholinergic anti-inflammatory processes. To administer the DN recovery treatment, static needles were placed in specific bilateral locations that consisted of 5 points on both the anterior and posterior aspect of lower extremity and lumbopelvic complex. Needles were placed from distal to proximal, starting with anterior points with the patient supine followed by posterior points while the patient was prone. Needles were inserted for a duration of 15 minutes (supine and prone) for all points, with the total treatment lasting 35-40 minutes. The ARSS was used to evaluate the effect of the DN recovery treatment on patient perception of recovery. The ARSS consists of 32 Likert style questions that evaluate the recovery stress cycle to produce scores within 4 recovery subcategories (Physical Performance Capability [PPC], Mental Performance Capability [MPC], Emotional Balance [EB], and Overall Recovery [OR]), and 4 stress subcategories (Muscle Stress [MS], Lack of Activation [LA], Negative Emotional Stress [NES], Overall Stress [OS]). Total ARSS scores for each subcategory range from 0 to 24, higher scores on recovery scales and lower scores on stress scales are indicative of positive findings for better recovery and less stress. Baseline ARSS assessments were completed when physical and academic stressors were low. The ARSS was again completed prior to (pre-DN), 24 hours post (24-post), and 48 hours post (48-post) DN treatment.

Outcomes or Other Comparisons: The recovery subcategory scores increased in all cases between pre-DN and 48-post (Table). Additionally, 62.5% of all recovery subcategory scores were equal to or above baseline at 48-post. The stress subcategory scores decreased between pre-DN and 48-post for all cases (Table). 50.0% of all case scores on the stress subcategory scores had returned to or were better than baseline at 48-post. Overall, total and average scores of ARSS for all cases were closer to baseline at 48-post than the other time points.

Conclusions: Recovery techniques historically have been used post-activity because even normal training loads, which are considered positive, produce athlete stress and fatigue and can lead to injury. Results from this case series suggest that ice hockey athletes who are experiencing post-exercise stress, such as soreness and fatigue, may benefit from treatment with a lower extremity DN recovery protocol. Findings support the pursuit of larger, prospective studies that include control groups to compare DN recovery protocols to other recovery techniques to determine effectiveness.

Clinical Bottom Line: Post-activity DN using a lower extremity recovery protocol may produce improvement in patient-perceived recovery and warrants consideration as an intervention to support athlete health.

Total Word Count: 588

209864MD

A Testing Battery's Predictive Validity of Reporting an Injury During U.S. Army Basic Combat Training

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Context: The physical requirements of U.S. Army Basic Combat Training (BCT) result in a high incidence rate of musculoskeletal injuries (MSKI) annually. Previous research on balance, ankle dorsiflexion, and muscle strength measurements have indicated that assessments may be beneficial at identifying individuals with an increased risk of lower extremity (LE) injury. The objective of this study was to establish the predictive validity of a shortened version of the Star Excursion Balance Test (QSEBT), Weight-Bearing Lunge Test (WBLT), and Single-Leg Wall Squat (SLWS) in the reporting of a back or LE injury to a medical provider during BCT.

Methods: This study was a prospective longitudinal cohort study completed utilizing one U.S. Army BCT battalion at Fort Jackson, SC. Four hundred and twenty-seven U.S. Army basic trainees (age: 21.4 ± 3.6 years; females: $n=141$, height: 162.1 ± 6.3 cm, weight: 63.7 ± 8.6 kg; males: $n=286$, height: 176.3 ± 6.7 cm, weight: 78.4 ± 12.5 kg) were included for analysis. Participants completed baseline questionnaires on previous activity levels (average days of 30 minutes of exercise per week in the 2 months prior to BCT) and menstruation patterns, body composition testing (dual x-ray absorptiometry), and physical performance measures (QSEBT, WBLT, SLWS) in a gym setting and followed up weekly throughout BCT to self-report injury. Normalized reaching distances on the QSEBT bilaterally, wall distances on the WBLT bilaterally, and successful trials on the SLWS were analyzed. ICCs for inter-rater comparisons and test-retest reliability of the QSEBT ranged from 0.83 to 0.98 and 0.64 to 0.88, respectively. Multiple logistic regression was applied to assess the relationship between the measures taken prior to beginning BCT and the report of injury.

Results: Female participants reached for shorter distance than males with their non-dominant leg on the QSEBT (3-Direction Composite: 81.73 ± 9.34 to 85.68 ± 10.79 cm, $P=0.04$) after normalizing to leg length and also measured shorter distances on the WBLT bilaterally (dominant: 9.88 ± 3.26 to 10.17 ± 3.92 cm, $P=0.03$; non-dominant: 9.68 ± 3.14 to 10.00 ± 3.81 cm, $P=0.02$). Ultimately, 34.4% of participants (53.9% of female participants, and 24.8% of male participants) indicated they reported a MSKI to a medical provider during training. We estimate each centimeter increase in the reach distance of the 3-direction composite QSEBT score (dominant stance leg) is associated with a 2.1% reduction (OR=0.979, 95% CI [0.958, 1.001], $P=0.06$) in the odds of a basic trainee in reporting an injury during BCT, after adjusting for sex, bone mineral density, and prior physical activity.

Conclusions: Dynamic postural control assessment measured by the QSEBT may be helpful in identifying basic trainees who have increased odds of reporting a LE or back injury during BCT. Ongoing research will examine the predictive validity of the QSEBT on specific diagnoses of injury, injuries that cause lost time, and attrition from training.

Total Word Count: 444

209425QB

A Theoretical Model of Transition to Practice

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Context: Transition to practice of newly credentialed athletic trainers has become an area of focus within the athletic training literature. To this point, there has been no theoretical model that explains the phenomena and can guide investigation beyond description. Therefore, the purpose of this study was to better understand transition to practice through the development of a theoretical model.

Methods: A longitudinal, grounded-theory, qualitative study design was used. Upon IRB approval, 14 professional master's athletic training students (7 male, 7 female, age=26 ±4 years) participated in semi-structured telephone interviews from graduation through their first year of autonomous practice. Phone interviews occurred at 3-time points over the course of 12-15 months. The starting period was just prior to graduation (from 9 higher education institutions), with follow-up interviews at 4-6 months and 10-12 months their first year of practice. Interviews were transcribed and analyzed using a grounded theory approach. Trustworthiness and credibility were established through peer-evaluation and a constant comparative approach.

Results: A theoretical model emerged that explained the transition to practice for newly credentialed athletic trainers (Figure 1). The model includes the causal conditions that trigger transition, how the causal conditions were experienced, the coping strategies used to persist through the first year of practice, and the consequences of those strategies. A dissonance is produced from the clash between the educational and professional cultural norms and expectations. Specifically, new clinicians become more aware to the safety net provided during the educational experience. They become aware of areas where they did not experience with many of those areas being related to communication and administration. This clash of cultures was experienced as feelings of being overwhelmed by chaos, and self-doubt and fear. The new clinicians coped with these feelings through trial and error, self-reflection and grace, and a search for support. Through the use of these strategies, new clinicians achieved rhythm in the chaos.

Conclusions: Transition to practice is a rite of passage as former students develop their professional identities. The model created provides a framework for new clinicians, educators, and employers to better understand the process of transition. Through this framework, the profession will be able to investigate ways to aid new clinicians in their response to transition through acceptance or adaptations of their environment and/or behaviors to deal with the experience of transition. This can be accomplished by allowing athletic training students opportunities to fail, providing new clinicians opportunities and outlets to discuss concerns, and to encourage self-reflective opportunities.

Total Word Count: 408

[207032DD](#)

A Unique ACL Tibial Avulsion Without Bony Fragment in an Adolescent Football Player

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Background: Level 3 CASE Study of 14 year old adolescent male that sustained Right ACL Tibial Avulsion with no bony fragment. Most ACL avulsions occur at the tibial level, however this case was unique because no bony fragment pulled off with the ligament. Because no bony fragment was present, the ACL was repaired surgically using a unique Pullout Suture technique with no absorbable suture. The athletic trainer was in her residency training and provided assistance with examination and surgery of this case.

Patient: 14 year old adolescent male, football player diagnosed with Right ACL Tibial Avulsion. Injury occurred 8/29/2019. The patient reports cutting and was pulled to the ground by opponent. He heard a pop, had immediate swelling, and pain scale at 6/10. Upon examination, patient presented with mild effusion, normal alignment, flexion: 50° active, 85° passive, extension: -5 active/passive. He tested positive for Lachman, Anterior Drawer, and Pivot Shift tests. All other tests were stable and negative. MRI showed distal ACL pathology representing partial avulsive injury from the tibial attachment and/or high grade sprain, bone contusion without fracture/dislocation, no meniscal or MCL tear, and moderate sized knee joint effusion. Patient was diagnosed with a Right ACL Tibial Avulsion with surgical options being ACL Reconstruction with Quadriceps Tendon Autograft or ACL Repair/open reduction internal fixation (ORIF).

Intervention & Treatment: Intra-operatively it was determined that reconstruction was not necessary and a repair was the chosen intervention. Intra-operative findings were tibial footprint avulsion of the anterior medial bundle with some of the posterior lateral bundle still attached. No significant bone knee fragment came off with the ACL. Due to no bony fragment being present, Pullout suture technique was chosen over screw fixation. Screw fixation is the typical procedure, with Pullout suture technique being not as common. The procedure included ACL footprint cleaned and area taken down to bleeding bone, 2 breakaway pins placed on both sides of the ACL footprint, Fiber tape through the posterior aspect/posterior lateral bundle of the ACL, Housan suture passers placed through the breakaway pinholes then pulled out into anterior medial tibia and tension placed on them. ACL avulsion is perfectly reduced and at full extension tied over a bony bridge. The post-operative plan included putting patient in a post-operative brace locked into full extension for 4 weeks. Patient instructed to use brace while ambulating. A custom functional ACL brace was placed on patient at 4 weeks post-operatively during clinic visit. The treatment plan at 4 weeks post-operatively included our institution's standard ACL Rehabilitation Protocol and to begin physical therapy immediately.

Outcomes or Other Comparisons: Due to patient living in another state, the athletic trainer spoke with the patient the following day after surgery, and patient stated no complications or pain. The athletic trainer followed up with patient via phone call 2 weeks post-operatively. Patient stated again no complications or pain. Patient was seen in clinic at 4 weeks post-operatively and presented with pain scale 0/10, flexion: 120° active, 130° passive, straight leg raise 60-90°, and no extension lag.

Conclusions: This was a unique case in that it did not present as a typical ACL avulsion injury, and the surgical plan had to change intra-operatively. Surgical intervention was also unique in that a novel technique was used to secure the avulsion and maximize patient's ability to regain full healing and extension range of motion.

Clinical Bottom Line: Pullout suture technique to repair ACL tibial avulsions with no bony fragment was a successful technique. With the exception of the knee locked in full extension for 4 weeks, a standard ACL protocol can be used for rehabilitation.

Total Word Count: 584

205124EA

Abductor Hallucis Fatigue Influences Dynamic Balance Depending on Foot Type

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Context: There is conflicting evidence concerning the association between foot morphology and dynamic balance performance on the star excursion balance test (SEBT). The objective of this study was twofold. First, to investigate whether individuals with pes rectus and pes planus foot types perform differently on the SEBT. Second, to test whether fatiguing the abductor hallucis (AH) muscle prior to performing the SEBT would reduce dynamic balance ability among these foot types.

Methods: Twenty-six healthy, physically active adults volunteered for this descriptive laboratory study (11 males, 15 females, age=21.42±1.47 years, height=170.78±12.36 cm, weight=73.07±15.18 kg). Subjects were divided into two groups depending on foot type: 1) Pes Planus (n=10), and 2) Pes Rectus (n=16). All subjects completed the SEBT in the anterior, posterolateral, and posteromedial directions before and after an AH fatigue protocol. Stance limb muscle activity was measured in the tibialis anterior (TA) and AH using electromyography. Separate three-way mixed factor ANOVAs were conducted to understand the effects of AH fatigue, reach direction, and foot type on each continuous dependent variable (SEBT reach distance (normalized to percent limb length), mean AH activation, and mean TA activation).

Results: There were no significant three-way interactions between fatigue, reach-direction, or group for AH activation ($F(2,48) = 0.09, p = 0.91$), TA activation ($F(2,48) = 0.80, p = 0.46$), or reach distance ($F(2,24) = 0.57, p = 0.57$). We found a significant main effect for fatigue ($F(1,24) = 5.70, p = 0.03$) on AH activation, with a 1.44% (95% CI, 0.20-2.69) decrease in mean AH activation regardless of foot type or reach direction (Figure 1). TA activation was similar between groups, and did not change as a result of the fatigue protocol. Finally, there was a significant two-way interaction between fatigue and group ($F(1,24) = 4.36, p = 0.047$) for SEBT reach distance. The pes rectus group had a 3.8% decrease in mean reach distance post AH fatigue [81.2%, (95% CI, 78.7-83.6) to 77.4% (95% CI, 74.3-80.5)]. The pes planus group only experienced a 0.7% decrease in mean reach distance post-fatigue [83.4% (95% CI, 80.3-86.5) to 82.7% (95% CI, 78.8-86.6)] (Figure 1).

Conclusions: We found no difference in SEBT performance between foot types prior to AH fatigue. Fatiguing the AH muscle caused a significant reduction in AH activation during dynamic balance in both foot types. Additionally, the TA did not increase activation as a result of this reduction of intrinsic muscle activity. The pes rectus group experienced a significant decrease in cumulative SEBT reach distance post AH fatigue, while the pes planus group was unaffected by the decrease in AH activity. This result suggests that pes rectus foot types rely more on the AH to perform dynamic balance tasks.

Total Word Count: 421

[207364CD](#)

Ability of an Eye-Tracking Device for Detecting Concussion in Military Cadets: A Pilot Study

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Context: Despite the prevalence of concussion in athletes and military service members, diagnosis remains challenging and relies heavily on self-reported symptoms. There is a critical need to develop objective metrics to diagnose and monitor recovery after concussion. Post-concussion oculomotor functional deficits associated with the visual system have been advocated as a promising objective method for concussion evaluation. The purpose of this study was to examine the ability of a commercially available eye tracking device to discriminate between military cadets with and without concussion.

Methods: A nested case-control design was used to examine the I-Portal Portable Assessment System's (I-PAS™, NeuroKinetics, Inc. Pittsburgh, PA) ability to discriminate between concussed patients and healthy controls. All subjects completed a test battery that included smooth pursuit (horizontal and vertical), vergence pursuit, optokinetic nystagmus, anti-saccade, predictive saccade, and random saccade (vertical) assessments on a portable 3D head-mounted video display system with integrated eye tracking technology (I-PAS™). Controls were matched based on sex, age, height, and sport level (intramural, club, or varsity athlete) and completed the assessment battery at pre-injury baseline. Cases completed the battery within 48 hours of a diagnosed concussion. Univariate logistic regression models with odds ratios (OR) and 95% confidence intervals (95%CI) were used to identify eye tracking metrics that discriminated between cases and controls ($p < 0.10$). Significant eye tracking metrics were carried over into a backward logistic regression model. The predictive capability of the final model was assessed using area under the receiver operating characteristic curve (AUC). An AUC of 0.5 suggests no discrimination, 0.7-0.8 acceptable, 0.8-0.9 excellent, > 0.9 outstanding. Sensitivity and specificity were also calculated.

Results: Of the 2,972 (23.4% female) cadets that agreed to participate, 16 cadets diagnosed with a concussion (13 males, 3 females: 19.38 ± 1.15 y, 71.31 ± 3.93 in, 184.31 ± 39.31 lbs) and sixteen matched controls (13 males, 3 females: 19.38 ± 1.02 y, 70.86 ± 3.46 in, 179.63 ± 28.85 lbs) with no history of concussion were included in this analysis. The strongest univariate associations with group status were found for pupil stimulation correlation (OR=19.11, 95%CI: 0.78-463.69, $p=0.070$), total predicted saccades (OR=0.62, 95%CI: 0.43-0.90, $p=0.012$), and latency grand mean (OR=2.08, 95%CI: 0.02-2.24, $p=0.089$). The backward regression model only retained total predicted saccades (OR=0.62, 95%CI: 0.42-0.90, $p=0.012$). The metric total predicted saccades from an eye tracking test battery was able to discriminate between concussed patients and controls. For each additional saccade predicted correctly participants were 38% less likely to be in the concussed group. Total predicted saccades had a sensitivity of 75.00, a specificity of 81.25, and an AUC of 0.81 (Figure 1).

Conclusions: These preliminary findings suggest total predicted saccades displayed excellent predictive capabilities for discriminating between concussed patients and uninjured healthy controls. Additional prospective data is needed to confirm these findings and determine if additional oculomotor assessments can improve sensitivity and specificity.

Total Word Count: 449

200085AD

Additional Injuries When Football Athletes Sustain Sport-related Concussion: Findings from the Ivy League-Big Ten Epidemiology of Concussion Study

Wiebe DJ, D'Alonzo BA, Bretzin AC

Context: Athletes who sustain a sport-related concussion (SRC) may experience additional injuries. Little is known about the incidence of additional injuries or potential implications for recovery. We examined this issue among football players within a large, ongoing concussion surveillance system of collegiate athletes.

Methods: The Ivy League – Big Ten Epidemiology of Concussion Study spans 28 sports at the 8 Ivy League and 12 of 14 Big Ten universities. Athletic trainers identify and enroll athletes who sustain an SRC into this large prospective cohort study (N = 2,720). Data on 22 concussion symptoms from the SCAT3, presence of other injuries, and demographics are collected and entered into the online database. Athletic trainers monitor athletes; time is calculated as number of days from SRC to recovery outcomes. Here we focused on football athletes who sustained SRC between 2013-2019. We used Kaplan-Meier survival curves to determine differences in time to recovery based on having isolated SRC vs. SRC with additional injury.

Results: Of 637 football athletes with SRC, 23.2% were freshmen, 31.1% were sophomore, 27.0% were juniors, and 18.6% were seniors. Median times to recovery were 6 days (IQR 3-13) to symptom resolution, 7 days (IQR 4-14) to return to exertion activities, and 12 days (IQR 9-19) to return to full play. The median number of symptoms endorsed was 9 (IQR 5 -13). A total of 36 (5.6%) of the 637 athletes experienced an additional injury. The most common additional injury was sore neck (25.0%), neck sprain (22.2%), whiplash (13.9%), and laceration to nose or cheek (13.9%). Other injuries were nose fracture (5.7%), bruised rib (5.7%), chipped tooth (2.8%), muscle spasm (2.8%), ache (2.8%), sprain (2.8%), and rupture (2.8%). Having an additional injury was not associated with time to symptom resolution ($p=0.586$), but was associated with delays ($p<0.05$) to return to exertion and return to full play.

Conclusions: In this large sample of football athletes with SRC, having an additional injury was uncommon (5.6%). Though not associated with symptom resolution, having an additional injury carried a burden in delays to exertion and full play. These results suggest that athletic trainers could tailor treatment and recovery plans for athletes with injuries secondary to concussion symptoms.

Total Word Count: 358

208463CD

Age of First Exposure Influences Neurovascular Coupling in High School Football Athletes

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Context: Late-life physiological and clinical impairments are associated with age of first exposure (AFE) to tackle football. There is a dearth of literature describing how AFE may influence physiological outcomes in current high school (HS) football athletes. Neurovascular coupling (NVC) uniquely describes cerebrovascular response to neural activation and is commonly assessed in response to visual tasks. Understanding how AFE may affect cerebrovascular function in high school athletes may better inform athletic trainers on interpreting potential long-term deficits following cumulative head impact exposure.

Methods: High school football athletes ($n=28$; age= 15.8 ± 1.1 yrs; height= 175.9 ± 8.2 cm; mass= 74.2 ± 12.7 kg) self-reported AFE (median=13 years old, IQR=3.75). We employed transcranial Doppler (TCD) ultrasound to measure athletes' posterior cerebral artery velocity (PCAv) prior to beginning the competitive season. Changes in PCAv were measured in response to two progressively challenging visual tasks: 1) reading and 2) search. Each task was presented in 5 one-minute trials (20s eyes-closed/40s eyes-open). All raw PCAv data were measured at 125Hz and filtered using a dual-pass 4th-order Butterworth filter (2Hz cutoff). Baseline PCAv data were derived by averaging PCAv across a 2-minute baseline period that preceded the visual tasks. Filtered task data were converted to time-series curves representing 40 consecutive 1-second averages for each trial. Curves were then averaged across the 5 trials and time-aligned to stimulus onset (eyes-open) to generate a single ensemble-averaged 40-second curve representing NVC response for each participant for each task. Differential NVC response was defined as the difference between reading NVC response and search NVC response. Custom Matlab scripts were used to filter and reduce all data. We employed separate linear mixed effects models to evaluate the effect of AFE on NVC response profiles for each individual visual task (reading or search) as well as on the differential NVC response between search and reading tasks.

Results: The AFE did not significantly predict NVC response during reading ($F(1,1090)=0.87$, $P=0.35$) or search ($F(1,1090)=0.22$, $P=0.64$) tasks. The AFE significantly predicted a differential NVC response to visual task ($F(1,2208)=6.97$, $P=0.008$), such that we observed a 0.17% increase in differential NVC response for each one-year increase in AFE (Figure 1).

Conclusions: Despite NVC response to each individual task not being associated with AFE, the interaction between AFE and differential NVC response suggests that high school football players with younger AFE demonstrated a more similar response to each visual stimuli and players with an older AFE demonstrated a more divergent response to each visual stimuli. The underlying neurophysiological mechanisms associated with AFE remain unclear. Our data offer compelling and innovative insights for athletic trainers to understand neurophysiological observations associated with the ongoing scientific discussion surrounding AFE.

Total Word Count: 433

205594FD

Altered Ankle Kinematics as a Strategy to Reduce Hip Moments During a Drop Vertical Jump in Individuals with Femoroacetabular Impingement Syndrome

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Context: Femoroacetabular impingement syndrome (FAIS) preferentially afflicts athletes, many of whom report modifying their movement to continue sports participation. Kinematic alterations at the ankle are a possible compensatory strategy to reduce loads to the painful hip during landing tasks. We have observed a phenomenon in our laboratory characterized by a sagittal plane kinematic reversal at the ankle in some patients with FAIS; however, the biomechanical effect of this strategy is unknown. Understanding whether this ankle reversal effectively reduces loads to the affected hip during a drop vertical jump (DVJ) in individuals with FAIS may assist clinicians in developing targeted rehabilitative interventions to optimize sport function. As such, the aim of this project was to determine the effect of a kinematic ankle reversal on hip and knee kinetics and kinematics during a DVJ.

Methods: Thirty-two active participants (16F and 16M; age: 24.78 ± 10.19 years; BMI: 24.69 ± 4.71 kg/m²) with FAIS were recruited from a hip preservation clinic. A 12-camera three-dimensional (3D) motion analysis system and four embedded force plates were used to capture kinetics (1200 Hz) and kinematics (240Hz) of the lower extremities during DVJs. Each participant performed five DVJs; the last three were selected for analysis. Each of the 96 DVJ trials were categorized based on the absence or presence of a kinematic ankle reversal defined by a change from ankle dorsiflexion into plantar flexion for at least 10 frames/ 42 milliseconds. The primary variables of interest were peak hip and knee kinetics and kinematics in the sagittal plane. Following Shapiro-Wilk tests for normality, separate Generalized Linear Models with Generalized Estimating Equation corrections were used to evaluate the effect of a kinematic ankle reversal on hip and knee kinetics and kinematics.

Results: Of the 96 DVJ trials 26 (27.1%) contained a kinematic ankle reversal (involved 12 (46.2%); uninvolved 5 (19.2%); bilateral 9 (34.6%)). Compared to trials without a kinematic ankle reversal, those with a kinematic ankle reversal landed with less hip flexion on both the symptomatic ($33.8^\circ \pm 8.3^\circ$; $40.3^\circ \pm 11.1^\circ$, $P \leq 0.001$) and asymptomatic limbs ($33.8^\circ \pm 8.0^\circ$, $39.6^\circ \pm 11.7^\circ$, $P \leq 0.001$), lower peak hip flexion moments on both the symptomatic (1.85 Nm/kg \pm 0.47 Nm/kg, 2.10 Nm/kg \pm 0.48 Nm/kg, $P=0.05$) and asymptomatic limbs (1.91 Nm/kg \pm 0.50 Nm/kg, 2.12 Nm/kg \pm 0.54 Nm/kg, $P=0.03$), and greater peak knee flexion angle on the symptomatic limb ($93.5^\circ \pm 17.0^\circ$, $88.0^\circ \pm 9.9^\circ$, $P=0.02$).

Conclusions: A kinematic ankle reversal during a DVJ task may be a compensatory strategy in individuals with FAIS as it was associated with lower peak hip flexion moments.

Total Word Count: 420

206813FD

Altered Lower Extremity Biomechanics Exhibited in Walking, Not Running Following Anterior Cruciate Ligament Reconstruction

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Context: Individuals with history of anterior cruciate ligament reconstruction (ACLR) often exhibit gait impairments, which may contribute to poorer articular cartilage health and patient-reported knee function, compared to healthy individuals. The purpose of this study was to compare peak sagittal plane percent contribution of the hip, knee, and ankle joints during walking and running in the ACLR limb compared to the limb of a healthy-matched control. We hypothesized that the ACLR limb would exhibit lesser contributions of the knee extensor moment and greater contributions of hip extensor and ankle plantarflexor moments, when compared to healthy-matched controls.

Methods: Nineteen participants with history of primary, unilateral ACLR (Age: 22.8 ± 5.2 Years, BMI: 24.4 ± 3.7 kg/m², Sex: 10M/9F, Months Since Surgery: 35.0 ± 23.5 , Tegner: 6[5,9]) and 19 healthy-matched controls (Age: 22.3 ± 3.7 Years, BMI: 24.0 ± 3.0 kg/m², Sex: 10M/9F, Tegner: 6[5, 9]) participated in this study. The International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form was utilized to assess patient-reported knee function. The Tegner Activity Scale was utilized for patient-reported level of sport or physical activity participation. Gait analysis was completed via three-dimensional motion capture and an instrumented treadmill. All participants were asked to walk at 1.34 m/s and run at 2.68 m/s, standardized speeds previously utilized to evaluate lower extremity biomechanics in knee-injured populations. Gait data were analyzed during stance phase utilizing a standard inverse dynamics approach and normalized to body mass. The sum of peak hip extension moment, knee extension moment, and ankle plantarflexion moments were expressed as total sagittal plane moment. The percentage contribution(%) of the lower extremity joint moments were calculated as the quotient of peak joint moment and total sagittal plane moment. Walking and running gait data were compared between the ACLR limb and healthy control limb utilizing fixed effects general linear models. Alpha was set a-priori at $p < 0.05$.

Results: Participants with ACLR and healthy-matched controls did not significantly differ based upon demographic variables. However, ACLR participants reported significantly poorer knee function, evaluated by the IKDC score (ACLR: 90.8 ± 8.7 , Healthy: 99.2 ± 1.7 , $p = 0.001$). During walking, ACLR participants exhibited lesser peak knee extension moments (ACLR: 0.28 ± 0.13 Nm/kg, Healthy: 0.36 ± 0.11 Nm/kg, $p = 0.04$) and peak ankle plantarflexion moments (ACLR: 0.87 ± 0.10 Nm/kg, Healthy: 0.98 ± 0.08 Nm/kg, $p < 0.001$), compared to healthy-matched controls. During walking and running, there were no significant differences ($p = 0.10$ to 0.87) between groups for total sagittal plane moment or lower extremity support contributions.

Conclusions: Consistent with previous research, individuals with ACLR exhibited reduced involved limb loading and poorer loading responses during walking, but not running. If poor loading techniques exhibited during walking are not addressed during rehabilitation, they may contribute to poorer patient-reported knee function and articular cartilage health. Future investigations should examine the role of running mechanics and long-term joint health in patients with ACLR, since a common goal following ACLR is return to sport-level activity.

Total Word Count: 449

[206481PD](#)

American Football Uniforms Cause Failures on the Heat Tolerance Test

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Context: The heat tolerance test (HTT) is an objective test that may help clinicians with return-to-activity decisions following exertional heatstroke cases. The HTT assesses thermal tolerance by having athletes walk for 2 hours on a treadmill (5 km·h⁻¹, 2% incline) in the heat (40°C, 40% humidity). Test failure occurs if rectal temperature (TREC) or heart rate (HR) do not plateau during the test and exceed 38.5°C or 150 bpm, respectively. Ideally, tests assessing heat tolerance would incorporate sport-specific factors (e.g., protective equipment). Because minimal clothing (i.e., shorts, undergarments, socks, shoes) is worn during a standard HTT, its applicability to American football may be limited. Our study determined if wearing an American football uniform during a HTT would result in classifications of heat intolerance.

Methods: Ten physically-active men without a history of heat illness completed this randomized, counterbalanced, crossover study (age:23±3y; mass:78.5±10.3kg; height:179.6±7.6cm; VO₂max:52.1±4.5ml·min⁻¹·kg⁻¹). Participants completed a standard HTT (CONTROL) or an HTT with a full American football uniform donned (PADS). TREC and HR were monitored continuously for 2 hours or until TREC reached 39.5°C. We noted when HTT failure criteria occurred but continued the HTT beyond the standard failure thresholds because we questioned if TREC or HR would plateau at higher values with PADS donned. We also calculated body heat storage and the rate of TREC and HR increase during the HTT's first and second halves. Condition x time repeated measures ANOVAs with Tukey-Kramer post-hoc tests assessed TREC, HR, and rate of TREC or HR increase. Dependent t-tests examined differences between conditions for body heat storage and the duration of the HTT participants completed before failing (means±SD; NCSS v.2007, α=.05).

Results: HR (F_{16,144}=35.5, P<.001) and TREC (F_{16,144}=146.8, P<.001) were higher in PADS from minute 20 and 30 until the end of the HTT, respectively. All subjects failed the HTT in PADS (n=2, TREC >38.5°C; n=8, HR >150 bpm); 5 failed in CONTROL (n=1, TREC >38.5°C; n=4, HR >150 bpm). Subjects completed more of the HTT in CONTROL than PADS (87.6±34.9 min vs. 41.5±13.7 min; t₉=5.9, P<.001). Body heat storage in PADS was higher than CONTROL (88.1±15.7 W·m² vs. 49.9±18.9 W·m²; t₉=12.5, P<.001). PADS rate of TREC increase (F_{1,9}=41.8, P<.001) and rate of HR increase (F_{1,9}=23.7, P<.001) were higher than CONTROL for both halves of the HTT and failed to plateau. Eight of 10 subjects TREC reached 39.5°C in PADS (time to 39.5°C=100.7±11.7 min); 0 CONTROL subjects reached this safety cut-off.

Conclusions: PADS significantly impaired thermoregulatory ability and produced more false positive HTT results. Since TREC and HR failed to plateau with PADS, we could not identify a new, higher failure threshold for the HTT. The HTT cannot be made more sport-specific to American football by simply donning PADS.

Total Word Count: 444

[205964FD](#)

Analysis of Pronation in Recreational Runners Treated with Kinesio® Tape

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Context: Recreational runners who pronate are subject to chronic lower extremity injuries. The application of Kinesio® Tape may mitigate the excess trauma through correcting foot posture. The purpose of this research was to analyze foot posture and running mechanics through the use of the Navicular Drop Test (NDT) and three-dimensional (3D) motion analysis.

Methods: The study was a randomized controlled trial conducted in a biomechanics laboratory at a mid-sized research university. A convenience sample of 20 recreational runners, as defined by self-reported running habits of an average distance of 10 miles/week for the last 3 months, ($m=10$, $f=10$, $24.4\pm 7.36y$) who were diagnosed with bilateral pronation (NDT score >10 mm) served as their own control. The independent variable was the Kinesio® Taping Method application for medial longitudinal arch correction. The dependent variables were NDT scores and 18 kinematic angles. Participants were randomized and counterbalanced into 1 of 2 conditions: Kinesio® Tape applied with tension (treatment) or no-tension (sham) as they ran 2, 0.50 miles. NDT scores (mm) were obtained at baseline, immediately following initial application, and after each running trial. Gait kinematics were measured using 3D motion analysis with reflective markers at 36 anatomical landmarks. Eight Vicon 3D motion analysis cameras operating at 240 Hz captured motion for 10 seconds after each tenth of a mile. A repeated measures, 2-way analysis of variance (ANOVA) was employed to assess the difference in NDT scores. The differences in joint angles between the treatment and sham conditions were appraised using a repeated measures, 2-way ANOVA.

Results: NDT scores between conditions were comparable at baseline ($F[1,19]=0.461$, $p=.505$, $\eta^2=.023$), but were significant immediately following initial application ($F[1,19]=27.14$, $p<.001$, $\eta^2=.588$), and significant at the completion of the run ($F[1,19]=29.68$, $p<.001$, $\eta^2=.610$). Descriptive results for NDT scores can be found in Table 1. Analysis of 18 angles resulted in statistical significance for hip sagittal ($p=.034$, $\eta^2=.016$), ankle sagittal ($p=.002$, $\eta^2=.063$), knee transverse ($p=.006$, $\eta^2=.036$), and pelvis frontal ($p=.047$, $\eta^2=.009$) planes. Thus, the change in the aforementioned 6 angles were statistically significant. However, effect sizes are small and there is a high chance of type I error.

Conclusions: Kinesio® Tape, as measured by NDT scores, can support the medial longitudinal arch immediately after application and at the completion of a run. Few superior kinetic chain angles were affected by the taping application. Longitudinal research should be conducted to examine the role Kinesio® Tape may have in altering pathomechanics.

Total Word Count: 393

205533CD

Analyzing Sideline Concussion Assessment Scores Across Time to Guide Return-to-Play After Concussion

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Context: The current best practice for assessing sport-related concussion (SRC) is multifaceted and uses various sideline assessment tools to determine cognition, balance and neurological status in concussed patients. Individually, these tools present challenges due to clinical usefulness being largely undefined, limitations accompanied with symptom reporting, and guidance for return to (RTP) decision remaining unclear. Quantifying, comparing, and determining the strength of relationship between these tools will provide data to improve return to play (RTP) guidance among allied healthcare professional. Therefore, the purpose of our study was to compare and quantify patient symptoms, balance, cognition, and ocular motor function with sideline assessment tools across multiple time points after sport related concussion and to examine the relationships between sideline assessment tools.

Methods: A prospective case series design was used for this study. We evaluated 17 intercollegiate athletes across the 2016 – 2018 that sustained a concussion (8 men, age=21+2 years, height=182+16.4 cm, mass=80+8.1 kg; and 9 women, age=19+2 years, height=167.4+7.6 cm, mass=64.1+9.8 kg). All athletes had baseline cognition and neurological scores using the Standardized Assessment on Concussion (SAC) in Sport Concussion Assessment Tool – 3 (SCAT3), patient reported symptoms in SCAT3 (PCSS), and measuring center of pressure using Balance Tracking Systems®. Those who sustained a head impact related injury were reassessed on a 24-hour continuum using the same sideline assessment tools at baseline in addition to measured vestibular-ocular motor function (VOMS) and near point convergence (NPC). Post-injury assessments at 24, 48, and 72 hours served as the independent variables. A repeated measures ANOVA was used to quantify differences in assessment scores across time. Pearson’s correlation coefficient was used to examine the relationships between assessment tools. The α value was set to $P=.05$ a priori.

Results: Subjects reported to baseline status within 4 to 8 days following concussion. We found a statistically significant effect of time on mean VOMS ($F_{1,075}, 11.825=9.946, p=.008, \eta^2=.475$) and mean PCSS scores ($F_{2,22}=3.917, p=.035, \eta^2=.263$). Pairwise comparisons revealed statistically significant differences with mean VOMS scores at 24 hours (61.38+66.73) vs. 48 hours post-injury assessment (24.56+30.33, $p=.028$) and 24 hours (61.38+66.73) vs. 72 hours post-injury assessment (17.94+30.64, $p=.025$) (Figure 1). Pearson correlation coefficient revealed significance between VOMS and PCSS scores at 48 hours post-injury ($r=.777, n=17, p=.000$) and 72 hours post-injury ($r=.874, n=16, p=.000$). Significant, strong correlations across remaining assessment tools over time were also found.

Conclusions: Based on our results, the use of VOMS and PCSS illustrates connections between evaluating the pathophysiology of concussion and the clinical signs and symptoms manifested by injured patients. These results indicate a multifaceted approach for concussion management is highly important as some tools could potentially jeopardize RTP safety. Therefore, these tools should be used in conjunction to support the entire clinical examination at each time point.

Total Word Count: 449

[208232FD](#)

Anticipation of Jump Task Impacts Lower Extremity Biomechanics During A Jump-Cut Maneuver

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Context: The high frequency of non-contact lower extremity injuries during athletic maneuvers, such as cutting, demand a better understanding of extrinsic factors that may predispose individuals for injury-prone biomechanics. While the role of physical fatigue on cutting biomechanics are understood, the role of mental fatigue & interruption of motor planning on injury-related biomechanics has not been studied. We aimed to investigate ankle, hip, and knee biomechanics during an anticipated and unanticipated jump-cut, before and after mental fatigue.

Methods: This study implemented a pre-test post-test design. Thirteen individuals (23±2yrs, 168.6±9.7cm, 73.8±14.4kg, 5M/8F) reported to a biomechanics laboratory for a single test session. Ankle, knee, and hip joint kinematics were tracked with an 8-camera motion tracking system through reflective markers placed on lower extremity landmarks. Participants stepped off a 30cm box placed 70cm from two in-ground force plates. Instructions to jump or cut after landing were either provided before the jump (anticipated) or after initiation of the jump (unanticipated). The cut was performed 45° in the opposite direction of a randomly-determined test leg (e.g. cut left off right test leg). Participants performed 5 jumps per condition before and after a 60-minute mental fatigue intervention, consisting of three 10-minute blocks of the N-back test, and three 10-minute blocks of the AX-continuous performance test. Fatigue before and after the intervention was assessed with the profile of mood states (POMS). Differences in joint excursion and peak joint angles of the test leg were assessed from force plate contact through load acceptance using two-way analyses of variance (condition, anticipated vs. unanticipated; time, pre- vs. post-fatigue, $\alpha=0.050$).

Results: Significant condition main effects were observed for sagittal knee ($F=6.921$, $p=0.025$) and hip ($F=9.804$, $p=0.011$) ranges, whereby more joint excursion was observed in the unanticipated condition (Knee: $71.8\pm 23.6^\circ$; Hip: $64.7\pm 24.8^\circ$) than the anticipated condition (Knee: $67.9\pm 22.5^\circ$; Hip: $58.0\pm 20.9^\circ$). Significant effects of condition were also observed for peak ankle eversion ($F=12.451$, $p=0.005$) & dorsiflexion ($F=7.932$, $p=0.018$) angle, indicating more eversion (anticipated: $14.7\pm 9.9^\circ$, unanticipated: $16.7\pm 10.5^\circ$) & plantarflexion (anticipated: $42.3\pm 16.5^\circ$, unanticipated: $40.8\pm 15.5^\circ$) in the unanticipated condition. A significant condition-by-time interaction was observed for peak ankle external rotation angle ($F=8.805$, $p=0.014$); however, pairwise comparisons revealed no significant differences. Fatigue, assessed from the POMS, increased from pre-fatigue (1.27 ± 0.34) to post-fatigue (1.97 ± 0.57 , $p<0.001$).

Conclusions: These findings suggest mental fatigue had minimal effects on lower extremity biomechanics during anticipated & unanticipated jump-cuts. However, unanticipation resulted in more hip and knee joint flexion excursion, as well as greater eversion and plantarflexion angles, potentially indicating a less protective landing strategy. Subsequent investigations should explore these landing strategies in individuals with musculoskeletal injuries.

Total Word Count: 420

208821ED

Apophysitis of the Left Anterior Superior Iliac Spine in High School Golf Athlete

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Background: This level 3 CASE study focused on the diagnosis, treatment, and impending recovery of a high school golf athlete with an apophysitis of the left anterior superior iliac spine (ASIS). Apophysitis of this nature are common between the ages 13 and 15 but can manifest until the age of 25. The apophysis is composed of cartilage, making the site highly susceptible to repetitive stress. Sport participation greatly increases the chance of apophysitis or an apophyseal avulsion fracture due to the sport's biomechanical demands on the body. The iliopsoas and the internal and external abdominal oblique muscles inserting on the iliac crest help stabilize the trunk during rotation activities. In combination with the sartorius, these muscles are active with sprinting and kicking activities (i.e. soccer, track & field) and eccentric loading of the hip and knee (i.e. gymnastics). However, limited research is available on apophysitis in golf athletes.

Patient: A 16-year-old male with ten years of golf experience reported to the athletic training facility complaining of pain on his left ASIS during the final stages of his golf swing. He was diagnosed with apophysitis of the left ASIS and treated by the athletic trainer. Patient continued playing golf after diagnosis, despite pain. Evaluation revealed a moderate sway-back posture, pain of gluteus minimus and medius while side-lying, and pain with active and resistive hip flexion. Passive internal and external hip flexion with the knee extended were painful and patient complained of tightness of his left hamstring and rectus femoris. The sway-back posture could potentially be enough to "tug" the external abdominal obliques on the apophysis posteriorly, as the pelvis in the lumbar region is tilted inferior causing a forward shift. He was referred for X-rays and an MRI, however imaging studies have not been completed.

Intervention & Treatment: The goal was to decrease pain and avoid removing the patient from practice and competition. A strengthening protocol to improve core stability and hip strength was implemented. Additionally, gait analysis on the treadmill was used to observe signs of abnormal trunk rotation of the lumbothoracic spine while running. Therapeutic modalities including hot pack with interferential current therapy, Graston technique with desensitizing pressure, and soft tissue massage. Therapeutic exercises included gentle proprioceptive neuromuscular facilitation (PNF) contract-relax of bilateral hamstrings and quadriceps, as well as, the left sartorius. To decrease pain and limit biomechanical restrictions during competition, kinesiology tape (i.e., star pattern with 50% stretch) was placed on the patient's left ASIS. A physician evaluation has not been performed and imaging have not been completed due to insurance limitations. Physician and imaging findings would be imperative to further understand the cause of apophysitis in young athletes.

Outcomes or Other Comparisons: Patient continues to rehabilitate and has reported a decrease in pain and improved performance in sporting activities. Despite rehabilitation, patient is still not 100% pain free.

Conclusions: This CASE study examines a condition not commonly seen in high school golfers. Observing the patient's biomechanics in multi-plane disciplines can distinguish abnormalities in thoracic rotation and lumbopelvic dysfunction. Gradually progressing flexibility and strength, in congruence with literature research, can potentially benefit other similar cases.

Clinical Bottom Line: Potential abnormal gait patterns and postural dysfunctions can lead to apophysitis in sports involving extreme rotational forces.

Total Word Count: 524

209701CD

Arterial Pulse Waveform Characteristics in Recently Concussed Female Athletes with Orthostatic Hypotension

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Context: Cardiovascular autonomic nervous system (CVANS) dysfunction is a recognized consequence of concussion injury that can present as an abnormal arterial blood pressure (ABP) response during postural transitions. Orthostatic hypotension (OH) is defined as a ≥ 20 mmHg decline in systolic blood pressure (SBP) within 3 minutes of standing upright (STND). The purpose of this study was to explore arterial pulse waveform (APW) characteristics in recently concussed female athletes with OH (CONC) compared to a non-injured control group of female athletes (CTRL) during a transition from supine rest (SUP) to STND.

Methods: A prospective, parallel-group study on CVANS function (i.e., digital electrocardiogram and continuous beat-to-beat ABP) was performed in 8 female athletes with CONC within 48 hours of injury and 10 CTRL in a university laboratory setting. All participants completed CVANS assessment including 10 minutes of SUP data and during a transition to STND for 3 minutes. Changes in APW were compared at SUP and during the final 15 seconds of the STND condition. The mean APW for SUP and STND were analyzed to calculate the systolic slope (SysSlope; slope of the systolic upstroke), the reflection index (RI; peak pressure of reflected wave divided by peak systolic pressure) and the notch relative amplitude (NRL; pressure of the diastolic notch divided by peak systolic pressure). Separate analysis of variance (ANOVA) were performed to identify group (CTRL vs. CONC) differences in demographic (e.g., age, height, weight), vital signs [e.g., heart rate (HR; beats/min), SBP (mmHg) and diastolic blood pressure (DBP; mmHg)] and SUP APW characteristics [e.g., SysSlope (mmHg/sec), RI (unitless), NRL(unitless)]. Separate repeated-measures ANOVA were performed to determine if group differences existed in APW in SUP to STND; Tukey post hoc tests explored significant group or condition main effects.

Results: The groups were not different for demographics (CTRL: 21 ± 2 yrs, 1.66 ± 0.09 m, 62 ± 17 kg; CONC: 19 ± 1 yrs, 1.67 ± 0.08 m, 67 ± 11 kg), SUP vital signs (CTRL: 67 ± 10 beats/min, 118 ± 7 mmHg, 70 ± 7 mmHg; CONC: 63 ± 9 beats/min, 117 ± 14 mmHg, 69 ± 10 mmHg) or SUP APW characteristics [CTRL: 351 ± 110 mmHg/sec, 59 ± 6 (RI), 0.78 ± 0.01 (NRL); CONC: 418 ± 145 mmHg/sec, 59 ± 8 (RI), 0.80 ± 0.01 (NRL)]. A significant group (CTRL and CONC) and condition (SUP and STND) main effect ($p < 0.001$ for each) and group x condition interaction effect for SBP ($p < 0.0001$), SysSlope ($p < 0.01$) and RI ($p < 0.05$) were revealed. HR, DBP and NRL were not different. Post hoc analyses of STND in CONC versus CTRL revealed: a significantly lower SBP by study design (92 ± 16 vs. 114 ± 13 mmHg, respectively); SysSlope (e.g., 162 ± 80 vs. 305 ± 95 mmHg/sec, respectively); and, a significantly elevated RI [e.g., 0.88 ± 0.08 vs. 0.78 ± 0.08 (unitless), respectively].

Conclusions: Females with CONC and OH have altered APW characteristics reflecting a reduced ability of the CVANS to make appropriate adjustments to normalize ABP after transition to STND.

Total Word Count: 446

209443MD

Assessing Healthcare Professional' Knowledge of the Female Athlete Triad: A Pilot Study

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Context: Healthcare professionals found within the multidisciplinary team are responsible for identifying, diagnosing, screening, preventing, managing, treating, and making return to play decisions regarding the Female Athlete Triad (Triad). However, little literature exists to determine their overall knowledge related to the Triad. The purpose of this study was to pilot the Female Athlete Triad Knowledge Questionnaire designed to examine knowledge and confidence levels (in response to accuracy of their answers) among healthcare professionals.

Methods: A cross-sectional study design was used to pilot the Triad knowledge questionnaire in healthcare professionals. The independent variable included healthcare professionals (athletic trainers (AT), physical therapists (PT), physician assistants (PA), dietitians (RD), and physicians). The dependent variable was Triad knowledge and confidence level. The healthcare professionals (n=167) consisted of ATs (n=101), PTs (n=18), PAs (n=40), RDs (n=6), and physicians (n=1). Participants completed the Female Athlete Triad Knowledge Questionnaire (25 questions categorized into 5 domains: Triad criteria; Identifying Signs and Symptoms; Diagnosing the Triad, and Triad Screening and Prevention, and Treatment, Management and Return to Play protocols). Following each question, participants selected their confidence in their correct or incorrect responses (4-point Likert scale ranging from 1=not at all confident to 4=very confident). Adequate knowledge was defined as an overall score of 75% in all domains (highest achievable=100%). Statistical analysis included basic descriptive statistics (means \pm SD), and ANOVA to compare differences between professions on confidence level of knowledge for correct and incorrect answers. Due to unequal distribution of healthcare professionals, data was used as only pilot data to identify individual group scores and cannot be generalized to all healthcare professional groups at this time.

Results: Only 11.4% (n=19) of healthcare professionals had adequate knowledge on the Triad Questionnaire. Within individual disciplines: AT=7.9% (n=8); PT=11.1% (n=2); PA=20% (n=8); RD=0% (n=0); and physician=100% (n=1) displayed adequate Triad knowledge. Overall, participants averaged a 61.9 \pm 10.73% knowledge score across all domains. Percentages across all domains included: Triad Criteria (57.0 \pm 18.7%); Identifying Signs and Symptoms (86.4 \pm 16.2%); Diagnosing the Triad (50.0 \pm 21.1%); Screening and Prevention (58.4 \pm 17.3%); and Treatment, Management, and Return to Play (58.0 \pm 22.8%). Across all domains, the confidence level for correct and incorrect answers respectively were 2.8 \pm 0.8 and 2.4 \pm 0.8.

Conclusions: Overall, a lack of Triad knowledge and decrease in confidence in their correct answers was demonstrated in healthcare professionals. It is unknown how much of the Triad content is delivered in individual healthcare professional curriculums; future research should expand on examining larger sample sizes within each healthcare profession. ATs, PTs, PAs, RDs, and physicians are most often included in a multidisciplinary team to provide care for those who have the Triad. Therefore, continuing educational efforts should be established for current healthcare professionals to increase the standard of care provided to physically active populations.

Total Word Count: 444

207083CD

Assessing Influencers of Perceived School-Level Concussion Care and Support Among Collegiate Student-Athletes

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Context: Proper care and support is essential for improving athlete outcomes after sport-related concussion (SRC). Little is known about factors that influence perceptions of school care and support following SRC. This study objective was to assess if concussion history, high school collision/contact sport exposure, institution, or race is associated with care and support perceptions following SRC among first-year student-athletes.

Methods: First year collegiate student-athletes from two institutions (n=389, age=18.3+/-0.8 years, 66.8% male) completed a pre-validated survey assessing demographics, concussion history, and concussion behavioral factors. Primary outcomes were athletes' perception of care and support from their school after SRC. To assess perceived school care, the question, "Schools like mine provide appropriate care for individuals with concussion," was categorized as yes (strongly agree/agree) or no (neutral/disagree/strongly disagree). To assess perceived school support, the question, "If I suffered a concussion, I would feel supported by my school," was categorized as yes or no in the same manner previously described. Explanatory variables included concussion history (yes/no), high school sport exposure (contact/non-contact), institution (A/B), and race (Caucasian/other race). Separate univariable binomial regression models were used to examine relationships between the explanatory variables and primary outcomes. Separate multivariable models were used to analyze all explanatory variables on the two primary outcomes and to model adjusted Prevalence Ratios (PRs) and associated 95% Confidence Intervals (CIs).

Results: Overall, 111 (28.53%) respondents reported a concussion history, 325 (83.55%) participated in a high school contact sport, 281 (72.24%) were from institution A, and 276 (70.95%) identified as Caucasian. Also, 360 (92.54%) believed their school provides appropriate care for SRC and 332 (85.35%) believed their school would provide support after SRC. There were no significant associations (univariable and multivariable models) regarding perceptions of appropriate school concussion care ($p>0.05$). The proportion of participants that agreed/strongly agreed they would feel supported if they had a concussion was lower among those with a concussion history versus without (PR=0.90; 95%CI: 0.89-0.99). The proportion of respondents at institution B that agreed/strongly agreed they would feel supported if they suffered a concussion was higher than the proportion at institution A (PR=1.16; 95%CI: 1.09, 1.24). No other associations (univariable and multivariable models) were found for perceived institution support after concussion ($p>0.05$). Table 1 shows the adjusted PRs and 95%CIs from the multivariable models for perceived care and support.

Conclusions: First-year student-athletes with a concussion history may perceive their school environment as less supportive. Additionally, institutional culture also influences perceived support. These data support the importance of Athletic Trainers and others educating student-athletes about proper expectations for recovery and the need for supportive social structures post-concussion. Future research should investigate relationships among perceived school support, concussion care-seeking behaviors, and post-concussion outcomes.

Total Word Count: 438

208161RD

Assessing the Readability of Metered-Dose Inhaler and Epinephrine Auto-Injector Pinterest Pins: A Content Analysis

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Context: Readability of health-related content is critical of any published work, especially when educating the public on a specific subject. Established guidelines for readability suggest that reading levels should target between 4th and 6th-grade education levels to avoid disadvantaging individuals with lower literacy skills and creating health disparities. This study aimed to evaluate the readability level of Pinterest pins related to metered-dose inhalers (MDI) and epinephrine auto-injectors (EAI).

Methods: Pinterest pins (pins) identified and selected in the content analysis were collected from Pinterest, a web-based social media platform. To perform the readability analysis, we began by identifying potential pins obtained from two previous content analyses on MDI (n=17) and EAI (N=19). The text was extracted and re-entered into a Microsoft Word (Redmond, WA) document precisely as it originally appeared. The Word text was copied into an online readability calculator (Readabilityformulas.com). A sufficient sample size of 4-5 full sentences, approximately 200-600 words (3000-word limit), is recommended; however, a minimum of 100 words was needed to evaluate the sample. Pins not meeting the 100-word minimum and those deemed unreadable (i.e., small text) were excluded (7=MDI, 9=EAI). Twenty pins (10=MDI, 10=EAI) were analyzed. Seven readability formulas were used to produce a consensus readability score. The readability formula considers factors like number and length of sentences, word count, characters, syllables, adjectives, and nouns in the sample. A consensus score was produced for each pin. However, no specific description of the consensus score's formulation was reported on the website.

Results: Grade level scores for the 20 pins were produced, except for the Flesch Reading Ease Score (FRES), which utilized a different scale. An average 5th grader can understand FRES scores of 90-100. 8th and 9th-grade students can understand documents with a score of 60-70, and college graduates understand documents scoring 0-30. Based on the consensus score, the MDI (n=10) and EAI pins (n=10) were written above the recommended 6th-grade reading level, 8.40 ± 4.53 and 11.40 ± 3.66 , respectively. Median grade level scores were 8.5 (MDI pins) and 10.5 (EAI pins). FRES MDI and EAI pins scored 67.48 ± 17.84 (standard) and 48.53 ± 14.44 (difficult), respectively.

Conclusions: In their current format, MDI and EAI Pinterest pins do not currently meet the recommended 4th to 6th-grade reading levels. Health literacy positively influences patient outcomes and that effective health-related communication to the public is critically important. While visuals can offer a great deal of communicative value, failing to account for the targeted reading level can negatively impact the effectiveness of educational material, as seen in the current MDI and EAI pins. Therefore, providers and developers of patient education content need to tailor training materials to meet the appropriate levels of readability and health literacy to target populations.

Total Word Count: 439

208533RD

Assessment of Leadership Education Through Graduates of Doctorate in Athletic Training Programs

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Context: Within athletic training education, doctor of athletic training (DAT) programs are responsible for advanced leadership development. The current standards of the Commission on Accreditation of Athletic Training Education (CAATE) for post-professional programs do not emphasize leadership competencies; yet many programs detail leadership development within their mission statements. Leadership development in DAT programs has not been studied. The purpose to this research is to assess DAT graduates' perceived importance of and confidence in performing specific leadership behaviors, and the level of influence their DAT program had on their level of confidence with the leadership behaviors.

Methods: We used a cross-sectional design and data were collected through a 29-item web-based instrument. We used criterion sampling to recruit credentialed ATs who were also graduates of a DAT program. The survey included 7 demographic questions and a section on 22 leadership behaviors adapted from the Leadership Development in Athletic Training (LDAT) instrument. Each defined leadership behavior had three associated questions measured on a 5-point Likert scale: perceived importance (1=unimportant to 5=very important), perceived confidence (1=not at all confident to 5=very confident), and influence of the DAT on confidence for each behavior (1=not at all influential to 5=extremely influential). We used statistics of central tendency to analyze the data and partial data were included.

Results: Of 205 current DAT graduates (reported by Program Directors), 77 responded to the survey, and 32/77 were excluded for not meeting inclusion criteria and/or not giving their consent. Forty-five participants (age= 31.5+/-6.1 years; time since earning DAT degree= 1.13+/-0.90 years; years of experience= 8.69+/-5.6 years; time employed at current job= 3.00+/-4.04 years) were included in this study. All 22 leadership behaviors were rated as "important" or higher with "critical thinking" (4.84+/-0.37) rated as the most frequent "very important" skill (mode = 5, n=37/45, 82.2%) for DAT graduates. All behaviors were rated as "moderately confident" or higher with "credible - to be believable, honest, trustworthy, and ethical in dealings with subordinates, peers, and supervisors" (4.5+/-0.55) rated as the behavior graduates are most confident (mode=5, n=23/45, 51.1%) in performing. All behaviors were rated as "somewhat influential" or higher by a DAT program with "future minded" (4.63+/-0.58) being the most frequently selected "extremely influential" response (mode=5, n=29/45, 64.4%) by graduates.

Conclusions: This study suggests DAT programs are successfully emphasizing leadership behaviors. However, DAT graduates may have decreased confidence in performing certain behaviors if those behaviors are perceived as less important. Overall, DAT programs may be viewed as less influential for leadership behaviors that are not perceived as important by DAT graduates. Future work should examine why certain leadership behaviors are rated as more important than others, specifically if this is a result of the DAT curricula, market demands, or personal preference.

Total Word Count: 445

206144AD

Association Between Socioeconomic Status and Sport Specialization in High School Baseball Players

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Context: Young athletes often feel pressure to focus on a single sport year-round because many stakeholders believe that specializing will provide a competitive advantage. The costs of sport specialization in baseball may be prohibitive for some families, and therefore family socioeconomic status (SES) may influence sport participation decisions. The purpose of this study was to examine the associations between SES and sport specialization/baseball participation in high school baseball players. We hypothesized that high-SES athletes would have higher rates of specialization, participate in more baseball, and be more likely to receive private coaching.

Methods: This cross-sectional study was conducted using 15 high schools from Alabama, California, and Michigan matched on variables identified to influence specialization rates. Participants completed a survey that examined demographic information, sport participation history, baseball participation volume, and a widely-utilized specialization scale (n=620; age=15.8±1.3 years; baseball experience=10.7±2.4 years). Completed surveys were electronically entered and sport specialization classification and socioeconomic status were calculated. Sports specialization was determined using a validated 3-point specialization scale. SES was estimated by median household income within their zip code, and participants were split into tertiles based on median household income. Descriptive statistics were calculated for participant demographics, and chi-square analysis was used to evaluate associations between SES and sport specialization/baseball participation.

Results: A significant relationship exists between level of baseball sport specialization and SES ($\chi^2=12.2$, $p=.002$). Descriptive information is provided in Table 1. Baseball athletes in the high-SES group were significantly more likely to be highly specialized than those in the low-SES group (OR[95%CI]: 2.36[1.38-4.05], $p=0.002$) or middle-SES group (OR[95%CI]: 1.50[1.02-2.21], $p=0.039$). There were no significant differences between the average hours per week spent playing organized baseball between SES groups ($p=0.519$); however, those in the high-SES played significantly more months per year than those in the middle-SES ($p=.001$) and low-SES ($p=.002$). High-SES participants were more likely to have quit another sport so they could focus on baseball than low-SES participants (OR[95%CI]: 1.90[1.26-2.88] $p=0.002$), and middle-SES participants (OR[95%CI]: 1.57[1.05-2.35] $p=0.027$). High-SES participants were more likely to receive private baseball coaching than low-SES participants (OR[95%CI]: 1.90[1.24-2.82] $p=0.003$) and middle-SES participants (OR[95%CI]: 1.63[1.09-2.43] $p=0.016$).

Conclusions: SES influences baseball participation patterns, with the high-SES group more likely to: 1) be highly specialized, 2) play more months per year, 3) quit other sports so they could focus on baseball, and 4) receive private coaching. Education of parents and players is important, as these participation patterns are risk factors for the development of a shoulder or elbow overuse injury in baseball. Further, analysis of how sport specialization impacts retention and success in baseball is needed to better understand how these identified specialization patterns may influence baseball participation and injury rates between SES.

Total Word Count: 438

206244CD

Association Between Symptom Burden at Initiation of a Graduated Return-to-Activity Protocol and Time to Return to Unrestricted Activity After Concussion in Service Academy Cadets

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Context: Clinical practice guidelines recommend a patient be asymptomatic prior to initiating a graduated return to activity (GRTA) protocol post-concussion. However, there is a lack of literature describing the symptom characteristics of patients at the beginning of the GRTA protocol and how symptom endorsement upon exercise initiation influences time to return to activity (RTA). The purpose of this investigation was to describe symptom endorsement at the beginning of the GRTA protocol and examine the association between symptom endorsement at the beginning of the GRTA protocol and time to RTA in cadets.

Methods: A prospective cohort study was conducted with cadets enrolled in the Concussion Assessment, Research and Education Consortium at three US Service Academies. Cadets underwent evaluation at baseline and post-injury. Post-concussion Sport Concussion Assessment Tool (SCAT) and Brief Symptom Inventory-18 (BSI-18) scores were recorded upon initiation of a GRTA protocol. SCAT symptom endorsement upon initiation of the GRTA protocol was used to classify participants as symptomatic (≥ 1 symptom) and asymptomatic (0 symptoms). The primary outcome of interest was time from initiation of a GRTA protocol to unrestricted RTA. Kaplan-Meier survival estimates were calculated by SCAT symptom endorsement (symptomatic vs asymptomatic) at GRTA protocol initiation to estimate time to RTA. Univariate and multivariable Cox proportional hazards regression models were used to estimate the association between symptom endorsement at initiation of the GRTA protocol and time to RTA ($\alpha < 0.05$). Sex, varsity status, and BSI-18-Total score were accounted for in the multivariable model. Hazard ratios (HR) and 95% confidence intervals (95%CI) were calculated. Median and interquartile range (IQR) were calculated to describe symptom endorsement.

Results: During the study period 860 cadets (36% Female; 19.1 ± 1.4 y) sustained a concussion. Upon initiation of the GRTA protocol, 560 cadets (35% Female) were asymptomatic, endorsing zero symptoms. Symptomatic cadets (38% Female) endorsed a median of 1 (IQR=1-3) symptom, headache was the most common. Kaplan-Meier survival estimates for RTA time by symptom endorsement at the initiation of a GRTA protocol are presented in Figure 1. Univariate results revealed a significant association between symptom endorsement at initiation of GRTA and time to unrestricted RTA ($p < 0.001$). In univariate models, sex, varsity status, and BSI-18 scores at initiation of a GRTA protocol were also associated with time to RTA. In the multivariable model, symptomatic cadets at initiation of a GRTA protocol took longer to RTA (HR=0.82, 95%CI=0.70-0.98). Females (HR=0.81, 95%CI=0.70-0.95), non-varsity cadets (HR=0.74, 95%CI=0.64-0.87), and higher BSI-18 scores (HR=0.96, 95%CI=0.93-0.99) were associated with significantly more time to RTA after controlling for the other variables.

Conclusions: Symptom endorsement at initiation of a GRTA protocol is associated with time to RTA. Cadets who were symptomatic at initiation of GRTA protocol took 18.3% longer to RTA after accounting for sex, varsity status, and BSI-18 scores.

Total Word Count: 446

208595AD

Association Between Work Activities and Situations and Work-Related Injuries and Symptoms Among Athletic Trainers

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Context: The purpose of this analysis was to examine the association between the frequency and intensity of exposure to strenuous or injurious activities and the prevalence of work-related injuries and musculoskeletal symptoms experienced by athletic trainers (AT).

Methods: 1826 athletic trainers completed a baseline survey May of 2012 as part of the Work Related Risks of Certified Athletic Trainers (WRROCAT) study. Self-reported outcomes of interest in the past 12 months included: 1) any injury; 2) an injury requiring time off work; 3) musculoskeletal symptoms in any of nine body regions that interfered with work activity; and 4) lower back musculoskeletal symptoms that interfered with work activity. An Exposure Index was created to quantify each individual's frequency and level of exposure to 16 work activities and situations. Participants rated each item according to "things at work that could contribute to job-related pain and injury" on a scale from 0 (no problem) to 10 (major problem). For each activity, standardized and scaled z-scores were computed from the frequency and perceived level of risk measures. The two measures were combined to represent frequency multiplied by the risk level and summed across all 16 activities to create a cumulative Exposure Index for each individual. Exposure indices were compared by work setting (school, clinic, other) using one-way ANOVA ($\alpha=0.05$). Multivariate binomial regression models assessed the risk of the four outcomes by Exposure Index (quartile cut-points, Q1 (referent)). Demographic and occupational factors known to be associated with work-related injury and symptoms (age, gender, work tenure) were included in the initial multivariate models as were other factors with $RR \geq 1.20$ or $RR \leq 0.80$ (body mass index, work setting, only AT at work, other assistance at work, >40 hours/week, second job with ergonomic stress). Final models were determined using step-wise backwards elimination strategy by comparing AIC/AICC model fit criteria between the models adjusted and unadjusted for the factor(s).

Results: Mean Exposure Index for the 1709 participants with complete exposure information was 1350 (SD=275.3, median=1350). Exposure Index varied by work setting: school settings had higher mean Exposure Index (1381) compared to clinic/hospital (1152) and other settings (1208) ($F=125.45$, $p<0.0001$). Higher Exposure Indices were associated with higher prevalence of any injury and symptoms that interfered with work in lower back and any body region compared to lower Exposure Indices (Table). Though not statistically significant, a dose-response was observed for prevalence of an injury with days off work and increasing Exposure Index.

Conclusions: Higher cumulative Exposure Index was associated with increased prevalence of all outcomes – injury with or without time loss and musculoskeletal symptoms that interrupted work activities. Interventions targeted to reduce both the frequency and intensity of exposure to strenuous or injurious activities are important for ATs.

Total Word Count: 446

[207071LA](#)

Association of Heart Rate Variability with Measures of Cognitive-Motor Status Among ROTC Cadets

Grillo AN, Rogers AJ, Perry TS, Wilkerson GB, Acocello SN

Context: Neural processes underlying situational awareness share circuits with those that regulate autonomic function. Heart rate variability (HRV) may provide an important indicator of cognitive-motor performance capabilities in challenging situations.

Methods: A cohort of 32 male ROTC cadets (21.21 ± 2.69 years; 178.82 ± 7.65 cm; 79.30 ± 10.43 kg) provided survey responses, completed 2 visual-motor reaction time (VMRT) tests, and 2 whole-body reactive agility (WBRA) tests. One-minute HRV measurements were acquired immediately prior to physical training sessions conducted twice weekly for 9 weeks. The 10-item Overall Wellness Index (OWI) generates a 0-100 score for frequency and recency of 82 health-related or behavioral problems. The 10-item Sport Fitness Index (SFI) generates a 0-100 score for musculoskeletal injury effects on performance capabilities. The VMRT tests included Single-Task (ST) and Dual-Task (DT) conditions, with the latter including a cognitive-motor flanker test. The WBRA tests included Lateral and Diagonal movements in response to visual targets, with measurements of reaction time (RT), speed (Spd), acceleration (Acc), deceleration (Dec), and test duration (Time). Measurements of HRV were used to calculate the natural log of the root mean-square of successive differences in R-R intervals (RMSSD) and intra-individual session-to-session variability in RMSSD represented as coefficient of variation (CoV). Cohort median values defined suboptimal ($RMSSD \leq 4.49$; $CoV \geq 0.07$) versus optimal categorization.

Results: Factors that discriminated suboptimal from optimal RMSSD included Left–Right VMRT–DT Difference ≥ -22 ms (OR=9.5), History of ≥ 2 Concussions (OR=5.0), Lateral WBRA Time ≥ 62 s (OR=5.0), Lateral WBRA RT ≤ 558 ms (OR=4.3), and Diagonal WBRA Asymmetry Average for RT, Spd, Acc, and Dec $\geq 18\%$ (OR=4.3). Receiver operating characteristic area under curve (AUC) = .895, with ≥ 3 of 5 factors positive providing 75% sensitivity and 88% specificity (OR=21.0). Factors that discriminated suboptimal from optimal CoV included OWI ≤ 82 (OR=9.0), Lateral WBRA RT Asymmetry $\geq 33\%$ (OR=6.8), Left–Right VMRT-DT Difference ≥ -22 ms (OR=5.8), VMRT Outer/Inner Ratio ≥ 1.29 (OR=5.0), and Diagonal WBRA Asymmetry Average for RT, Spd, Acc, and Dec $\geq 20\%$ (OR=5.0). Receiver operating characteristic AUC = .857, with ≥ 3 of 5 factors positive providing 56% sensitivity and 94% specificity (OR=19.3).

Conclusions: Our findings strongly support those of previous studies that have documented relationships between HRV and neural processes associated with brain executive functions. Each of the performance measures and survey responses that discriminated suboptimal from optimal RMSSD and CoV have previously been related to neural processes that support situational awareness. The associations we identified may have been influenced by prior concussion, emotional state, overtraining, or some combination of these factors.

Total Word Count: 405

[209733CB](#)

Association of Lower Extremity Non-Contact and Contact Injuries With Previous Concussion History in Adolescent Athletes

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Context: A growing body of literature suggests that there is an increase in the likelihood of musculoskeletal injuries following clinical recovery and return to play after a concussion. Currently, there is a paucity of evidence that has examined this relationship in adolescent athletes and the association of concussion with contact or non-contact lower extremity injuries. Therefore, the purpose of this study was to determine the association between concussion and subsequent contact and non-contact lower extremity injuries in a cohort of adolescent athletes.

Methods: This study used a cross-sectional survey design to determine the association between concussion and subsequent contact or non-contact lower extremity injuries in a cohort of adolescent athletes. The study took place at adolescent sport club tournaments with athletes ages 12 to 18 that participated in club sports. Participants completed an anonymous survey which included injury history (previous 24 months), sport participation history, and demographic information. Participants reported injuries (including month/year) in organized sport and classified their injuries based on provided descriptions as either a contact, non-contact, gradual onset injury, or concussion. For participants that reported a concussion, lower extremity injuries were then categorized as prior to the concussion date (previous injury) or after the concussion date (future injury). Non-concussed participants were matched on age (+/- 1 year), sex, and primary sport for each concussed participant. For non-concussed participants, the date of lower extremity injury was compared to their matched participant's concussion date and categorized as a "previous injury" or "future injury." Multivariable logistic regression analyses were used to examine associations between a concussion event and a subsequent lower extremity injury while controlling for age and any previous lower extremity injury.

Results: Two-hundred and thirty-eight athletes reported a prior concussion (Female=96, 40.3%) and were matched with 238 non-concussed athletes. Reporting a concussion was significantly associated with any future lower extremity injury (OR [95%CI]=2.37 [1.55-3.68], $p<0.001$). Reporting a concussion significantly increased the odds of a non-contact lower extremity injury (4.93 [1.80-17.3], $p=0.004$). However, reporting a concussion was not significantly associated with contact lower extremity injuries (1.42 [0.81-2.52], $p=0.223$).

Conclusions: Concussions in adolescents may predispose these athletes to future lower extremity musculoskeletal injuries, especially non-contact injuries. The mechanism of a non-contact lower extremity injury after a concussion in adolescents may demonstrate neuromuscular impairments that are difficult to detect with current clinical tests. A 4.93 OR is greater than previous studies observed, which may demonstrate the vulnerability of the developing brain to potential neuromuscular deficits proposed in previous studies. Athletic trainers should be aware of the risk of non-contact lower extremity injuries after a concussion. Lower extremity neuromuscular interventions directed by an athletic trainer may help reduce the risk of lower extremity injuries after a concussion event during adolescence.

Total Word Count: 444

207441MA

Association of Visual-Cognitive-Motor Integration With Core and Lower Extremity Injury in College Football

Rogers KE, Bridges VA, Johnson QW, Albright AT, Acocello SN, Wilkerson GB

Context: Recent research has linked mTBI to substantially increased risk for sport-related musculoskeletal injuries upon return-to-sport. Although mTBI and musculoskeletal injury history are non-modifiable factors, previous research has established visuomotor reaction time (VMRT) and whole-body reactive agility (WBRA) performance as potentially modifiable factors that associate with reduced injury risk.

Methods: A cohort of 52 Division I-FCS football players (20.1 ± 4.2 yrs, 186.3 ± 5.3 cm, 104.2 ± 16.3 kg) were assessed prior to initiating preseason practices. Single-task (ST) and dual-task (DT) VMRT was quantified using Dynavision D2TM 60-s tests, with the DT condition including a cognitive-motor flanker test. WBRA was quantified by TRAZER[®] using 20 lateral and 12 diagonal movements. Training was then conducted over a 7-week period and consisted of VMRT-DT and WBRA trials 1-3 times per week. A median of 11 training sessions was completed by 48 players (Range: 3-13 sessions). Injury surveillance was performed throughout the following pre-season and 11-game season, with each practice or game counting as 1 exposure. Injury was defined as any core or lower extremity (CLE) sprain or strain requiring evaluation and treatment. Receiver operating characteristic analyses were used to define the optimal cut-point for each potential predictor value. Cross tabulation, logistic regression, and time-to-event analyses were used to quantify associations with CLE injuries.

Results: A total of 51 injuries were sustained among 52 players with ≥ 1 injury sustained by 50% of players. Seven variables were identified to associate with CLE injury and logistic regression analyses yielded a 5-factor model ($\chi^2(5) = 30.03$; $P \leq .001$; Hosmer & Lemeshow Goodness-of-fit $\chi^2(8) = 5.08$; $P = .749$; Nagelkerke $R^2 = .586$). Factors retained in the model included starter status, positive CLE injury history, positive concussion history, WBRT Diagonal-Back Acceleration ≤ 2.26 m/s², and WBRT Diagonal Total Time ≥ 68 s. Training improvement in WBRA Diagonal Total Time ≥ 6 s (OR = 2.80) and WBRA Diagonal-Back Acceleration of any amount (OR = 6.05) were associated with avoidance of CLE injury. Failure to improve in both factors resulted in a 53% Positive Predictive Value and 100% Negative Predictive Value. Cox regression analysis demonstrated significant high vs. low risk (defined as 5-Factor Beta Sum ≥ 4.38) difference in time-to-injury ($\chi^2(1) = 30.13$; $P \leq .001$; HR = 8.54, 90% CI: 4.06, 17.97).

Conclusions: Our findings suggest that interactions among non-modifiable and modifiable factors highlight the importance of individualized risk profile assessment. The greatest potential for CLEI risk reduction, based on our results, appears to be training for improvement of whole-body visual-cognitive-motor integration in those with suboptimal neuromechanical performance, particularly when concomitant concussion history or starter status exists.

Total Word Count: 411

206745CD

Associations Between Contact/Collision Sport Participation and Key Concussion Care-Seeking Behaviors Among First-Year Collegiate Student-Athletes: The BANK Study

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Context: Timely concussion care-seeking is essential for student-athletes to receive appropriate care and management post-concussion. Athletic trainers often lead concussion education and policy efforts at their institutions. However, data on key factors, such as participation in contact sports and other team level considerations that may contribute to these behaviors are limited. Understanding such factors may support Athletic Trainers' efforts in providing targeted concussion education and development of concussion-related policy. This study aimed to: 1) describe the prevalence of concussion care-seeking behaviors in a sample of collegiate student-athletes; and 2) examine the association between contact/collision sport participation and concussion care-seeking behaviors.

Methods: The cross-sectional survey study included a convenience sample of first-year collegiate student-athletes from two institutions (n=389; age=18.3±0.8 years; 33.2% female, 28.6% with a previous concussion history; 86.4% with contact/collision sport participation). Participants completed a pre-validated questionnaire in a classroom setting. All constructs had acceptable internal consistency (Cronbach's alpha >0.80). The independent variable was previous participation in collision/contact sports versus non-contact sports and was obtained by student-athletes reporting high school sport participation, prior to arriving at their current institution. Dependent variables included self-reported engagement in four concussion care-seeking behaviors: 1) reported possible concussive symptoms to someone in authority or a medical professional; 2) continued participation in athletic activity with concussion symptoms; 3) removed self from athletic participation due to possible concussion symptoms; and 4) witnessed a teammate report another teammate's possible concussion to someone in authority or a medical professional. Four separate multivariable binomial regression models, all adjusted for self-report concussion history and gender, examined the association between contact/collision sport participation and care-seeking behaviors. Resulting Prevalence Ratios (PRs) whose 95% Confidence Intervals (CI) excluded 1.00 were statistically significant.

Results: Overall, 29.6% indicated reporting concussions symptoms, 24.9% reported participating with concussion symptoms, 22.1% indicated removing themselves from participation due to concussion symptoms, and 41.4% indicated witnessing a teammate report another teammate's concussion. When adjusting for previous concussion and gender, a significantly higher proportion of individuals with contact/collision sport participation observed a teammate report one of their teammate's concussions (PR=2.4; 95%CI=1.4, 4.5; Table 1). No other associations were observed between contact/collision sport participation and concussion care-seeking behaviors. Table 1 includes the adjusted PRs and 95%CIs for each outcome comparing those with previous contact/collision sport experience versus those without.

Conclusions: These findings suggest a greater proportion of first year contact/collision sport athletes have observed teammates reporting others' concussions to someone in authority or a medical professional. Teammates may serve as advocates for their teammates' health and well-being, particularly with identifying concussions that may otherwise remain unreported. These data may help athletic trainers inform student-athletes that reporting a teammate's concussion and helping them seek care is relatively common, especially in contact/collision sports.

Total Word Count: 444

[208683DD](#)

Associations Between Quadriceps Function and Changes in Gait Biomechanics Between Level and Downhill Walking Following Anterior Cruciate Ligament Reconstruction

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Context: Aberrant gait biomechanics and quadriceps dysfunction predispose individuals with anterior cruciate ligament reconstruction (ACLR) to post-traumatic osteoarthritis (PTOA) development. However, there is limited evidence evaluating the influence of quadriceps function on gait biomechanics during downhill walking following ACLR. Navigating the environment involves changing grades, and walking downhill places greater demands on the quadriceps compared to walking on level ground. As such, understanding the influence of quadriceps function on downhill walking mechanics may provide insight to the pathogenesis of PTOA following ACLR. We hypothesized that individuals with greater quadriceps dysfunction would display changes in gait biomechanics from level to downhill walking consistent with greater PTOA risk.

Methods: This cross-sectional study was completed in a research laboratory with 28 individuals who were greater than 1-year post ACLR (age 20 ± 2 yr, time since ACLR 3.6 ± 2 yr). Quadriceps function was assessed in the involved limb via an isokinetic dynamometer with the participant positioned at 90° of knee flexion and 85° of hip flexion. Three maximal voluntary isometric contractions (MVIC) were completed from which the peak torque, linear rate of torque development (RTD), and instantaneous RTD (InstRTD) were averaged for analysis. Level and downhill walking biomechanics were assessed at the participant's self-selected walking speed on an instrumented split-belt treadmill. Downhill biomechanics were assessed with the treadmill at a 10° grade. Discrete variables were evaluated over the first 50% of stance including the peak vertical ground reaction force (vGRF), internal knee abduction moment, internal knee extension moment, knee flexion angle, and knee abduction angle. Moments were normalized to %body weight*height and vGRF was normalized to %body weight. Gait biomechanics were reported as change scores from level to downhill conditions. All analyses were evaluated with one-tailed partial-Pearson correlations controlling for gait speed and time post-ACLR.

Results: Greater peak torque was significantly associated with a larger increase in internal knee extension moment ($p= 0.042$, $r= 0.345$) from level to downhill. Similarly, greater InstRTD was significantly associated with a larger increase in peak knee flexion angle ($p= 0.011$, $r= -0.447$) from level to downhill. There were no other significant correlations between our variables of interest.

Conclusions: Quadriceps dysfunction following ACLR has been linked to smaller knee flexion angles and internal extension moments. Downhill walking requires greater knee flexion angles and extension moments compared to level ground, thus placing greater demands on the quadriceps. Individuals with poorer quadriceps function displayed smaller changes in these outcomes, mimicking the "stiffened knee response" that has been linked to PTOA development. Continued clinical emphasis should be placed on improving quadriceps function following ACLR and engaging patients in more challenging in functional gait retraining tasks. Future research should be directed towards creating interventional strategies to improve gait following ACLR.

Total Word Count: 445

[208614ED](#)

Associations of Diaphragm Contractility with Postural Control, Health-Related Quality of Life and Perceived Instability in a Chronic Ankle Instability Population

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Context: It has been suggested that altered reorganization of the sensorimotor system following an initial ankle sprain may lead to a chronic neuromuscular maladaptation in multiple body locations. Specifically, our previous work has identified altered diaphragm contractility in individuals with CAI. Recently, published literature has demonstrated altered diaphragm function during postural activity in patients with other musculoskeletal conditions. Further, previous studies have documented potential associations between chronic maladaptions of diaphragm activity and HRQL. Altered diaphragm contractility could associate with clinical deficiencies, such as postural control deficits and self-reported disability, commonly observed in CAI patients. However, no study has determined if diaphragm function contributes to postural control and self-reported disability in a CAI population. The purpose of this study was to examine associations of diaphragm contractility with postural control, regional and global HRQL, as well as perceived ankle instability in individuals with CAI.

Methods: Using a cross-sectional design, 25 participants with CAI (5M, 20F; Age=23.08±3.37yrs; Height=169.67±8.03cm; Mass=68.71±9.89kg) volunteered. An ultrasonography assessment was performed to quantify the right and left hemi-diaphragm thickness at the end of resting inspiration and expiration in supine while breathing quietly. The degree of diaphragm contractility was calculated from the diaphragm thickness measured as the distance from the middle of the pleural line to the peritoneum lines using electronic calipers. Participants performed 3 eyes-closed trials of a 20-second single-leg balance task on the involved limb. Center of pressure trajectories in the anteroposterior and mediolateral directions were sampled at 100Hz and used to calculate approximate entropy for each direction. The resultant approximate entropy (R-ApEn) was then calculated and used as a postural control outcome variable. Regional and global HRQOL was assessed with the Foot and Ankle Ability Measure Activities of Daily Living (FAAM-ADL) and Sport (FAAM-S) subscales, the Short Form-36 (SF-36), and the Psychological Response to Sport Injury Inventory (PRSII). Perceived ankle instability was assessed with the Cumberland Ankle Instability Tool (CAIT). Pearson product moment correlations were employed to examine correlations of diaphragm variables with static postural control, HRQL, and perceived instability measures. Significance was set at $P < .05$.

Results: Fair to moderate correlations of the left hemi-diaphragm contractility were observed with R-ApEn ($r = -0.47$, $P = .009$), mental component scores of the SF-36 ($r = -0.53$, $P = .006$), FAAM-ADL ($r = -0.34$, $P = .049$), FAAM-S ($r = -0.40$, $P = .025$), and CAIT ($r = -0.39$, $P = .027$). The right hemi-diaphragm contractility was fairly correlated with R-ApEn ($r = -0.38$, $P = .032$), physical component scores of the SF-36 ($r = -0.38$, $P = .040$), the PRSII devastation subscale ($r = -0.37$, $P = .045$), and CAIT ($r = -0.45$, $P = .012$).

Conclusions: Our findings indicate that diaphragm contractility could be a potential source for clinical deficiencies and disability commonly observed in CAI patients. Future investigation is needed to determine whether incorporating diaphragm breathing exercises have beneficial effects on improvements in patient outcomes in CAI patients.

Total Word Count: 442

208033QB

Athletic Trainer Services by Locale and Employment Provider in the Secondary School Setting: The Athletic Training Locations and Services Project 2019 Update

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Context: Athletic trainer (AT) services across public (PUB) and private (PVT) United States (U.S.) secondary schools (SS) is known, however the extent of these services by geographic locale is yet to be determined. The purpose of this study is to provide updated key information pertaining to the extent of AT services by locale and employment trends across U.S. SS.

Methods: Data was acquired and continually updated using a longitudinal, multimodal acquisition process from June 2015-May 2019. Information related to PUB (n=16,076) and PVT (n=4,196) SS with a school-sanctioned interscholastic athletics program from all 50 states and the District of Columbia, was obtained and included. Descriptive statistics, including counts and percentages for full time (FT), part time (PT), and no AT services data for PUB, PVT, and combined (PUB+PVT) by state, employment, locale, and by NATA district, are included. FT services were defined as: AT services provided to only 1 school, ≥ 5 days/week, ≥ 30 hours/week, and ≥ 10 months/year. PT services were defined as anything less than FT, and no AT services is self-explanatory. Locale information was accessed through the National Center for Education Statistics framework and relies on standard definitions developed by the U.S. Census Bureau. Employment settings included: school district employee (SD), school district employee with teaching responsibilities, medical/university facility (MUF), and independent contractor (IC).

Results: In PUB+PVT SS schools with athletics programs (n=20,411), 66% (n=13,488) receive AT services, while 34% (n=6,923) have no AT services. Of those SS with AT services, 36% (n=7,417) receive FT services and 30% (n=6,071) receive PT. Table 1. depicts access to AT services in U.S. PUB+PVT SS by NATA District and Nationally by locale. City and suburban locales (72% and 80%, respectively) have higher access than town (69%) and rural (54%) locales. PUB SS have the highest percentage of AT access across all locales, while PVT SS have the lowest. Of the SS ATs who completed the ATLAS Survey (n=7,817), 59% are employed by MUF (59%), while 36% are employed by the SD (23% without teaching responsibilities, 13% with teaching responsibilities), 6% are employed as IC and 3% are unknown.

Conclusions: The national percentage of SS with AT services and percentage of SS with FT and PT services were similar to previous reports, with the same concern that 34% of U.S. SS do not have access to an AT. Additionally, as locale becomes less populated, access to AT services decreases, with PUB schools having overall greater access than PVT schools. These findings can support current ATs in advocating for access to appropriate medical care for their student athletes.

Total Word Count: 420

208125ID

Athletic Trainers' Attitudes, Beliefs and Use of Patient-Reported Outcome Measures Vary by Educational Background

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Context: There has been a strong push towards the integration of patient-reported outcome measures (PROMs) in athletic training. This is evidenced by the inclusion of Evidence-Based Practice within the 5th Edition of the Athletic Training Education Competencies in 2011 and the 2014 Standards for Accreditation of Post-Professional Degree Programs. The impact of these educational changes on the attitudes, beliefs, and use of PROMS in clinical practice is unknown.

Methods: A standardized scale for healthcare professionals was distributed via email to 4,000 athletic trainers practicing in collegiate and secondary-school settings. The scale consisted of 20 Likert-type questions regarding attitudes towards PROMs with subsections for Acquiring and Using PROMs and Benefits of PROMs. Also, included in the survey were questions concerning their actual use of PROMs, demographics, and educational background. Acquiring and Use and Benefits subscores along with an Overall Attitude score were calculated from responses. Higher scores indicated more positive beliefs/attitudes. Scores were compared based highest degree (bachelor's, master's, clinical doctorate, research/educational doctorate), year of professional program graduation (2013-2018 vs. pre-2013), and type of post-professional master's degree (AT related vs. non-AT) using one-way analyses of variance with Tukey's post-hoc, independent T-tests, or Kruskal-Wallis tests based on independent variables and normality. Frequency of PROM use (about half or greater vs. sometimes or never) was evaluated using a chi-square test ($\alpha=0.05$).

Results: A total of 482 participants completed the survey (12.1% response rate, 222(44%) males, age 36 ± 10 years, 12 ± 9 years practicing). Significant differences for Acquiring and Use, Benefits, and Overall Attitude were observed based on highest degree ($p=0.039, 0.029, 0.012$), type of master's degree ($p=0.043, 0.262, 0.049$), and year of professional program graduation ($p=0.049, 0.036, 0.037$; Table). Specifically, those with clinical doctorates reported higher scores as compared to those educated at the bachelors ($p=0.049, 0.001, 0.016$) and/or master's ($p=0.024, 0.001, 0.007$) level. Those completing an AT-related master's reported more positive Acquiring and Use scores than those completing a non-AT related master's post-certification ($p=0.049$). Similarly, those graduating 2013-2018 had higher scores on all three measures compared to pre-2013 graduates. There were no meaningful differences seen in use of PROMs with 90% of participants reporting using PROMs "sometimes" (30%) or never (60%) in their clinical practice ($p=0.104, 0.401, 0.462$).

Conclusions: Athletic trainers' attitudes and beliefs towards PROMs varied based on educational background. These variations may be due in part to changes in educational policy and professional framework over the last decade. However, actual use of PROMs remained low regardless of background.

Total Word Count: 388

208004PA

Athletic Trainers' Behaviors Considering the Adoption of Environmental Heat Policies in the Secondary School Setting

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Context: Exertional heat stroke is one of the top three causes of sport-related death. Consequently, athletic trainers (ATs) need to develop heat-related injury policies. Current evidence suggests that Wet-Bulb Globe Temperature (WBGT) is the most suitable environmental heat stress index that should be used by ATs to guide heat stress mitigation policies in sports. The purpose of this study was to evaluate current behaviors of ATs concerning the adoption of environmental monitoring policies for the modification of activity in the heat using a health behavior model.

Methods: Utilizing a cross-sectional design, a national sample of ATs practicing in the secondary school (SS) setting (n=3309) were invited to complete an online questionnaire regarding best-practice recommendations related to environmental heat monitoring policies at their SS. Recommendations were derived from the NATA Inter-Association Task Force Document – Preventing Sudden Death in Secondary School Athletics Programs. Questions were structured following the Precaution-Adoption Process Model (PAPM); a health behavior model that examines participant's readiness to act. If participants stated they were not adopting a global heat illness prevention policy, they were not asked further questions. SS zip codes as reported by the ATs were categorized into heat-safety regions (region 1, 2, 3). Overall, 365 ATs (59.2% female, age: 35±10 years, 82.5% working in a public school) completed the questionnaire and were included in analyses (response rate = 11.0%). Frequencies were tabulated for each recommendation and heat safety region. Prevalence ratios (PR) with 95% confidence intervals (CI) compared the prevalence of health behavior stages between specific recommendations, and among regional locations.

Results: Overall, 70.8% (n=255/360) of the ATs in this sample reported adopting a policy for activity modification in the heat; however, only 54% (n=136/252) reported using WBGT (Table 1). Of the ATs that reported adopting a heat policy, 10.3% (n=26/252) reported they have decided not to adopt a WBGT policy. Athletic trainers were significantly more unaware for the need of a WBGT policy compared to the need for a regional specific policy (12.7% vs. 6.8%; PR=1.87; 95% CI= 1.07, 3.29). The prevalence of reporting 'decided not to act' for the adoption of a WBGT policy was higher in region 1 compared to region 3 (25.6% vs. 6.9%; PR=3.69; 95% CI= 1.66, 8.23).

Conclusions: Most ATs appear to be adopting a written policy for activity modification in the heat; however, only half report adoption of a WBGT-specific policy. Variations in the PAPM highlight the need for tailored interventions based on the behaviors experienced by ATs. The higher prevalence of ATs 'deciding not to act' for WBGT in cooler regions (region 1) of the United States suggests the need for increased education to ATs in SS on the need for environmental policies, regardless of geographical location.

Total Word Count: 445

[207944AA](#)

Athletic Trainers' Perception on Treating and Managing Ankle Sprains

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Context: Ankle sprains are a common occurrence in athletes and the general population. The high volume of ankle sprains places an elevated clinical burden on Athletic Trainers (AT). While there is a position statement from the National Athletic Trainers' Association (NATA) regarding the treatment and management of ankle sprains, there may be factors that impact an AT's ability to effectively implement the recommendations. Therefore the purpose of this study was to evaluate the current understanding, perceptions and difficulties ATs have regarding the treatment, management, and long-term effects of sustaining an ankle sprain.

Methods: Seven hundred and ninety-six ATs across all athletic training job settings (years certified= 12.1 ± 9.2 years) participated in this cross sectional study. Participants completed a thirty-eight-question survey that recorded demographic information, as well as perceptions and knowledge on the epidemiology, treatment, and management of ankle sprains. The survey also documented participants' patient education practices, attitudes regarding the NATA position statement concerning ankle sprains, and any challenges and pressures to its implementation. Descriptive statistics and analyses of variance were used to analyze the data collected and evaluate group differences.

Results: Eighty-three percent of the participants exhibited answered four to six out of nine questions regarding ankle sprain epidemiology correctly. Group differences were seen between education levels, years certified, and job setting in the way patient education was emphasized. Overall, 38.1% of ATs were either unsure or unaware of the existence of the NATA position statement, but those aware of it expressed it to be a 3.89 on a scale from one to five, regarding usefulness; with a one being "Not Useful at All", three being "Neutral" and five "Very Useful". There were on average of 1.9 ± 0.88 challenges documented to implementing effective treatment and management practices, and an average of 2.0 ± 0.95 pressures reported to returning athletes to play following a LAS, with the top two pressures coming from coaches and student-athletes, respectively.

Conclusions: Nearly 40% of ATs were either unaware or unsure of the current recommendations available to inform how ankle sprains are treated, which could impact how care is delivered. Although ATs of all settings, education levels and years certified expressed confidence in the NATA position statement, challenges and pressures were also reported to effectively implementing its recommendations.

Total Word Count: 364

208415BD

Athletic Trainers' Perceptions of Accessibility to Healthcare Delivery Resources for Those Working Per Diem Services

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Context: As the demand for athletic training services has grown, the per diem athletic training setting has expanded to fulfill this need. Per diem services are provided by athletic trainers (AT), hired as independent contractors for shorter periods, such as a day or week. Although per diem services allow medically underserved populations to connect with healthcare providers, there is potential for inconsistent access to necessary infrastructure and resources. The purpose of this study is to examine current practices in per diem services and evaluate ATs' accessibility to healthcare delivery resources.

Methods: We used a cross-sectional design with certified ATs who have provided per diem services within the past year. Participants were recruited via email to complete a web-based survey, content validated using best practice guidelines and an expert panel. The survey assessed the ATs access to other healthcare providers, referral network, medical equipment and supplies, and a site-specific emergency action plan (EAP) during their most recent per diem experience. Data was extracted from a larger research study.

Results: Emails were sent to 4733 potential participants; 448 participants responded (access rate=9.57%), of which 210 were ineligible (46.9%). Of those that were eligible, 192 participants completed the tool in its entirety (completion rate=80.7%) (age=38±12y; years certified=14±11y; years providing per diem services=8±8y). Most participants indicated they were recruited by an event coordinator (n=42/192, 21.9%) to provide services. A majority of participants provided services in the youth sports setting (n=135/192, 70.3%). Most participants had access to a site-specific EAP (n=122/192, 63.5%), medical equipment and supplies (n=108/192, 56.3%), and/or a referral network (n=117/192, 60.9%). Of those that had access to a site-specific EAP, most indicated that it was imperative to providing services (n=96/122, 78.7%). A majority of participants with access to medical equipment and supplies indicated it was imperative (n=97/108, 89.8%). Of those with access to a referral network, a majority of participants indicated it was imperative to providing patient care (n=66/117, 56.4%). On the contrary, many participants did not have access to other healthcare providers (n=49/192, 25.5%). Of those that had access to other healthcare providers, most indicated that it made no difference on their ability to provide patient care (n=29/49, 49.1%) and similarly those who indicated they did not have access to other providers, perceived no impact on their ability to provide services (n=76/127, 59.8%).

Conclusions: A majority of per diem ATs had access to healthcare delivery resources and they indicated the resources were imperative. Per diem ATs without access to the resources believed healthcare delivery resources were important, but may not have impacted them when they last provided per diem services. However, resources like an EAP could be critical to both practicing at the top of the license and saving lives.

Total Word Count: 445

208293BD

Athletic Trainers' Perceptions of Accessibility to Informatics Resources for Those Working Per Diem Services

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Context: Athletic trainers (AT) hired for short, periodic terms of work provide per diem services. Per diem services help to increase access to care for medically underserved populations, but due to the transient nature of the work, quality of care may be compromised. The purpose of this study was to examine the accessibility to informatics resources for ATs providing per diem services.

Methods: The research team used a cross-sectional design with certified ATs who have provided per diem services within the past year. The web-based survey was content validated using best practice guidelines and an expert panel. ATs indicated their access to consent to treat, medical history, and documentation methods during their most recent per diem experience. If they had access to the resource, they specified whether it was essential to provide patient care. If the participant indicated they did not have access or were unsure if they had access, they indicated the degree to which this impacted patient care and their perceived importance in providing patient care. Data were extracted from a larger research study.

Results: Emails were sent to 4733 potential participants; 448 participants responded (access rate=9.57%), of which 210 were ineligible (46.9%). Of those that were eligible, 192 participants completed the tool in its entirety (completion rate=80.7%) (age=38±12y; years certified=14±11y; years providing per diem services=8±8y). Most participants indicated they were recruited by an event coordinator (n=42/192, 21.9%) to provide services. A large majority of participants provided services in the youth sports setting (n=135/192, 70.3%). Most participants had access to a method of documentation (n=118/192, 61.5%) and indicated it was imperative to providing per diem services (n=96/118, 81.4%). On the contrary, most participants did not have access to patients' medical history (n=154/192, 80.2%) or consent to treat verification (n=126/192, 65.6%). Of those with access to medical histories, most indicated that it was imperative to their work (n=21/33, 63.6%). Those who indicated they did not have access to medical histories, indicated not having access was only slightly impactful (n=71/154, 46.1%). Of those with verified consent to treat, most indicated it was imperative to provide patient care (n=34/43, 79.0%). ATs that did not have access to consent to treat verification indicated there was no impact on their ability to provide care (n=56/126, 44.4%).

Conclusions: When provided access to either consent to treat, medical history, and/or a documentation method, ATs found these informatics resources to be imperative for per diem services. In contrast, when there was no access or participants were unsure, there was little to no perceived impact. Although these resources are necessary for delivering best practice, there were variations in the perceived importance of these resources while providing patient care during their latest per diem experience.

Total Word Count: 443

[208665BD](#)

Athletic Trainers' Perceptions of Accessibility to Legal Resources for Those Working Per Diem Services

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Context: Athletic training per diem services are provided by athletic trainers (AT) who are hired specifically for on demand work, typically in shorter time periods. The purpose of this study is to examine current practices in per diem athletic training and evaluate ATs' accessibility to legal resources to perform medical services.

Methods: We used a cross-sectional design of certified ATs who have provided per diem services within the past year. Participants were recruited via email to complete a web-based survey, content validated using best practice guidelines and an expert panel. The survey assessed the ATs access to a written contract, directing physician, standing orders, and professional liability insurance (PLI) during their most recent per diem experience. Data were extracted from a larger research study.

Results: Emails were sent to 4733 potential participants; 448 participants responded (access rate=9.57%), of which 210 were ineligible (46.9%). Of those that were eligible, 192 participants completed the tool in its entirety (completion rate=80.7%) (age=38±12y; years certified=14±11y; years providing per diem services=8±8y). Most participants indicated they were recruited by an event coordinator (n=42/192, 21.9%) to provide services. A majority of participants provided services in the youth sports setting (n=135/192, 70.3%). Most participants had access to professional liability insurance (n=162/192, 84.4%) and indicated it was imperative for providing per diem services (n=36/74, 48.6%). On the contrary, most participants did not have access to a written contract (n=106/192, 55.2%), directing physician (n=97/192, 50.5%), or standing orders (n=105/192, 54.7%). Of those who did have access to a written contract, most felt it was imperative for patient care (n=38/82, 46.3%). Most participants who did not have access to a written contract, indicated the lack of access had no impact on their ability to provide services (n=60/106, 56.7%). Of those who had access to a directing physician, most indicated that it was imperative for their work (n=32/53, 60.4%). Whereas ATs who did not have access to a directing physician, most indicated that not having access made no impact on their services (n=51/97, 52.6%). Of those who had access to standing orders, most indicated that the orders were imperative for patient care (n=126/162, 77.8%). Of those ATs who did not have access to standings orders, a majority perceived no impact on their ability to provide services (n=58/105, 55.2%).

Conclusions: ATs with access to written contracts, a directing physician, standing orders, and/or professional liability insurance found them imperative for patient care while rendering per diem services; ATs who did not, found they had no impact. Although participants articulated varied perceptions about the need and access to legal resources, these create a safe infrastructure for which to provide medical services and should be part of the regular dialogue when considering independent contracting.

Total Word Count: 444

209933JB

Athletic Trainers' Perceptions of and Experience with Social Determinants of Health in the Collegiate and University Setting

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Context: Individual and population health are affected more by factors related to living, school, and work environments than health care received. These factors, referred to as social determinants of health (SDOH), include education, transportation, housing, employment, health systems and services, income, physical environment, public safety, and social environment. Few efforts have been made to understand athletic trainers' (ATs) perceptions of and experience with SDOH and the impact that they have on both the patient. The purpose of this study was to evaluate ATs perceptions of and experiences with SDOH in the collegiate/university setting.

Methods: This was a cross-sectional, survey based study. The survey was distributed to a sample of ATs via email invitation. The survey consisted of three repeating questions relating to 10 SDOH. These questions were focused on ATs' perceptions of each SDOH to 1) recognize specific personal experience managing a patient case related to the negative impact of the SDOH, 2) evaluate perception of influence of SDOH on health and well-being, and 3) determine the level of agreement with whether the SDOH is a concern in athletic health care. Responses were recorded on a 4-point Likert scale (strongly disagree-strongly agree). Descriptive statistics were reported including frequencies, percentages, means, and standard deviations.

Results: Of the 1694 ATs who completed the survey (completion rate=92.6%), 403 reported working in the collegiate/university setting (159 males, 242 females, 1 preferred not to respond, 1 missing; age=36.5±11.0 years, AT experience=15.2±10.6 years). ATs reported having at least one experience managing a patient case where a social factor had a negative influence on patient health and well-being with an average of 6.5 out of 10 social factors. ATs most frequently reported managing patient cases in which lifestyle choices (94%, n=377/403), social support (80.9%, n=326), and access to quality and timely health care (71.2%, n=287) negatively influenced a patient's health. Reported less often were government policies and programs (43%, n=174/403) and employment status (52%, n=211/403). The majority of ATs agree (40%) or strongly agree (56%) that social factors influence a person's health and well-being and agree (50%) or strongly agree (36%) social factors are a concern in athletic health care (Figure 1).

Conclusions: ATs working in the college/university setting report having managed a patient where a social factor negatively influenced patient outcomes and also perceive social factors to be influential on patients' health and well-being. Social factors, such as lifestyle choices, social support, and access to quality and timely health care were reported most often. Efforts to educate ATs on commonly reported, impactful social factors and associated evaluation approaches are needed to support whole patient care. Additionally, future research should explore effective interventions aimed at reducing the negative impact of SDOH at the point of care.

Total Word Count: 445

[209384JB](#)

Athletic Trainers' Perceptions of Social Determinants of Health

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Context: Social determinants of health (SDOH) include education, transportation, housing, employment, health systems and services, economic status, physical environment, and social environment, and public safety. It is important for health care providers to understand and address SDOH, as these factors can impact and influence patient outcomes. However, it is unclear how athletic trainers (ATs) perceive SDOH or how knowledgeable they are about the social factors that contribute to SDOH. A better understanding of ATs' perceptions of SDOH will help inform patient care with the goal of producing positive patient outcomes. The purpose of this study was to evaluate ATs' perceptions (self-reported familiarity, knowledge, comfort) of and knowledge about SDOH in athletic healthcare.

Methods: The study was a cross-sectional survey design, administered via Qualtrics (Qualtrics, LLC, Provo, UT). Out of 17,000 ATs invited to complete the survey, 1,829 accessed the survey (access rate=10.8%) and 1,694 completed the survey (completion rate=92.6%; 533 males, 856 females, 1 intersex, 1 transgender, 3 other, 6 prefer not to respond, 294 missing; age=36.6±10.8 years; athletic training experience=15.2±10.6 years). The survey consisted of several multipart questions that evaluated ATs' perceptions of their familiarity, knowledge, and comfort with SDOH concepts, as well as measured knowledge. Composite knowledge scores were calculated by correctly identifying SDOH (range=0-9 points), with higher scores indicating greater knowledge. Descriptive statistics were used to report means, standard deviations, frequencies, and percentages.

Results: Only a small percentage (4.14%; n=70/1691) of ATs self-reported they were extremely familiar with SDOH, while the remainder reported being moderately familiar (45%; n=761/1691), minimally familiar (34.71%; n=587/1691) or not familiar at all (16.14%; n=273/1691) with SDOH. Very few ATs self-reported being extremely knowledgeable (2.73%; n=46/1686) about SDOH, while the majority of ATs self-reported being moderately (38.89%; n=622/1686), minimally (41.76%; n=704/1686), or not knowledgeable at all (18.62%; n=314/1686). ATs demonstrated average composite knowledge scores of 6.1±2.7 (Figure 1). Further, few ATs reported being extremely comfortable (3.49%; n=59/1691) with SDOH, while the majority of ATs reported being moderately comfortable (35.36%; n=598/1691), minimally comfortable (41.10%; n=695/1691) or not comfortable at all (18.62%; n=314/1691).

Conclusions: ATs perceived their self-reported familiarity of, knowledge about, and comfort with SDOH to be moderate to low. Given the relative newness of SDOH in athletic health care, these findings are not surprising. Efforts are needed to develop strategies for educating ATs about SDOH in patient care and promoting familiarity and comfort with identifying these factors in practice because of the significant impact on patients' health and wellbeing. Additionally, future research should explore which SDOH are observed by ATs at the point-of-care among patients in a variety of settings so that efforts to promote their assessment in patient care can be obtained with the aim to create positive patient outcomes.

Total Word Count: 444

[208253QD](#)

Athletic Trainers' Perspectives of Telemedicine

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Context: Telemedicine is the use of technology in the delivery of healthcare. Its use can result in increased healthcare efficiency, decreased cost to patients, and enhanced inter-professional collaboration resulting in increased clinician and patient satisfaction rates. While the benefits of telemedicine have been noted in the literature, the use in athletic training has been limited. Therefore, the purpose of the study was to examine athletic trainers' perspectives of telemedicine.

Methods: We used a cross-sectional web-based survey delivered to credentialed athletic trainers that were members of the National Athletic Trainers' Association (n=628/5,666; access rate=11.1%). Overall, 512 (81.5% of respondents) athletic trainers qualified for the study and completed at least 50% of the survey (age= 37+11 years; females=294; master's degree holder=323; worked in secondary or collegiate setting=299). In the survey, the participants self-identified as users or non-users of telemedicine technology in clinical practice based on a provided definition. The survey also consisted of a 39-item telemedicine experience tool adopted from previous literature and adapted for athletic training. The telemedicine tool consisted of questions from six subscales of telemedicine: perceived advantages, perceived disadvantages (inverse Likert-scale), current knowledge, perceived necessity, perceived security, and perceived ease-of-use measured on a 5 point Likert-scale respective to agreement (1=strongly disagree to 5=strongly agree) or rating (1=none at all to 5=a great deal). Data were analyzed using descriptive statistics and a one-way ANOVA between users and non-users along the six telemedicine tool subscales.

Results: We identified approximate groups for telemedicine users (n=214; 41.8%) and non-users (n=298; 58.2%). Both telemedicine users and non-users self-identified knowledge of telemedicine as their lowest subscale (Table 1). We identified mutual disagreement that telemedicine caused psychological harm to patients (n=495/512; mean=1.90+0.84) and a strong mutual agreement that a framework to prevent breaking data confidentiality when using telemedicine was necessary (n=468; mean=4.85+0.44).

The users of telemedicine agreed more strongly with the advantages of telemedicine ($P \leq 0.01$), strongly disagreed about disadvantages ($P \leq 0.01$), had higher knowledge ($P \leq 0.01$), found telemedicine simple to use ($P \leq 0.01$), and identified a greater necessity for telemedicine ($P \leq 0.01$). There was no difference between groups for perceived importance of security ($P = 0.801$) with users and non-users both strongly agreeing about the importance of security.

Conclusions: These results suggest athletic trainers that self-identify as users of telemedicine technology in their athletic training clinical practice have more positive perceptions respective to the efficiency, knowledge, necessity, benefits, and drawbacks for telemedicine. Regardless of previous experience, concerns related to security were identified in both groups. We suggest that athletic trainers have formal exposure to telemedicine during professional, post-professional, or continuing education modules to encourage future use. During the education and training on telemedicine, we recommend a focus on security relative to safeguards, data breaches, and legal frameworks for technology in clinical practice.

Total Word Count: 446

209854MD

Athletic Training and Wildland Fire: Providing Athletic Training Services to Smokejumpers

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Context: Previous Wildland Firefighter (WLFF) injury research indicates that WLFF injuries are largely musculoskeletal in nature. Although continued research into WLFF injuries is critical in order to develop and implement injury prevention strategies, it is also clear that an intervention is necessary to gain further insight into the types of injuries WLFF face to effectively develop these strategies. By providing athletic training services to WLFF on a routine basis, we can gain understanding to this escalating problem in hopes of improving WLFF performance on the fire line and reduce injury risk. The purpose of this study was twofold: 1) to examine utilization of an athletic trainer at a Smokejumper base throughout the 2019 wildland fire season; and 2) to document Smokejumper satisfaction with the services provided.

Methods: An athletic trainer (AT) was introduced to 80 Smokejumpers on a regional base and was available on site daily for consultation and mobility assessments throughout the 2019 fire season. The AT maintained a journal documenting patient encounters with Smokejumpers. Forty-three smokejumpers (54%) sought out AT services and 192 patient encounters occurred. Two researchers independently conducted thematic analysis on the patient encounter journal. Frequency of each theme was then calculated using Microsoft Excel. At the end of fire season, the Athletic Training Satisfaction Survey (ATSS) was administered to Smokejumpers who had interacted with the AT. The researchers developed the ATSS and 5 subject matter experts reviewed the survey to establish face and content validity. The ATSS consisted of 13 questions (11 Likert scale items scored 1 as not satisfied at all to 5 very satisfied and 2 closed ended questions relating to desired additional AT services). Mean scores on each Likert statement and a composite score were calculated summing the total of each Likert scale statement in the survey for a total possible score of 55. Twelve Smokejumpers completed the survey (28%, n=12/43) which was offered both in paper and electronic format.

Results: The patient encounter journal revealed four primary reasons for AT consultation: exercise prescription (31%, n=59/192); mobility assessments (30%, n=58/192); injury consultation (27%, n= 51/192); and patient education (12%, n= 24/192). Likert scores regarding satisfaction with AT services ranged from 4.67 to 4.92 (see Table). The average composite score was 53.5 + 2.9 out of a possible 55 points. The most common additional services requested included manual therapy and on site injury rehabilitation.

Conclusions: Smokejumpers were very satisfied with AT services provided throughout the 2019 fire season on a single regional base. The AT was most sought after for exercise prescription and mobility assessments; however, interest was expressed in expanding services offered on site. A need for additional AT services and further integration into the Smokejumper community was suggested in this study.

Total Word Count: 446

209815RD

Athletic Training Perceptions of Community Service and Civic Engagement Following a Service-Learning Experience

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Context: The benefits of service learning experiences have been reported throughout health care education. However, there are currently no empirical investigations of the impact of service learning experiences on athletic training students. Two commentaries regarding service learning in athletic training education were published nearly 10 years ago, both of which promoted the benefits of and need for service learning experiences in athletic training education, yet no investigations have been published that explore service learning in athletic training education. Therefore, the purpose of this study was to assess athletic training students' attitudes and perceptions of community service and civic engagement after participating in a service learning experience.

Methods: This study was conducted using a descriptive research design in a classroom setting. Twenty eight final year students (18 females, 10 males, 21.3 ± 0.6 years old,) in an accredited undergraduate athletic training program at a public university participated in a service learning experience and were subsequently recruited to participate in the study. Each student participated in 4 hours of service learning experience in the fall and spring semesters, for a total of 8 hours. The service learning experience took place in a free medical clinic in an urban location. The Center for Healthy Communities Service Learning Survey (1999, with permission) was administered anonymously online (Qualtrics Inc., Provo, UT) prior to and following the service-learning experience. The Mann-Whitney U test was used to analyze each item on the instrument, with significance set at $p < .05$ (IBM SPSS Version 24; Armonk, NY).

Results: There were statistically significant changes in 3 of the 15 items on the instrument. Mean scores decreased on the Likert-scale (1 – strongly agree, 2 – agree, 3 – somewhat agree, 4 – neutral, 5 – somewhat disagree, 6 – disagree, 7 – strongly disagree) from pre to post for the following items: I feel well prepared to practice my profession in a community similar to the community in which my placement is located ($U = 242, Z = -2.205, p < 0.05$), I believe students should volunteer their time helping people without resources ($U = 235.5, Z = -2.244, p < 0.05$), I feel that I can have a positive impact on the community in which I work by volunteering my time ($U = 253, Z = -2.054, p < 0.05$).

Conclusions: Athletic training students' perceptions of preparation for and recognition of the importance of volunteering in underserved communities increased following the service learning experience, indicating that the positive impact of service learning that has been documented in other health care professions also transcends into athletic training service learning experiences.

Total Word Count: 425

208835RC

Athletic Training Student Application of the Core Competencies During Clinical Education: A Report From the Athletic Training Clinical Education Network

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Context: To enhance the quality of patient care, it is important that athletic trainers integrate the components of the core competencies (evidence-based practice [EBP], patient-centered care [PCC], health information technology [HIT], interprofessional education and collaborative practice [IPECP], quality improvement [QI], professionalism) as a part of routine clinical practice. While research has previously focused on athletic training students' (ATs) perceptions of these core competencies, it is unclear in what ways, if any, they are integrating them throughout patient encounters (PEs) during clinical education experiences. The purpose of this study was to describe which core competencies ATs are incorporating during PEs.

Methods: Twelve CAATE-accredited professional athletic training programs (7 undergraduate, 5 graduate) participated in this study. A multi-site panel design was used to promote ATs of the participating programs to track PEs via E*Value (MedHub, Minneapolis, MN) during the 2018-2019 academic year. In addition to other variables collected, ATs were asked to report if behaviors reflective of five of the core competencies (professionalism excluded) occurred during each PE. Descriptive statistics (frequencies, percentages) were used to summarize the characteristics of the core competencies during PEs.

Results: Data on 30,630 PEs were entered by 363 ATs. Of the five core competencies reported, EBP behaviors were the most frequently incorporated during PEs (74.3%, n=22773/30630), followed by QI (72.8%, n=22147/30630), PCC (56.6%, n=17326/30630), HIT (35.4%, n=10,857/30630), and IPECP (18.4%, n=5627/30630). A breakdown of the behaviors of each core competency is displayed in Figure 1.

Conclusions: It is unsurprising that EBP behaviors were most frequently incorporated during PEs due to the heavy emphasis of this core competency in athletic training education over the past several years. It is also unsurprising that of the PCC behaviors, ATs reported discussing the patient's goals most frequently since this component is also connected to EBP. Of concern is the fact that ATs only reported using clinician-rated outcomes (CROs) during 14.4% of PEs, suggesting a need to better understand whether ATs are not using CROs or are not familiar with the term. It is alarming that ATs reported the components of HIT were not included in 65% of PEs, indicating that an electronic medical record (EMR) was not used nor were data from an EMR considered during the PE. However, the biggest concern is that IPECP behaviors were omitted from 82% of the almost 31,000 PEs documented, suggesting that ATs are not routinely engaging with other healthcare professionals or learners during clinical experiences. Findings from this study suggest that more effort is needed to ensure the core competencies are being integrated during ATs' clinical experiences. Future research should compare inclusion of the core competencies by clinical experience setting as well as an ATs' role during PEs.

Total Word Count: 440

209163QC

Athletic Training Student Patient Encounter Characteristics During Immersive and Non-Immersive Experiences: A Report from the Athletic Training Clinical Network

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Context: The 2020 Standards for professional athletic training programs from Commission on Accreditation of Athletic Training Education (CAATE) contain many changes from the last iteration of standards. One of the more significant changes for professional programs is the requirement to include at least one immersive clinical experience (ICE). Per the 2020 Standards, students at ICEs are expected to see more patient-care opportunities and job responsibilities and duties that athletic trainers complete than those at a non-immersive clinical experience (N-ICE), but it is unknown whether immersive experiences provide more of these opportunities than integrated experiences do. Therefore, the purpose of this study was to compare the characteristics of patient encounters (PEs) that occurred at ICEs and N-ICEs.

Methods: This study used a multi-site panel design in which 336 athletic training students from 12 professional, CAATE-accredited programs (5 undergraduate, 7 graduate) logged PEs for one academic year (2018-2019). Patient encounters were documented in E*Value (MedHub, Minneapolis, MN) and included whether the PE occurred at an ICE or N-ICE. Participants documented the clinical site type, student role (observed, assisted, performed), patient diagnoses, and procedure(s) performed. Descriptive statistics were used to summarize the characteristic of each PE. Chi-Square tests were used to compare the percentages of student role during PEs in ICEs and N-ICEs ($p < 0.05$).

Results: A total of 10,999 PEs occurred at ICEs and 18,228 PEs occurred at N-ICEs. Immersive experiences mostly occurred at collegiate settings (64%) followed by secondary school settings (29.8%); similar frequencies were found with N-ICEs (collegiate=67.2%, secondary school=24.4%). At ICEs, students performed 70.6% of reported PEs, assisted with 17.2%, and observed 12.2%. At N-ICEs, students performed 72% of reported PEs, assisted with 16.3%, and observed 11.7%. Participants averaged 0.80 diagnoses and 1.35 procedures per PE that occurred at ICEs, compared to 0.82 diagnoses and 1.33 procedures per PE at N-ICEs. Chi-square analyses revealed that there were no significant differences in the percentages of observed ($\chi^2(1) = .00$, $p=1.00$), assisted ($\chi^2(1)=.03$, $p=.862$), or performed ($\chi^2(1)=.007$, $p=.933$) PEs between ICEs and N-ICEs.

Conclusions: Student role during PEs, clinical site type, and PE length similarly occurred at both ICEs and N-ICEs. Programs may intend to use ICEs later in their curriculum to demonstrate progressive clinical autonomy, but administrators should consider that there were no statistically significant differences in student role during ICEs or N-ICEs in this study. More research is needed to examine additional characteristics of ICEs that may have impacted the results of this study such as length of the ICE, timing of ICEs and N-ICEs within program structure, and frequency of patient encounters per day at ICEs.

Total Word Count: 424

208872ED

Atypical Presentation of a Coccyx Dislocation in a High School Football Player

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Background: The coccyx is a site of multiple muscle, ligament, and tendon insertions, providing weight-bearing support during the gait cycle. (Lirette, Chaiban et al. 2014). Dislocation of the Sacrococcygeal is rare, but has been reported in the literature. (Rijal, Pradhan et al. 2004, Kanabur, Gowd et al. 2017). Coccyx dislocations typically present with localized pain around the tailbone and lower back. This is a level 3 exploration case study on the dislocation of the coccyx. The MOI was typical however; the patient had an atypical presentation.

Patient: The patient is a 16-year-old male, plays football, special teams, and offense. The patient fell onto buttock and back while playing football. The patient reported to the Athletic Trainer four days following the injury, with the chief complaint of posterior right knee pain and tightness. Initial evaluation resulted in a diagnosis of strain of the calf complex. The patient had an antalgic gait due to pain with knee extension. The pain persisted and patient presented to Emergency Department for evaluation and treatment two days following the evaluation by the Athletic Trainer. The knee pain was worsening and radiating up the leg, the patient reported to Orthopedic Department for the secondary elevation and treatment. An MRI of the knee revealed no knee or lower leg pathology. The patient's symptoms were exasperated with physical work. The patient reported lumbar pain; the knee and throbbing leg pain, and the antalgic gait patterns persisted. On repeat Orthopedic evaluation a lumbar spine MRI and lower leg ultrasound evaluation were ordered. The MRI was not performed, the ultrasound elevation found no evidence of DVT. The patient sought chiropractic evaluation and treatment. Chiropractic evaluation found radicular pain as well as decreased mobility and tenderness of the lumbar spine. The slump test was positive and the sciatic nerve was tender to palpation.

Intervention & Treatment: The patient was treated with rest, thermal modalities, and rehabilitation. Due to the antalgic gait, the patient was placed on crutches. Reducing pain and increasing ROM were the goal. As the case progressed treatment was advanced with the goal to reduce the patient's pain. With the variable reports of pain and disability, the treatment plan was altered to include stretching and strengthen the low back. The patient was seen daily in the Athletic Training Facility. The literature supports open and closed reduction, physical therapy, and surgery for the treatment of coccygeal dislocation. The patient received Chiropractic care including closed manipulation. Two case studies reported closed reduction, 1 failed and 1 succeeded. Closed manipulation reduced pain, normalized gait, and trunk range of motion. (Rijal, Pradhan et al. 2004, Kanabur, Gowd et al. 2017)

Outcomes or Other Comparisons: After diagnosis and reduction of the coccyx, our patient's symptoms resolved relatively quickly. The athlete returned to sport one-week post diagnosis; however, the patient reported an increase of hamstring tightness and glute tightness that restricted ROM and function. There are few occurrences of this injury in sports reported in literature. This outcome reflects other outcomes reported in case studies focusing on individuals in the normal population. (Rijal, Pradhan et al. 2004, Kanabur, Gowd et al. 2017)

Conclusions: Coccyx dislocations are a rare occurrence, especially in sports. Due to the presentation of symptoms manifesting in the patient's lower leg and an absence of discomfort around the lower back until weeks after the incident, it was difficult for a variety of medical professionals to reach an accurate diagnosis in an appropriate amount of time.

Clinical Bottom Line: Athletic trainers must be sure not to dial in on one location during an evaluation and remember to think locally, regionally, and globally.

Total Word Count: 582

200004QD

Auditing Medical Documentation: A Quality Improvement Project

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Context: Recent literature within athletic training has suggested that medical documentation is not occurring at the frequency or with the quality recommended by the Best Practice Guidelines for Athletic Training Documentation. Various reasons for medical documentation challenges have included time, knowledge of how to use an electronic medical record, and the lack of peer or supervisory review of the completed documentation. Because athletic trainers do not typically bill for their services, medical documentation is rarely audited. The purpose of this quality improvement project was to establish a method and review process for medical documentation chart review.

Methods: We used a quality improvement approach to evaluate medical records at one NCAA Division I athletic training facility in the Midwest. The athletic training facility agreed to engage in quality improvement through medical documentation chart review and all records remained HIPAA-compliant and were reviewed by a healthcare professional within the facility. Faculty advisors, engaged in medical documentation research, previously created a 39-item chart review that was adopted and modified by a previous text and used within the study. The chart review previously underwent two rounds of Delphi panel review until consensus on the included items was met. For each prompt, a positive, negative, and not applicable option was available. Consistency was established through a 3-member team. The final version of the tool was placed within Qualtrics® to allow for an electronic review by the healthcare professional. The healthcare professional randomly reviewed medical documentation of 16 different athletic trainers working in the facility. Data were analyzed by measures of central tendency. Ten documentation files from each clinician were included within the review.

Results: A total of 160 total documentation entries were evaluated in this initial chart review (Table). Athletic trainers' documentation showed that they typically included a specific diagnosis that was signed and dated (154/160, 96.3%). Additionally, athletic trainers often included the patient's societal role (155/160, 96.9%) and previous level of function (151/160, 94.4%). Prompts that related to goals were rarely included within medical documentation [patient goals listed (3/18, 1.9%), goals for every 2-3 weeks of rehab (8/160, 5.0%) goals are quantifiable/measurable (8/160, 5.0%), impairment listed in every goal (160, 4.3%). Additionally, only 25% of the cases (40/160) included the medical history of the patient relative the present illness. As the chart review was an effective method and review process, professional development was provided on the best practices of medical documentation to address deficiencies. Athletic trainers improved on overall chart review scores from 48.1±9.7% pre-professional development to 64.3±11.0% following professional development.

Conclusions: Chart review of medical documentation is a reasonable mechanism to assess quality. Professional development strategies improve medical documentation practices. System-wide quality improvement practices can improve patient care and healthcare delivery.

Total Word Count: 444

200204QB

Becoming an Athletic Trainer: Development of Newly Credentialed Athletic Trainers Through the Transition to Practice

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Context: Transition to practice is a period of growth in which a new athletic trainer (AT) responds to a stressful change and develops confidence and self-efficacy. This transition typically lasts through the first 12-18 months of professional practice. The purpose of this study is to explore this transition longitudinally throughout the first year of practice to further understand how new ATs develop as professionals.

Methods: In this grounded theory study, seventeen newly credentialed ATs who graduated from professional masters' programs participated (11 female, 6 male; 25.6±2.2 years; work settings included college, secondary school, and clinic). Data saturation guided the number of participants. Participants were recruited via purposive sampling. Participants were interviewed via phone using a semi-structured interview guide four times throughout their first year of professional practice. Participants were interviewed at approximately 3, 6, 9, and 13 months after beginning employment. All interviews were recorded and transcribed verbatim. Data were analyzed through grounded theory, with data coded for common themes and subthemes. Trustworthiness was established via peer review, member checks, and multi-analyst triangulation.

Results: Four themes emerged: understanding role, developing relationships, evolution of challenges, and development as an AT. Throughout the transition, new ATs gained further understanding of their role and expectations by living the job and gaining experience. Developing relationships was essential to integrating into the organization, especially with coaches. These relationships were vital to success in their role. If new ATs did not feel supported by coaches, they felt less stability in their roles. Over the course of the first year, ATs faced many initial challenges in understanding roles and managing the athletic training facility; however, as the year progressed challenges evolved to focus more on work-life balance and educating others on the role of ATs. Support from supervisors, coaches, and mentors helped in overcoming challenges. During the first year of practice, new ATs built confidence and relationships. Through time, experience, and reflective practice, new ATs developed their professional practice and felt success in their roles. New ATs defined success as the ability to provide competent patient care while feeling valued as ATs.

Conclusions: The first year of professional practice can be stressful and produce many challenges; however, gaining experience, building positive relationships, and reflective practice can lead to success. While new ATs may not understand every aspect of their role initially, being immersed into the setting can lead to better understanding; however, providing an orientation and onboarding contributes to better role understanding earlier. New ATs should strive to develop quality relationships with coaches and show commitment early in their role, which assists with role integration. Over the first year of practice, new ATs should regularly reflect on their experiences to further develop their style of clinical practice.

Total Word Count: 446

205104MD

Benefits and Barriers Associated With Intention to Participate in an Exercise-Related Injury Prevention Program Within ROTC Cadets

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Context: Exercise-Related Injury Prevention Program (ERIPP) participation is imperative to reduce the risk of musculoskeletal injuries from occurring. There is a lack of participation in ERIPPs within Reserve Officer Training Corps (ROTC) which limits the effectiveness of the programs. Identification of factors which may influence participation in ERIPPs within ROTC cadets is an important first step in improving adoption and adherence rates. Therefore, the purpose of the study was to identify factors associated with intention to participate in an ERIPP within ROTC cadets.

Methods: The study design was cross-sectional design where a paper survey was distributed. Twenty-eight (M/F=23/5; Age=20.68±2.02years; Height=175.78±8.95cm; Mass=75.30±11.10kg) ROTC cadets volunteered to participate in this study during the spring semester. Participants completed the Theory of Planned Behavior Scale (TPBS) on one occasion. The TPBS assesses attitudes towards participating in an ERIPP. The TPBS contains five subscales (perceived benefits, perceived barriers, social norms, social influence, and intention to participate) and consists of 20 items with response choices ranging along a 7-point Likert scale from strongly agree (3) to strongly disagree (-3). A higher score is interpreted as an increased likelihood to participate in an ERIPP for all subscales except perceived barriers where a high score is associated with a decreased likelihood of participating in an ERIPP. The psychometric properties of the scale have previously been established within a physically active population. The independent variables were the subscales of the TPBS and the dependent variable was intention to participate in an ERIPP. Total scores and associated means and standard deviations were calculated for each of the TPBS subscales. A backwards multiple linear regression was used to determine if significant associations between the subscales of the TPBS and intention to participate in an ERIPP existed. Partial eta squared was calculated for each significant variable to determine the strength of the association (small=0.06> η^2 ≥0.01, moderate=0.14> η^2 ≥0.07, or large= η^2 ≥0.15). Alpha was set at P ≤0.05 for all analyses.

Results: There was a significant association between the subscales of the TPBS and intention to participate in an ERIPP ($R^2(4,27)=0.80$, $p<0.001$). Perceived benefits ($B=4.364$, $\eta^2=0.68$, $p<0.001$) had a positive and large association with intention to participate while perceived barriers ($B=-2.43$, $\eta^2=0.40$, $p<0.001$) had a negative and large association with intention to participate. There were no other statistically significant associations ($p>0.05$).

Conclusions: Perceived benefits and perceived barriers were significantly associated with intention to participate in ERIPPs within ROTC cadets. Implementation strategies for ERIPPs may need to focus on the benefits and barriers of participating in an ERIPP to increase adoption and adherence. Therefore, ROTC cadets should be educated on the benefits of ERIPP participation such as decreases in musculoskeletal injury and improvements in functional performance as well and strategies to overcome common barriers to an ERIPP.

Total Word Count: 444

208892QA

Black Athletic Trainers' Experiences Joining and Being Part of the Athletic Training Profession

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Context: The lack of racial diversity in athletic training is immense. Patients report better healthcare experiences when the provider and the patient are of the same race. Black athletic trainers make up 4.3% of all athletic trainers compared to 14.6% of the US population and 16% of NCAA athletes. The purpose of this study was to determine the experiences of Black athletic trainers during their professional athletic training education, advanced degrees, and current job.

Methods: A phenomenological qualitative design consisting of semi-structured phone interviews was used. Interview questions addressed early and professional life experiences, resources, influences, and education. The study was advertised on social media and interested participants were sent a short demographic survey to complete. The survey asked for the participant's age, race, job setting, location, and years of experience. Participants were selected based on their responses in the demographic survey. Participants had to be Black, BOC certified, and currently practicing as an athletic trainer. Interviews were conducted until data saturation was reached. Thirteen athletic trainers (M=6, F=7) from high school (n=5), college (n=3), professional (n=2), physician practice (n=2), and military settings (n=1) participated (35.15±6.75 years). Interviews were recorded, transcribed, and analyzed for themes. Member checking was completed along with peer review of the themes to validate findings.

Results: Six themes emerged: Early Life Experiences, Lack of Diversity, Barriers to Education, Confidence, Lack of Mentorship, and Discrimination. Early Life Experiences includes the sub-themes Financial Need and Parent Involvement which describe the impact money and parenting had on them. Lack of Diversity defines the absence of minorities in the educational and professional setting. Barriers to Education involves the obstacles faced for someone who identifies as Black. Confidence indicates the hard-working ethic yet lack of self-assurance until later in their careers. Lack of Mentorship defines the absence of Black mentors in athletic training education and the profession. Discrimination looks at the situations where race is a key factor to an uncomfortable environment.

Conclusions: Black athletic trainers report early life experiences, specifically financial need and parental involvement that have an influence on their life. Once Black athletic trainers are pursuing their professional and post-professional education they find there are barriers to education, feelings of discrimination, a lack of diversity, a lack of mentorship, and they need to overcome confidence issues with a strong work ethic. Upon entering the workforce, athletic trainers continue to have many of the same experiences as when they were students with lack of diversity in the profession, lack of mentorship, and discrimination.

Total Word Count: 410

200021ED

Blood Biomarkers for Bone Remodeling are Expressed Differently Between Collegiate Cross-Country Athletes With and Without a History of Lower Extremity Stress Fracture

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Context: Lower extremity stress fractures are prevalent among cross-country runners, and a previous history of these fractures places individuals at higher risk of subsequent stress fractures. Blood biomarkers related to bone formation and resorption can be used to further understand this subsequent injury risk. However, the expression of these biomarkers in individuals with a history stress fracture has not been explored. The purpose of this study was to determine if there are differences in the blood biomarkers for bone remodeling between cross-country athletes with and without a history of lower extremity stress fracture. We hypothesize that those athletes with a history of stress fracture will express different blood biomarker levels than those without a history of stress fracture.

Methods: A cross-sectional study conducted at a University biomedical laboratory. A total of 34 (males=16, females=18, age=20.5±2.1 years, height=171.5±8.6 cm, weight=60.3±8.2 kg). NCAA Division-1 cross-country athletes participated this study. A stress-fracture history survey was given to the participants at the beginning of the season. The results of this survey were then used to divide the participants into two groups; those who reported a history of lower extremity fracture (SFX; n=12, male=7, female=5), and those who reported no history of lower extremity stress fracture (nSFX; n=22, male=10, female=14). Blood samples were also taken from each participant at the beginning of the season. A human bone panel and Magpix instrument were used to analyze the blood samples for biomarkers of insulin, DKK1, osteocalcin, osteopontin, PTH, and TNF α . The independent variable was group, and the dependent variables were the blood biomarkers. A Mann-Whitney U test was performed to detect differences in blood biomarker levels between the groups.

Results: There were significantly higher levels of DKK1 in then SFX group compared to the SFX group (834.11 ± 184.42 pg/mL vs. 681.66 ± 201.05 pg/mL, $p = 0.029$). Conversely, insulin levels were significantly lower in then SFX group compared to the SFX group (328.75 pg/mL ± 276.23 vs. 747.35 ± 388.60 pg/mL, $p < 0.001$). There were no significant group differences observed with the other bone biomarkers ($p > 0.05$).

Conclusions: An increased level of DKK1 and a decreased level of insulin were found in cross-country runners who had a history of lower extremity stress fracture compared to those with no history. These results suggest that bone formation is suppressed in individuals with previous lower extremity stress fractures. Further research is needed to determine if these biomarkers can be used to predict lower extremity stress fractures in athletes.

Total Word Count: 407

200091JD

Body Composition and Iron-Related Biomarkers are Influenced by Years of Cross-Country Collegiate Participation

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Context: It has been previously observed that iron deficiency anemia is associated with low skeletal muscle mass (SMM). In addition increases in adipose tissue resulting in obesity have been linked with elevated leptin levels. Participating in collegiate cross-country (CC) can result in physiological adaptations such as changes in body composition. Look at the effects of years of collegiate cross country training on body composition and iron biomarkers

Methods: The study design was cross sectional design. Body composition and blood samples were taken during pre-season. The study included 34 subjects, age 19-25 from a NCAA Div1 CC team. The independent variables were years of collegiate participation and body composition. Participants were grouped as upper division class (UDC) consist of juniors and seniors and lower division class (LDC) consist of freshman and sophomores. Blood samples were collected during pre-season. Body composition was measured using electrical impedance on an InBody 770. CBC and sFer levels were analyzed through enzymatic spectrophotometry. Leptin was measured through Luminex® MAGPIX® multiplex assays. T-test was used to compared Upper and lower classes metabolic biomarkers. Pearson correlations were used to stablish associations between biomarkers and body composition. Statistical analysis was completed with IBM® SPSS Statistics 25 software.

Results: LDC ferritin levels were significantly lower that their UDC counterparts (34.57 ± 27.36 vs 76.76 ± 65.69 pg/mL, $p = 0.04$). Conversely, leptin (3498.99 ± 2099.56 vs 1567.77 ± 1356.93 pg/mL, $p = 0.01$) and body fat mass (23.76 ± 8.17 vs 17.53 ± 6.08 lbs., $p = 0.04$) were significantly higher on the LDC group when compared with the UDC athletes. SMM was leptin ($r = -0.466$, $p = .00$) and positively associated with hemoglobin ($r = 0.725$, $p = 0.00$). Additionally, percent body fat (PBF) was positively associated with leptin ($r = 0.853$, $p = .00$) and negatively associated with hemoglobin (HB) ($r = -0.447$, $p = .00$) and HCT ($r = -0.580$, $p = 0.00$)

Conclusions: Years of collegiate CC training participation resulted in lower PBF, increased ferritin, decreased leptin. Continuous aerobic training on elite athletes commonly results in increase body fat oxidation and PBF reduction. Since leptin is produced primarily in the adipocytes it was expected to observed lower levels of this appetite-regulating hormone on the population with lower BFP. It is likely that the increased ferritin observed in the UDC was due to the university protocols stablished to address iron deficiency anemia in CC athletes. The strong correlation between muscle and hemoglobin may be mediated by the hematopoietic effects of testosterone. Increased hemoglobin may also result in increased ability to deliver oxygen to the working muscle resulting in increase SMM.

Total Word Count: 410

200353AD

Body Composition Measures and Injury Rates Within Collegiate Acrobatics and Tumbling Athletes

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Context: Acrobatics and Tumbling (A&T) is a sport with physical demands similar to gymnastics (e.g., tumbling, tosses, acrobatic lifts). The NCAA recently labeled A&T as an emerging sport, recommending that more NCAA institutions consider the addition of this sport. Due to its emerging status, information on body composition and injury prevalence in A&T is not as well-known as other sports recognized by the NCAA. Therefore, the purpose of this study was to identify and report the injury rates and body composition characteristics of A&T athletes.

Methods: A retrospective chart review occurred within 50 A&T athletes. Information collected included demographics, body composition information from dual-energy-x-ray-absorptiometry measurements (DXA), and injury information associated with the 2018-2019 academic year. Descriptive statistics, including means and standard deviations, were used to evaluate body composition measures including total fat mass (FM), fat-free mass (FFM), bone mineral density (BMD), body fat percentage (BF%), injury rates, and time loss. Dependent t-tests and Wilcoxon Signed-Rank Tests were used to determine the differences between pre and post-season body composition changes within injured and non-injured athletes. All statistical analyses occurred in SPSS version 26. Significance levels for hypothesis testing were set at $p < .05$.

Results: A total of 49 injuries occurred among the A&T athletes evaluated. The majority of injuries occurred in the lower extremity ($n=26$, 53%). Sprains were the most commonly reported injury ($n=12$, 24.5%) followed by overuse injuries ($n=8$, 16.3%), contusions ($n=7$, 14.3%), and fractures or bone-related pathologies ($n=6$, 12.2%). 28% of injuries resulted in time loss lasting over 1 week ($n=14$). Time loss within injured athletes ranged from 1-29 weeks (mean 10, SD 8.25). Injury demographics are provided in Figure 1. Body composition means were 23.36% (SD 3.27) for BF%, 1.273 g/cm² for BMD (SD .109), 29.41 lbs. (SD 7.88) for FM, and 92.44 lbs. (SD 15.04) for FFM. No significant difference was seen in pre and post DEXA body composition measures in BF%, FM, or FFM. However, a significant difference occurred in pre and post-season BMD measures among AT athletes over the year $z=-4.125$, $p < .001$ for all athletes. The mean BMD was higher post-season compared to pre-season.

Conclusions: This study is the first to report body composition measures and injury prevalence rates among A&T athletes. Our findings are similar to injury statistics reported within NCAA sports, including gymnastics athletes. A&T athletes did have differences in body composition findings compared to other reports in NCAA female athletes, including higher mean FM and FFM measures. BF% was within reported ranges compared to other NCAA female athletes. Mean BMD scores in AT athletes are higher than reports within other NCAA female sports, including gymnastics. Additionally, there was evidence that BMD increased by roughly 2% in A&T athletes by yearend.

Total Word Count: 446

209144EB

Capturing the Patient Perspective at Return-to-Play Following an Ankle Sprain Injury: A Report from the Athletic Training Practice-Based Research Network

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Context: The International Ankle Consortium has encouraged the assessment of the patient-reported outcomes when making return-to-play decisions following ankle sprain injuries. However, there is limited evidence regarding patient-reported outcomes at return-to-play, particularly in adolescent athletes. Our objective was to evaluate HRQL, and self-report of pain, function, and disablement at return-to-play following an ankle sprain injury in adolescent patients.

Methods: We retrospectively reviewed electronic medical records within the Athletic Training Practice-Based Research Network. Records were created by athletic trainers working in 19 secondary school facilities between 2009-2019. Patient cases were included if the patient was diagnosed with an ankle sprain injury, restricted from sport participation following injury, and subsequently cleared for full and unrestricted participation. Patients received usual care from an athletic trainer and completed a series of multi- and single-item patient-reported outcome measures at return-to-play capturing ankle-specific function (Foot and Ankle Ability Measure Activities of Daily Living [[FAAM-ADL] and Sport [FAAM-Sport] Modules), HRQL (Pediatric Quality of Life Inventory [PedsQL]), and self-report of pain (Numeric Pain Rating Scale [NPRS]), function (Global Rating of Function [GROF]), and disablement (Global Rating of Disability [GROD]). All patient-reported outcome measures have established measurement properties (reliability, validity, responsiveness), with maximum scores representing no deficits. Variables included patient demographics, sport, number of days to return-to-play, number of episodes of care (EOC), and patient-reported outcome scores at return-to-play, including FAAM-ADL (0-100%), FAAM-Sport (0-100%), PedsQL (0-100 points) NPRS (0-10 points), GROF (0-100%), and GROD (7-point Likert-scale). Descriptive statistics (percentages, frequencies, mean \pm standard deviation, median, interquartile range [IQR]) were also reported, as appropriate.

Results: Forty-four patients (female=58.6%, age=15.4 \pm 1.0 years, height=174.2 \pm 10.7 cm, mass=69.3 \pm 17.5 kg) who were diagnosed with an ankle sprain (ICD-10=S93.409A) were included in this study. Most injuries occurred during basketball (27.3%, n=12), football (27.3%, n=12) or volleyball (11.4%, n=5). Patients received 7.6 \pm 9.0 EOC (median=4.5, IQR=2.0-10.5) over 9.7 \pm 1.7 days (median=6.0, IQR=3.0-12.0) before returning to play. At return-to-play, patients reported deficits in ankle-specific function (FAAM-ADL=86.5 \pm 13.7, FAAM-Sport=71.3 \pm 21.1) and HRQL (PedsQL=88.2 \pm 11.0). A majority of patients (72.7%, n=32) reported some degree of pain (NPRS=2.1 \pm 1.9, median=2, IQR=0.0-3.0) and half of patients (50.0%, n=22) reported functional deficits (GROF=87.1 \pm 10.7%, median=90.0, IQR=80.0-95.0). In addition, 36.4%, (n=16) reported some level of disablement (GROD>"very mild difficulty with my activities of daily living").

Conclusions: Adolescent patients exhibit a myriad of deficits related to HRQL, function, pain, and disability following an ankle sprain injury. These deficits, in conjunction with short return-to-play timelines relative to tissue healing may place these patients at risk for recurrent, chronic, or additional injury. Additionally, single-item PROMs were able to capture similar deficits in these patients as the multi-item PROMs. Future research should determine if optimizing treatment strategies influences patient readiness to return-to-play.

Total Word Count: 432

[207642GD](#)

Carpometacarpal Joint Fusion for Severe Post-Traumatic Arthrosis in a Professional Football Player

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Background: Post traumatic arthrosis of the first carpometacarpal(CMC) joint can may result from Bennett’s fracture dislocations. While CMC arthrosis is a rare injury in the young, athletic population, it can be debilitating to those competing at an elite level, such as the National Football League(NFL). Thumb CMC fusions are common in patients aged 50 years and older, but are rarely performed in elite athletes. This level 2 CASE report describes the treatment and outcome following a CMC fusion for post traumatic CMC arthrosis in a NFL athlete.

Patient: 26 year old male reported to our clinic with a chief complaint of pain at the left base of the thumb. He sustained a Bennett’s fracture and dislocation one year prior and was treated with closed reduction and pinning, but continued pain limited his ability to play football. He had a positive CMC grind test and tenderness to palpation over the CMC joint. Plain radiographs of the CMC joint revealed severe arthrosis of the CMC joint. MRI of the hand revealed severe, chronic resorptive changes at the subchondral plate and subchondral bone of the first metacarpal base and at the entire radial surface of the trapezoid.

Intervention & Treatment: Non-operative treatments including steroid injections, NSAIDs, Tylenol, casting, and cold therapy had been performed to get him through the 2011-2012 football season. Surgery for a CMC fusion with plating and distal radius/allograft bone graft was recommended and the patient elected to proceed. Following surgery, the patient was placed in forearm based thumb spica splint for six weeks. At the six week mark he started weaning out of his splint and therapy started to focus on functional tasks. CT scans were obtained at the 11 and 15 week marks, with the 15 week CT showing full healing of the fusion site.

Outcomes or Other Comparisons: The patient went on to start all 16 regular season games the following season and win multiple Super Bowl championships in following years. This is significant because CMC fusions are most commonly performed in patients above the age of 50 for primary type arthritis who return to activities of daily living or recreational activity. Simonian and Trumble compared closed reduction and pinning with early ligamentous reconstruction and found that 50% of pinning patients had ongoing instability and pain, requiring a follow up surgery. Though the literature does not currently include reports of patients returning to high level sport following a CMC fusion, Lutonsky and Pellar reported positive outcomes of 14 arthrodeses of the CMC which yielded complete unions in all cases, as well as reduced grip pain and increased grip strength in nearly all patients.

Conclusions: This patient was treated with a thumb CMC fusion and was able to return to football as a defensive lineman in the NFL with limitations and no pain.

Clinical Bottom Line: CMC fusion allowed this high level NFL athlete to return to football.

Total Word Count: 467

206821AD

Cellulitis in Women's Soccer Preseason

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Background: Cellulitis is a bacterial skin infection that can potentially be fatal if left untreated. It is most commonly presented on the lower extremities though it can occur elsewhere on the body. It typically presents with symptoms of itching, rash, swelling, blisters, pain and tenderness over the area. Similar symptoms can also be presented with contact dermatitis, which is a reaction to a substance that causes an irritation on the skin. Open wounds associated with contact dermatitis can allow the bacteria, staphylococcus, to enter the body and form cellulitis. The best way to eliminate the infection is through antibiotics

Patient: A 19 year old female collegiate soccer athlete initially sought care for a sprained ankle. Athlete was taped with a preventative inversion ankle tape job. After that night's practice the athlete presented with a rash on her foot and lower leg. She was sent home with hydrocortisone cream to help treat the rash. It was believed that she had an allergic reaction to the Tuff Skin spray, though she had previously stated she had no known allergy to the spray. The next day the athlete was taped again without any spray and participated in practice as normal, still presenting with signs of an allergic reaction. The following day, at an away game, the athlete came to get taped but now had noticeable blisters on her foot surrounding the base of her toes. She also presented with noticeable hives and bumps up both thighs and on her chest.

Intervention & Treatment: She was sent to urgent care when she arrived back home where she was diagnosed with cellulitis as well as a heat rash; which explained the hives that had spread to her chest and thighs. It has now become known that the athlete has highly sensitive skin. It is common for cellulitis to present similar to a rash including signs of redness, itching, swelling and occasionally blisters. Due to the original presentation of the reaction it was just believed to be contact dermatitis until the blisters became noticeably worse. Athlete went to urgent care and was administered an antibiotic to help eliminate the bacteria and prevent it from traveling further. She was also given a solutions to soak her foot in to help reduce the severity of the contact dermatitis.

Outcomes or Other Comparisons: This case had initially presented as contact dermatitis due to the adhesive spray "Tuff Skin". It is believed that the cellulitis developed from the contact dermatitis. The itching and friction as well as the build up of a moist environment from sweating is ideal for bacteria to form and travel; the cellulitis was given its window of opportunity to form. It is common for cellulitis to present as painful, swelling, redness, blisters and tenderness.

Conclusions: Due to the intensity of the allergic reaction and rate of speed it had advanced to, it is recommended to clean the area consistently throughout the reaction. Early recognition and intervention of this diagnosis is most beneficial in order to prevent the spread and worsening of the infection. Knowing the athletes medical history is most challenging when they themselves are unaware, so treating the situation with caution and care serves the best outcomes.

Clinical Bottom Line: Athlete acquired contact dermatitis from adhesive spray used to help stabilize a previously injured ankle. The dermatitis rapidly progressed within 72 hours and the athlete was soon diagnosed with cellulitis. Due to the intensity of the allergic reaction from the tuff skin spray care must be carefully monitored and administered.

Total Word Count: 572

206012CA

Change in Baseline BESS Performance Among High School Athletes Following Sport-Related Concussion

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Context: Balance may be impaired following sport-related concussion. Therefore, it is recommended that baseline measures of balance performance are obtained to help clinicians determine concussion-associated balance recovery post-injury. While annual baseline assessments are recommended, resources are often limited in the high school setting, and it is not uncommon for baseline tests to be administered biannually. It is important for clinicians to understand how balance performance might change over those two years, especially with an intervening concussion, before relying on these baselines to inform clinical decisions. Therefore, our objective was to compare the change in baseline balance performance in high school athletes over a two-year timeframe with and without an intervening concussion.

Methods: This retrospective study used clinically-collected de-identified data from 420 high school athletes (236 males, 184 females, ages 15.4 ± 2.6) who participated in mass baseline testing settings at several high schools 630.6 \pm 152.1 days apart. The study was deemed exempt the Institutional Review Board. Balance Error Scoring System (BESS) testing was performed using the C3Logix iPad application strapped to each participant's back. Test administrators manually counted and recorded errors in each stance while sway volume was recorded automatically by the application. Data were coded, de-identified and exported from C3Logix and from separate electronic medical records (EMR) to confirm athlete match. The data were separated into two groups consisting of 390 non-concussed athletes (age= 15.4 ± 2.4 years), and 30 concussed athletes (age= 15.2 ± 2.8 years). Group classification was determined through the documentation of concussion in the school's EMR. BESS error scores and iBESS volumes (mathematical representation of three-dimensional sway) were utilized as outcome measures for each stance. Generalized estimating equations (GEE) were calculated using SPSS to determine if there was a difference between groups for each stance from baseline 1 to baseline 2. Significance level was set a priori at $p < 0.05$. Power was determined through calculation of effect sizes.

Results: In the concussed group, there were 283.3 \pm 184.6 days from baseline one to injury and 364.2 \pm 195.4 days from injury to re-baseline. There were 630.6 \pm 152.1 days between baseline assessments in the control group. The GEE results for total error count, error count and iBESS volume per stance were not significantly different between groups (Table). Small effect sizes indicate that any differences are likely of questionable clinical significance. Negative effect sizes present for both individual stance and iBESS volume indicate that the concussed group outperformed the control group in this study.

Conclusions: Our primary finding demonstrated little change between BESS error scores and ellipse volume from baseline 1 to baseline 2 regardless of an intervening concussion. Clinically, the overall stability between baseline assessments found in this study suggest that balance may not need to be assessed biannually.

Total Word Count: 434

208175EB

Changes in Patellofemoral Joint T1ρ Magnetic Resonance Imaging Relaxation Times Following ACL Reconstruction

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Context: The patellofemoral joint (PFJ) is at an increased risk for the development of posttraumatic osteoarthritis (PTOA) following anterior cruciate ligament reconstruction (ACLR); yet it remains unclear how early following ACLR PTOA changes begin within the PFJ. Compositional changes in the articular cartilage, such as decreased proteoglycan density, are early markers of PTOA development. Proteoglycan density can be estimated in vivo using T1ρ magnetic resonance imaging (MRI) relaxation times. The objective of this study was to compare T1ρ relaxation times of the PFJ articular cartilage at 6 and 12-months post-ACLR on the ACLR and contralateral limb.

Methods: A cross-sectional study design with 20 participants (11 males, 9 females; age=22±3.9yrs; mass=76.11±13.48kg; height=178.32±12.32cm) was used. All participants underwent a primary unilateral ACLR (31±16 days post-ACLR) using a bone-patellar tendon-bone autograft. MRI were acquired bilaterally at 6 and 12-months post-ACLR. Voxel by voxel T1ρ relaxation times were calculated using a five-image sequence created with a MatLab program (MathWorks, Natick, MA, USA). Greater T1ρ relaxation times were interpreted as worse proteoglycan density. The articular cartilage of the femoral trochlea and patella were manually segmented using ITK-SNAP software on the ACLR and the contralateral limb. Following the initial segmentation, the articular cartilage of the femoral trochlea and patella were evenly divided into medial and lateral regions of interest (ROI). Separate repeated measures ANOVAs were performed to compare 6 and 12-month T1ρ relaxation times of the femoral trochlea and patellar cartilage ROI in the ACLR and contralateral limbs (p<0.05).

Results: For the medial patella and lateral trochlea, T1ρ relaxation times increased in both limbs between 6 and 12-months post ACLR [medial patella: F(1,19)=7.79, P=0.012; lateral trochlea: F(1,19)=4.698, P=0.043]. For the lateral patella, T1ρ relaxation times were significantly greater on the contralateral limb compared to the ACLR limb [F(1,19)=14.156, P=0.001]. A significant limb by time interaction was found for T1ρ relaxation times at the medial trochlea [F(1,19)=6.136, P=0.023]. Simple main effects analysis demonstrated T1ρ relaxation times of the medial trochlea on the ACLR limb were significantly greater at 6 (ACLR=57.69±4.50ms vs. Contralateral=55.07±3.01, P=0.005) and 12-months (ACLR=61.10±4.22ms vs. Contralateral=56.20±3.88), P<0.001) compared to the contralateral limb. Further, T1ρ relaxation times of the medial trochlea significantly increased from 6 to 12-months on the ACLR limb (6-months=57.69±4.50ms vs. 12-months=61.10±4.22ms, P=0.003). There were no significant changes in T1ρ relaxation times of the medial trochlea on the contralateral limb from 6 to 12-months (P=0.163).

Conclusions: The PFJ articular cartilage in both the ACLR and contralateral limbs appears to undergo deleterious compositional changes associated with diminished proteoglycan density post-ACLR. These data suggest that PTOA related changes at the PFJ may begin early and bilaterally following ACLR. Continued research is needed to understand what factors may play a role in these changes at the PFJ post-ACLR.

Total Word Count: 447

[2079930D](#)

Changes of Ankle Dorsiflexion Using Compression Tissue Flossing: A Systematic Review

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Context: Impaired dorsiflexion range of motion (DFROM) has been contributed to a predictive measure for lower extremity injury. Compression Tissue Flossing (CTF) may address tissue restrictions associated with impaired DFROM, however, a consensus has yet to support these effects. The purpose of this systematic review was to collect, critically appraise, and summarize the available literature regarding CTF on DFROM in physically active individuals.

Methods: PubMed and EBSCO Host (CINAHL, MEDLINE, SportDiscus) were searched from 1965 to July 2019 for related articles using the combination of the following terms related to compression tissue flossing and DRFOM. Search limits were set to full text and peer-reviewed publications written in English. Additional articles were found through a hand search of references. Inclusion criteria was set for experimental designs that included physically active participants which investigated DFROM. Articles were excluded based on non-peer-reviewed text, absence of ROM measurement, absence of immediate effects of CTF, or if a non-experimental design was implemented. Two investigators independently assessed methodological quality of included studies with the Physiotherapy Evidence Database (PEDro) and Strength of Recommendation Taxonomy. Studies were categorized as high quality if they scored $\geq 60\%$ on the PEDro. Means, standard deviations, and sample sizes were extracted and categorized as pre to post-intervention and control to intervention. Hedges g effect sizes (ES) were calculated using extracted data to examine the magnitude of differences. Descriptive statistics (mean, median, minimum, maximum, and Z-skewness) were used to summarize ESs for each comparison.

Results: A total of 174 studies were retrieved from the systematic search and six were included in the analysis. All studies included pre versus post-intervention comparisons, while only five studies compared control versus intervention changes. DFROM was measured in all studies using the weight-bearing lunge assessment, while three studies included goniometric measurements. The average PEDro score was 60% (range=30-80%) with four out of six studies considered high quality and 2 as low quality. Pre to post-intervention comparisons of DFROM demonstrated a moderate effect after CTF was used (ES: Mean=0.48; Median=0.31; SE=0.20; Min=-0.56; Max=1.74; Z-skewness=0.50; Lower Bound: Mean=-0.39; Median=-0.32; SE=0.13; Min=-0.32; Max=1.74; Z-skewness=0.11; Upper Bound: Mean=1.34; Median=1.21; SE=0.30; Min=-0.16; Max=3.24; Z-skewness=0.77). Control versus intervention comparisons of DFROM demonstrated weak effect (ES: Mean=0.13; Median=-0.02; SE=0.19; Min=-0.32; Max=1.35; Z-skewness=0.48; Lower Bound: Mean=-0.70; Median=-0.60; SE=0.19; Min=-1.56; Max=-0.07; Z-skewness=0.22; Upper Bound: Mean=0.96; Median=0.82; SE=0.28; Min=0.07; Max=2.76; Z-skewness=0.37).

Conclusions: There is Grade B evidence to suggest CTF may result in moderate DFROM improvements from pre to post-intervention; as well as evidence to suggest CTF has a weak to no effect on DFROM when compared to a control. It is important to note that effects were highly variable between studies for both comparisons. Further research is needed to assess the true efficacy of CTF.

Total Word Count: 443

209355QC

Characteristics of Patient Encounters for Professional Athletic Training Students: A Report From the Athletic Training Clinical Education Network

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Context: Professional athletic training students (ATs) are required to complete athletic training clinical experiences and supplemental clinical experiences which are increasingly complex and which must occur with varied client/patient populations. Additionally, ATs must gain experience with patients with a variety of health conditions commonly seen in athletic training practice. The objective of this study was to examine characteristics of patient encounters (PEs) that occur during professional ATs' clinical experiences.

Methods: A multi-site, panel design was used to examine PEs (30,446) for ATs (n=363) in twelve CAATE-accredited professional athletic training programs (7 graduate, 5 undergraduate) through utilization of E*Value (MedHub, Minneapolis, MN) software during the 2018-2019 academic year. The ATs documented PE information on length of encounter, site of encounter, patient gender, patient age, student role (performed, assisted, observed), clinical experience type (immersive, non-immersive), diagnosis (ICD-10 codes, n=204 codes), and procedure (e.g. initial evaluation, thermotherapy, etc., n=65 procedures). ATs could provide more than one diagnosis and/or procedure per PE, but minimally recorded on of each per PE. Descriptive statistics (frequencies, percentages) were used to summarize characteristics of the PEs.

Results: PEs occurred at college/university (n=20060, 65%), secondary school (n=8343, 27.2%), clinic (n=1622, 5.3%) and other (n=589, 1.9%) settings. Patient gender included 58.8% males and 41.2% females with 27.5% of PEs being pediatric cases and 72.5% being adult cases. The majority of PEs were 1-30 minutes long (87.9%) with student role predominantly being performed (n=21,801/30523, 71.2%). ATs completed 60% of the PEs within a non-immersive clinical experience. The most frequent diagnoses recorded were ankle sprain/strains (n=2573/24562, 10.5%), low back pain (n=1069/24562, 4.4%), and knee sprain anterior cruciate ligament (n=1062/24562, 4.3%). The most frequent procedures recorded included knee/thigh rehabilitation (n=3194/41267, 7.7%), massage (n=3078/41267, 7.5%), and cryotherapy (n=2899/41267, 7.0%). Musculoskeletal evaluations (n=9904, 24%), modality applications (n=8666, 21%), and rehabilitation procedures (n=7840, 19%), were the most commonly reported thematic procedural areas.

Conclusions: The most common diagnoses recorded by ATs in clinical experiences aligns with epidemiological studies within athletic training practice related to injury prevalence. Prevalent procedures performed included rehabilitation, modality application, and musculoskeletal evaluation therefore supporting the foundation of athletic training. The frequency of all other health conditions was limited, therefore programs should be intentional about providing students with these opportunities possibly through patient simulations. Further investigation is warranted concerning the types of PEs commonly seen or absent within certain settings and with varied populations in order to address Standards.

Total Word Count: 390

204892BD

Chronic Idiopathic Urticaria and Angioedema in a Division I Long Jumper

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Background: An eighteen-year old female Division 1 long and triple jumper presented with painful urticaria of the thighs and elbows. The athlete was completing a warm-up run in the grass when she first noticed the onset of symptoms. Upon evaluation, the athlete reported a history of spontaneous swelling and anaphylaxis related to an unknown environmental trigger. After the initial reaction was controlled, she was referred to the team physician and then on to an allergist for further evaluation.

Differential Diagnosis: Allergic rhinitis, allergic conjunctivitis, pharyngitis, anaphylaxis, Lyme disease and hereditary angioedema, including C1 inhibitor and functional levels, and c1Q

Intervention & Treatment: Due to the nonspecific trigger of these episodes of swelling, a generalized antihistamine regimen, cetirizine hydrochloride, levocetirizine, and diphenhydramine, was prescribed by physicians in the Pediatric Allergy and Immunology department at the University of Chicago. Despite this intervention, symptoms worsened, and episodes began to occur daily. She developed severe angioedema of the face and neck on 9/12/18 and was treated with 0.3 mg epinephrine and 6 mg of prednisone in the emergency room. On 9/20/18, she was diagnosed with infectious mononucleosis. The frequency, intensity, and duration of the episodes of her swelling decreased following the resolution of the mononucleosis. She remained relatively asymptomatic, with only occasional, brief episodes of urticaria from –October of 2018 through May of 2019 and was able to return to full training and competition. During June of 2019, her episodes returned with increased severity and frequency. She was hospitalized again for swelling of the throat. Following the apparent failure of her high dose antihistamine regimen, consultation with the allergists at the University of Chicago and Carle Physician Group, suggested she be prescribed omalizumab to treat her chronic idiopathic urticaria and angioedema. She began the omalizumab injections in October of 2019.

Uniqueness: It was difficult to protect this athlete from subsequent episodes of swelling due to the unknown nature of the trigger to her symptoms. The varying severity and location of her swelling was cause for repeated patient education on independence and self-advocacy in the event of a potential emergency. The comorbidity of mononucleosis and its inherent immunosuppression may have been related to the repeated severe episodes of angioedema she sustained from August through September. However, it is still unclear why her symptoms again returned several months later.

Conclusions: The athlete did not sustain any episodes of significant urticaria or angioedema for several months before symptoms returned with increased severity and frequency. She remains on high dose antihistamines, levocetirizine 5 mg twice daily, 10mg montelukast sodium daily, 25 mg diphenhydramine as needed, and an epinephrine auto-injector if needed. After consultation with her sports medicine team, an acute treatment plan was devised to manage her case during training. When she is severely symptomatic with urticaria or having painful edema, she is withheld from practice until swelling has resolved and pain is tolerable before returning to activity. This plan has been successful in preventing the exacerbation of any urticaria and angioedema into an anaphylactic episode. If the omalizumab is successful in resolving her chronic spontaneous urticaria and angioedema, it is recommended that athletes with similar presentation of idiopathic swelling be immediately referred to an allergist for prescription of high dose antihistamines and the omalizumab injection if symptoms do not improve.

Total Word Count: 535

207625AD

Chronic Inflammatory Demyelinating Polyradiculoneuropathy in a Division II Baseball Pitcher

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Background: Patient is a 19 year old, Caucasian male left-handed baseball pitcher. Patient reported previously experiencing this issue the year before, which resolved with stretching and range of motion (ROM) exercises. Patient underwent a routine pre-participation orthopedic screening one month prior to onset. Initial complaint was right shoulder paresthesia in dermatomes C3-C6 during a barbell back-squat. Initial physical exam revealed no tenderness to palpation, equal bilateral shoulder strength, and unremarkable special tests. Postural assessment revealed rounded shoulders and excessive thoracic kyphosis. As the patient was asymptomatic, the upper quarter screen was normal. Initial plan was to remove from pitching, increase scapular strength, ROM, and monitor for improvement over the next week. Five days later patient experienced an inability to lift their right arm during a workout. Evaluation revealed a positive Roo's, Allen's, and Hawkins impingement test, but a negative Adson's test. Due to diminished strength and ROM no other special tests were performed.

Differential Diagnosis: Following the patient's initial evaluation and prior history, impingement was the leading differential diagnosis, with other possibilities including thoracic outlet syndrome and labral tear. The orthopedist ordered a MRI arthrogram of the right shoulder, and an EMG. The neurologist ordered a nerve conduction study (NCS), immunoglobulin A, complete blood count, erythrocyte sedimentation rate, hemoglobin A1C, complete metabolic panel, vitamin B12, thyroid stimulating hormone, free T4, lumbar puncture, and CT of the brain.

Intervention & Treatment: Upon orthopedic evaluation it was suspected the patient had a SLAP lesion that developed a cyst, causing the radiculopathy, and possible cubital tunnel syndrome. The MRI revealed a SLAP lesion without a cyst. EMG confirmed the suspected cubital tunnel syndrome, in addition to severe sensory axonal loss and demyelinating changes of the motor nerves tested. Based on EMG results the patient was referred to a neurologist, who ordered a full blood workup, and NCS prior to the patient's first visit. The only abnormal marker in the blood workup was an elevated alkaline phosphatase level. The NCS showed a sensory motor polyneuropathy with demyelinating features. Based on these results the neurologist diagnosed the patient with Chronic Inflammatory Demyelinating Polyradiculoneuropathy (CIDP). A CT of the brain and lumbar puncture were ordered to determine treatment. The lumbar puncture revealed an elevated red blood cell count and proteins in the cerebral spinal fluid. The CT was normal. The patient was treated with a prednisone taper starting at 40 mg per day, ending 12 weeks later at 10 mg every other day. At the conclusion of treatment the patient was asymptomatic, cleared to return to pitching, and made a full return to pitching.

Uniqueness: In this case the asymptomatic SLAP lesion led to the diagnosis of CIDP. CIDP is a condition where the immune system attacks the myelin sheath of the nerves, and has no known causes. CIDP mirrors Guillain-Barre Syndrome in its symptomology. However, CIDP is chronic, generally occurring over 8 weeks, whereas Guillain-Barre Syndrome presents acutely following an infection. CIDP has an incidence rate of 0.5-1.6 cases per 100,000. The majority of cases occur in males, children, individuals 30-60 years old, and the elderly. In this case it occurred in an otherwise healthy 19 year old male.

Conclusions: The importance of a sports medicine team that is able to work together and is able to refer to the other experts of the team is imperative. The team were able to diagnose and treat the CIDP quickly, which prevented muscular wasting and allowed for a safe to return to sport. This case highlights the importance of including non-orthopedic-related differential diagnoses in cases that may present as orthopedic.

Total Word Count: 585

200222GD

Chronic Type IV Acromioclavicular Joint Separation in a 25-Year-Old Recreational Ski Athlete

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Background: Acromioclavicular (AC) joint injuries are common, especially in the athletic population accounting for 9-12% of all shoulder injuries. The Rockwood classification identifies six types of AC joint separations. Type IV separations are characterized by rupture of the AC ligament and the coracoclavicular (CC) ligament, rupture of the joint capsule, deltoid and trapezius detachment, and posterior displacement of the clavicle into the trapezius. Type IV AC joint separations are rare, accounting for 1% of all AC joint injuries. A type IV AC joint separation can be mistaken as a type II if not evaluated properly. The position of the clavicle is the distinguishing factor between type II and type IV AC joint separations. Type IV AC joint separations are typically treated surgically shortly after injury to prevent further complications. This level 3 case study describes a patient who was misdiagnosed with a type II AC separation. Eight months after the initial diagnosis, he was appropriately diagnosed with a type IV AC joint separation and underwent late surgical treatment for this injury.

Patient: 25-year-old male presented with past medical history of left shoulder pain involving the AC joint. The mechanism of injury occurred while skiing and jumping off a 15-foot drop, landing directly on his shoulder in January 2019. At this time he was diagnosed with a type II AC joint separation and did not receive any additional treatment. The patient reported he re-injured the left shoulder in March 2019 while diving for a falling object. He presented to an orthopedic surgeon in September 2019 with chief complaint of left shoulder pain described as constant and dull, with associated popping sensation. Pain was located at the AC joint, both superficially and deep. Physical examination revealed left supraspinatus weakness with Jobe's Test and weakness with shoulder flexion in the scapular plane, pain with horizontal adduction, positive O'Brien's at the AC joint, and positive Speed's. MRI without contrast revealed superior elevation and posterior displacement of left distal clavicle, labral tear, and small intralabral cyst.

Intervention & Treatment: The patient was diagnosed with a left chronic type IV AC joint dislocation and posterior labral tear with paralabral cyst. The labral tear was not associated with AC joint injury. Patient consented to surgical treatment in October 2019 consisting of left shoulder arthroscopic posterior labral repair and glenohumeral debridement, open coracoclavicular ligament reconstruction and AC joint reconstruction with allograft. Postoperative rehabilitation began with a sling and passive/active-assistive ROM for the first six weeks, in addition to scapular stabilization. He began active motion 12 weeks post-surgery.

Outcomes or Other Comparisons: Ringenberg et al. describes the reliability of AC joint dislocation classifications and explains the difficulty in distinguishing the types on radiographic imaging. Viewing posterior displacement of the clavicle must be done on adequate axillary views, which may be difficult with patients in acute pain. Furthermore, Ringenberg et al. outlines lack of consensus on amount of posterior displacement needed to classify as a Type IV. While no gold standard exists for treatment of Type IV AC joint injuries, patients are typically treated surgically. If left untreated or treated improperly, patients may develop persistent pain, discomfort, and functional limitations.

Conclusions: This case outlines the examination and treatment of a chronic type IV AC joint separation.

Clinical Bottom Line: Type IV AC joint separations are often misdiagnosed as type II. A thorough history, physical exam, and proper imaging protocols are vital for a correct diagnosis. An axillary radiographic view is especially helpful in identifying a type IV. Imaging that evaluates comprehensive views of the acromion's placement in the frontal and sagittal planes can differentiate type IV separations from type II separations.

Total Word Count: 588

200104MB

Circadian Rhythm Chronotypes and Sleep Quantity Related to Injury in Reserve Officers' Training Corps (ROTC) Cadets

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Context: Exercise training at a time-of-day that is out of synchrony with a person's natural circadian preference (i.e. -"morning lark" or "night owl"), or chronotype, has been found to decrease performance and increase physiologic stress. However, many athletic teams or military members undergo time-mandated training. Reserve Officer Training Corps (ROTC) cadets typically participate in early morning physical training, regardless of chronotype. The previously established relationship between chronotype and elevated physiologic stress brings about the intriguing possibility that time-mandated training out of phase with one's chronotype could increase musculoskeletal injury risk. The relationship between chronotype and time-mandated training could further influence sleep quantity. The objective of this study was to analyze the relationship between chronotype, sleep quantity and retrospective injury status among ROTC cadets undergoing time-mandated (0600 AM) physical training. We hypothesized that evening chronotypes would be associated with injury incidence and decreased sleep.

Methods: A retrospective cohort study was performed in a clinical setting utilizing Army ROTC cadets who volunteered to participate. Cadets were asked to complete the Morningness-Eveningness Questionnaire (MEQ). MEQ responses correspond to scores (range:16-58) identifying chronotype. Chronotype categories include: Definite evening (scores:16-30), Moderate evening (scores:31-41), Intermediate (scores:42-58), Moderate morning (scores:59-69), and Definite morning (scores:70-86). Retrospective injury within the past two academic years was identified via electronic medical records and a binary (yes/no) question at time of consent to self-report injuries unreported to ROTC athletic trainers. Participating cadets were classified as either Retrospective Injury (documented or self-reported) or Injury-free. To identify sleep quantity, cadets completed one-week of the American Academy of Sleep Medicine's Two Week Sleep Diary. Mean hours slept per night was calculated for analysis. Pearson's Chi Square examined associations between chronotype category and injury status. Pearson's correlations evaluated hours slept to MEQ scores and injury status.

Results: Forty-one cadets (27 male, 14 female) completed the MEQ. Eleven cadets (7 documented, 4 self-reported) were classified as Retrospective Injury; 30 were Injury-free. Table 1 reports MEQ scores and injury incidence by chronotype. Chronotype was not significantly associated with injury ($\chi(1)=2.34$, $p=0.51$). Twenty-six cadets (17 male, 9 female) completed sleep diaries for analysis. The sample population as a whole slept 7.00 ± 1.04 hours/night. Hours slept according to chronotype are presented in Table 1. Hours slept was not correlated to injury ($r=-0.079$, $p=0.702$) or MEQ score ($r=0.312$, $p=0.121$). Post-hoc analysis of variance found no difference in hours slept between chronotypes ($F=1.088$, $p=0.354$).

Conclusions: In this preliminary investigation, chronotype was not associated with retrospective injury incidence in ROTC cadets undergoing time-mandated physical training. Findings were limited by the majority of cadets being classified as Intermediate chronotypes. Hours slept was not correlated to injury. However, limited sleep maybe of concern and sleep in evening chronotypes undergoing morning time-mandated training should be further evaluated.

Total Word Count: 445

207062GD

Clinical Case Study: Ulnar Nerve Injury at the Wrist with Isolated Motor Symptoms

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Background: This case report describes a 56-year-old male musician who sustained an isolated injury to the deep motor portion of the ulnar nerve proximal to Guyon's canal due to a puncture wound from a drill bit. The ulnar nerve is injured more than any other peripheral nerve in the body with most injuries occurring at or distal to the wrist crease and Guyon's canal, where the nerve splits into the motor and sensory portions. The patient's chief complaint was loss of motor function in his fingers specifically his 2nd, 4th and 5th digits. He presented with a claw deformity and Wartenberg's sign without any loss of sensation into the wrist and hand.

Differential Diagnosis: Based on the mechanism of injury and physical exam of the patient, there are four diagnoses: a particle laceration of the ulnar nerve, an undiagnosed ganglion effecting part of the nerve, a possible small tumor pressing on the nerve in the forearm, or possible neuroma formation that is effecting only part of the nerve.

Intervention & Treatment: The patient tried conservative treatment for 13 weeks with minimal or no improvement in the motor function of his hand before moving forward with exploratory surgery. This surgery determined the extent of the injury to the nerve and whether it was repairable. A neuroma was found on part of the ulnar nerve intraoperatively. A neuroplasty and decompression was performed to allow the nerve to begin to heal itself appropriately. It is important to note that none of the nerve was excised or transferred. The function of the deep motor branch has improved since the surgery and the patient has been able to return to playing music without a motor lag.

Uniqueness: An isolated motor injury is something that is seen with trauma to the hook of the hamate or distal to Guyon's canal making this injury unique because of the proximal location of the trauma to the nerve.

Conclusions: An injury to the ulnar nerve is extremely common, however, an isolated injury to the motor branch of the nerve proximal to Guyon's canal is very rare. The drill bit that punctured his nerve only cut a small portion of the ulnar nerve at the wrist level and that portion of the nerve formed a neuroma that led to decreased motor function. With a surgical decompression of the neuroma, there has been improvement in the motor function of the ulnar nerve in the hand. It is important to note that the patient never loss sensation in the hand and feels that since the surgery he has had a major improvement in motor function. It is important to note the exact location the nerve is compromised based on a strong understanding of the motor and sensory nerve anatomy.

Total Word Count: 449

[208144ID](#)

Clinical Utility of Mental Toughness Measures: A Systematic Review of Measurement Properties

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Context: Mental toughness (MT) is a psychological construct that has been recognized as an integral component for success in sport, due to the high-stress situations that athletes may experience throughout their careers. Numerous patient-reported outcome measures (PROMs) have been developed to evaluate MT in athletes; however, research investigating the measurement properties of these PROMs are often conflicted or limited to a single dimension of reliability and validity. Therefore, the purpose of this study was to conduct a systematic review on the measurement properties of MT PROMs.

Methods: A systematic literature search (key terms: mental toughness, validity, reliability) of electronic databases (EBSCO, CINAHL, MEDLINE, SPORTSDiscuss, PsychINFO) was conducted in May 2019 to identify relevant research studies. Studies that reported one or more measurement properties related to the use of MT PROMs were included in the analysis. Studies were excluded if they were not written in English or published in a non-peer-reviewed journal. The Consensus-based Standard for the Selection of Health Measurement Instruments (COSMIN) risk of bias checklist was used to evaluate the methodological quality of each study. The checklist consists of 10 sections (PROM development, content validity, structural validity, internal consistency, cross-cultural validity, reliability (ICC), measurement error, criterion validity, hypothesis testing for construction validity, and responsiveness) examining the quality of how the study was conducted. Each section was comprised of 5-18 items. Ratings of 'very good', 'adequate', 'doubtful', and 'inadequate' were assigned for each item. Overall scores for each section were based on the 'worst score counts' method. Results for the measurement properties of each PROM were consolidated into structural validity, internal consistency, reliability, and hypothesis testing categories.

Results: A total of 35 studies, investigating the measurement of 15 unique MT PROMs, met all the inclusion/exclusion criteria for this review. Of the 119 methodological qualities that were assessed 106 were rated very good; the remaining 13 were rated adequate or below. Among the included MT PROMs, the Mental Toughness Index (MTInd) was the only PROM with available data in all four categories. Strong positive evidence supported the structural validity, internal consistency, and hypothesis testing of the MTInd, but there was strong unacceptable evidence supporting the reliability of the MTInd. Ten of the included PROMs had evidence supporting three measurement properties and four PROMs only had evidence supporting two measurement properties.

Conclusions: Although validity evidence was examined for multiple instruments only one of the fifteen PROMs identified in this review investigated reliability, which is concerning for clinicians seeking to determine which instrument is the most appropriate for their patients. In addition, many of the included PROM were lacking validity data on at least one or more measurement domains. Future high-quality studies investigating the reliability and validity of these instruments are needed.

Total Word Count: 445

205173CB

Clinical vs. Functional Reaction Time Assessments Under a Dual-Task Paradigm: Implications for Post-Concussion Management.

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Context: Reaction time (RT) is fundamental to optimal sport performance and is commonly assessed post-concussion. Numerous studies indicate increased musculoskeletal injury risk following concussion that may be attributed to inhibited sport movement during simultaneous cognitive processing (i.e. dual-task) not directly measured on current clinical concussion assessments. Therefore, our purpose was to examine the relationship between clinical and functional RT assessments with and without a simultaneous cognitive task among healthy individuals.

Methods: Participants ($n=41$, 51% male; 22.5 ± 2.1 yrs; 172.5 ± 11.9 cm; 71.0 ± 13.7 kg) completed established clinical (dropstick, Stroop) and functional (gait, jump landing, cut) RT assessments (seconds) during one session in a randomized order. Dropstick consisted of catching a stick embedded in a weighted disk when dropped randomly, with distance (cm) mathematically converted to RT. Stroop assessed RT via computerized neurocognitive test (CNS-Vital Signs), with three standard sub-tests generating the single composite score used for analysis. Gait RT, measured with an instrumented walkway, was determined when center-of-pressure moved ≥ 3 cm in the sagittal or frontal planes after an auditory beep. Other functional RT assessments (recorded using 3D-motion capture [Qualisys]) involved participants jumping forward from a 30cm-tall box and performing a maximum vertical jump (jump landing) or a 45-degree cut (cut) following light stimulus at a random time interval. RT was the average time between light stimulus and the sacrum moving ≥ 3 cm in the sagittal or transverse planes. All RT assessments, except Stroop, were completed under single- and dual-task (subtracting by 6's or 7's) conditions. Pearson correlation coefficients were calculated between single- and dual-task RT assessments. A 4x2 repeated-measures ANOVA compared RT assessments and cognitive conditions ($\alpha=0.05$ a priori) with post-hoc t-tests.

Results: We observed significant weak to strong correlations among single- and dual-task RT assessments ($r=0.28-0.81$; Figure). Stroop RT was not significantly correlated with any other RT assessment ($p\geq 0.121$; Figure). We observed a significant RT assessment by cognitive condition interaction ($F_{3,120}=14.643$; $p<0.001$) with faster single-task RT among all assessments compared to their dual-task counterpart (mean differences: -0.098 – -0.097 ; 95% CIs: -0.120 – -0.075 ; $p<0.001$), except dropstick (mean difference: -0.015 ; 95% CI: -0.036 – 0.007 ; $p=0.195$). Main effects for RT assessment ($F_{3,120}=240.916$; $p<0.001$) and cognitive conditions ($F_{1,40}=167.728$; $p<0.001$) were present. Jump landing RT (0.528 ± 0.097 s) was significantly slower compared to cut (0.493 ± 0.094 s), gait (0.292 ± 0.073 s), and dropstick (0.209 ± 0.033 s; $p's\leq 0.033$). Dual-task conditions were significantly slower than single-task conditions (Mean difference: 0.077 ; 95% CI: 0.044 – 0.110 ; $p<0.001$).

Conclusions: Clinical and functional RT assessments were not significantly or weakly correlated with each other overall, suggesting functional, sport-like RT is not being assessed post-concussion. Dual-task RT was significantly slower than single-task during all assessments, except dropstick, indicating simultaneous cognitive processing introduces trade-off on movement initiation during more complex, functional tasks. Our findings cumulatively indicate functional and dual-task RT assessments may add clinical value and warrant further exploration post-concussion to better understand their utility.

Total Word Count: 449

207392JD

Collegiate Dancers' Aerobic Fitness Remains Similar Across their Collegiate Careers

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Context: Dance is physically demanding and requires dancers to have adequate aerobic fitness to perform successfully. More than 450 collegiate dance programs exist in the United States alone with Athletic Trainers(ATs) often providing care for these dancers. Similar to ATs working with sport athletes, these ATs also often conduct yearly baseline fitness screenings. However, it is unclear whether collegiate dancers' aerobic fitness changes as they advance in their academic programs from freshman to senior year. Understanding this information could help ATs choose if they need to conduct yearly aerobic fitness screenings or whether aerobic fitness assessed when dancers were freshmen can be used as baselines for the remainder of their collegiate career – saving ATs time and effort. Thus, our purpose was to prospectively compare estimated VO₂max in three cohorts of dancers as they progressed through the academic programs(freshmen to seniors).

Methods: 38 collegiate dancers(Females: n=33, Males: n=5; Ages when freshman =18.2±0.5 years) across 3 cohorts(Academic-Years: 2013-2017, 2014-2018, and 2015-2019) performed the 3-minute step test protocol to examine aerobic fitness. Specifically, as described in prior literature, dancers stepped up onto a 12-inch riser with one foot and then the other and stepped down at a cadence of 96 beats per minute for 3 minutes. Participants then sat on a chair and we measured recovery (HR_{rec},beats per minute(bpm)) heart rate 1 minute after the end of the test. We used HR_{rec} to derive estimated VO₂max(Men: VO₂max=111.33-[0.42 x HR_{rec}], Women: VO₂max=65.81-[0.1847 x HR_{rec}]). A repeated measures ANOVA compared estimated VO₂max between freshman and senior year (p<0.05).

Results: Across freshman to senior year, the dancers' estimated VO₂max remained remarkably similar: estimated VO₂max (Freshman: Senior; 51.5±9.0: 50.1±8.6 ml·kg⁻¹·min⁻¹, F_{1,35}=3.30, p=0.08).

Conclusions: Overall, as the dancers progressed through the academic years, their aerobic fitness generally stayed the same. Taking part in dance does not appear to change collegiate dancers' aerobic fitness across their academic careers. Thus, ATs working with collegiate dancers may not need not conduct yearly aerobic fitness screenings on their dancers. Rather, they can use their dancers' freshmen aerobic fitness assessments as baselines – ultimately saving ATs time and effort. Furthermore, ATs can use collegiate dancers' freshman baseline aerobic fitness measures to determine return to activity progressions when devising rehabilitation protocols post injury. Our observations are limited to a collegiate dance program focused primarily on modern and ballet dance. Thus, additional research is needed across different dance genres (tap, hip-hop etc.) and levels (students, pre-professionals, professionals) so that ATs working with those dancers can likewise optimize their baseline screening measures and return to activity protocols.

Total Word Count: 418

[206695ED](#)

Collegiate Soccer Athletes with a History of Recurrent Ankle Sprains Have Slower Visuomotor Reaction Time

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Context: Visuomotor reaction time (VMRT) evaluates the integration of visual processing and motor coordination. VMRT is an emerging component of sports related injury prevention and management and may provide insight into re-injury mechanisms following common sport-related injuries such as ankle sprains. Therefore, the purpose of this study was to compare VMRT in collegiate athletes based on ankle sprain history. We hypothesized that athletes with a history of recurrent ankle sprains would exhibit slower VMRT.

Methods: A total of 70 Division-I collegiate soccer athletes (26 male, 44 female; age:19.04±1.02yrs, height:171.63±10.01cm, mass:66.94±9.90kg) volunteered to participate. Based on self-reported injury history, participants were categorized as no ankle sprain history (n=39), single ankle sprain history (n=11), or recurrent ankle sprain history (n=20). During a single testing session, each participant completed an upper extremity VMRT task. The VMRT task was a custom protocol consisting of eight wireless LED discs which required participants to touch illuminated targets as quickly as possible. During a 60-second trial, targets randomly illuminated, one at a time, and participants had a maximum of 0.8 seconds to extinguish each target. VMRT (seconds) was measured for each successfully extinguished target and averaged across the trial. The number of targets extinguished (Hits) and missed (Misses) in each trial were also recorded. For all variables, the average of three trials was used for analysis. Faster VMRT (seconds), greater Hits (#/min), and fewer Misses (#/min) indicated greater test performance. Each variable was compared across groups using separate one-way ANOVAs with Tukey post-hoc comparisons and corresponding effect sizes (ES). The significance level was set at $p \leq 0.05$ for all analyses.

Results: Significant group main effects were identified for VMRT ($p=0.005$), Hits ($p=0.003$), and Misses ($p=0.003$). The recurrent sprain group (0.504 ± 0.039 s) had significantly slower VMRT compared to the single sprain group (0.461 ± 0.039 s; $p=0.011$, $ES=1.07$) and the no history of ankle sprain group (0.470 ± 0.041 s; $p=0.018$, $ES=0.83$). The recurrent sprain group (75.90 ± 16.88) demonstrated fewer Hits compared to the single sprain group (96.79 ± 13.01 ; $p=0.002$, $ES=-1.30$) and the no history of ankle sprain group (86.38 ± 16.02 ; $p=0.049$, $ES=-0.63$). Finally, the recurrent sprain group (17.23 ± 8.73) had a greater number of Misses compared to the single sprain group (7.85 ± 4.18 ; $p=0.002$, $ES=1.22$). No other group differences were identified.

Conclusions: Athletes with a history of recurrent ankle sprains exhibited slower VMRT, fewer Hits, and more Misses when compared to athletes with no previous ankle sprains or a history of a single ankle sprain. Performance did not differ between athletes with no history of ankle sprain or a history of a single sprain. Slower VMRT may represent a diminished ability to visually identify, cognitively process, and respond to stimuli and should be further examined as a contributing factor to recurrent ankle sprains in collegiate athletes.

Total Word Count: 442

206665GD

Comparison of Arm Positions for Exercise of the Teres Minor Muscle During a Quadruped Position With Horizontal Abduction

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Context: Baseball pitchers often complain of symptomatic tightness at the lateral border of the scapula, where the teres minor (TMi) muscle originates, after throwing. This may be attributed to the finding that the normalized EMG activity of the TMi muscle was considerably larger during both deceleration and follow-through phases of pitching than that of the infraspinatus (IS) muscle. However, few studies have demonstrated the activity of the TMi muscle during intervention exercises. Therefore, the purpose of this study was to identify the activity of the TMi muscle in different arm positions during moderate intensity isometric contractions.

Methods: Nineteen NCAA Division I asymptomatic collegiate baseball players (19.0 ± 1.1 yrs, 181.4 ± 7.7 cm, 87.8 ± 10.0 kg) were tested. The EMG signals (root-mean-square) for the TMi, IS, posterior deltoid (PD), upper trapezius (UT), lower trapezius (LT), and serratus anterior (SA) muscles on the dominant-side shoulder were collected in the quadruped position with 90° , 40° , and 0° of the horizontal adduction (HADD) angles at 90° of shoulder abduction and neutral rotation with the intensity of 40% maximum voluntary isometric contraction (MVIC). A 2×3 (Intensity \times Angle) repeated measures ANOVA design was used to determine if there was any significant difference in RMS values of EMG muscle activity. The correlation coefficient between TMi and IS muscle activity was also determined.

Results: TMi muscle activity was significantly higher in positions with less HADD (15.5, 26.3, and 41.4% MVIC at 90° , 40° , and 0° HADD) ($P < 0.05$). IS muscle activity was significantly less than that of the TMi muscle (8.6, 13.0, and 19.2% MVIC at 90° , 40° , and 0° HADD) ($P < 0.05$). PD muscle activity was significantly increased while the HADD angle was decreased (19.1, 30.3, and 53.7% MVIC at 90° , 40° , and 0° HADD) ($P < 0.05$). UT muscle activity was significantly increased while the HADD angles were decreased (8.5, 13.1, and 21.0% MVIC at 90° , 40° , and 0° HADD) ($P < 0.05$). LT muscle activity was significantly increased while the HADD angles were decreased (18.6, 28.7, and 39.3% MVIC at 90° , 40° , and 0° HADD) whereas SA muscle activity was significantly decreased (10.1, 8.1, and 6.9% MVIC at 90° , 40° , and 0° HADD) ($P < 0.05$). The correlation coefficient between TMi and IS muscle activity was 0.53 ($P < 0.05$).

Conclusions: The TMi muscle generates more muscle activity than the IS muscle when externally loaded into HADD without shoulder external rotation. The results of this study have clinical implications regarding the careful selection of arm position for exercise of the TMi muscle that may help prevent baseball pitchers from symptomatic tightness that is attributed to the deceleration phase of the throwing motion.

Total Word Count: 431

[209573DD](#)

Comparison of Femoral Cartilage Health Between Individuals With and Without Patellofemoral Pain - Ultrasonographic Quality Analysis

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Context: Ultrasonography images can be analyzed quantitatively and assessed through quality of the image. Previous quantitative analyses of femoral cartilage thickness, cross-sectional area, and echo intensity did not find significant differences between persons with PFP and healthy matched controls. However, cartilage margin quality may also indicate degradation of the cartilage and this metric is not accounted for in traditional cartilage thickness assessments. Therefore, the objective of this study was to assess the quality of femoral cartilage ultrasonographic images and compare patients with PFP and matched pain-free individuals. We hypothesized that persons with PFP would show worse femoral cartilage status compared to healthy individuals based on the quality analysis.

Methods: This was a case-control study conducted in a research laboratory setting. Twelve individuals with PFP (age: 21.0 ± 2.0 yrs, body mass index [BMI]: 23.1 ± 2.6 kg/m²) and 12 knee pain-free, age- and BMI-matched individuals (age: 21.3 ± 2.8 yrs, BMI: 22.3 ± 2.8 kg/m²) were included. Eligible participants rested 30 minutes with their knees extended prior to the image collection. Femoral cartilage ultrasonographic images were obtained at 140° knee flexion using a LOGIQe Ultrasound system with 12-MHz linear probe. The probe was placed transversely in line with the medial and lateral femoral condyles just above the patella. All collected femoral cartilage images were assessed using an established ultrasound grading system ranging from 0 to 6, evaluating the sharpness and clarity of the image as well as uniformity of cartilage thickness (Figure 1). Grade 0 indicates normal cartilage with absolute sharpness, clarity, and uniform thickness. Highest grade of 6 is given if there is no visualized cartilage band which may be an indication of partial or complete femoral cartilage loss. Two raters were blinded to image group and scored 15 femoral cartilage images twice for inter and intra-rater reliability analysis using weighted Kappa. Lastly, Mann-Whitney U test was used to identify the statistical differences on mean rank of ultrasound grades between PFP and healthy participants.

Results: Both intra and inter-rater reliability measures showed strong reliability (Intraclass(k)=0.86, $p < 0.001$; Interclass(k)=0.82, $p < 0.001$). Mann Whitney U test found the PFP group was rated higher based on the ultrasound grading system compared to the healthy group (PFP: Mean rank=17.58, Healthy: Mean rank=7.42, Mann-Whitney U=11.0, $p < 0.001$). This result is indicative of worse cartilage health in the PFP group.

Conclusions: Evaluating the femoral cartilage ultrasound image using the quality grading system showed strong reliability within and between raters. Despite previous quantitative analyses not identifying statistical differences between persons with and without PFP, image quality analysis found worse femoral cartilage quality in persons with PFP. Poorer quality cartilage images may be indicative of knee osteoarthritis. According to these findings, the diagnostic ultrasound and quality analysis of these images may be useful in evaluating the femoral cartilage health in clinical settings.

Total Word Count: 444

[206904DB](#)

Comparison of Free-Living Step Accumulation Among Adolescent Patients Six Months After ACL Reconstruction and Healthy Controls

Kuenze C*, Collins K*, Triplett A*, Montoye A[†], Pfeiffer K*, Shingles M*, Lisee C*: *Michigan State University, East Lansing, MI, [†]Alma College, Alma, MI.

Context: Diminished free-living daily step count and step accumulation at intensities >100 steps per minute are risk factors for premature non-communicable disease-related morbidity and mortality. While individuals with anterior cruciate ligament reconstruction (ACLR) demonstrate reduced moderate-to-vigorous physical activity (PA) in free-living conditions and persistent alterations in walking gait biomechanics in the laboratory compared to healthy individuals, it remains unclear if free-living temporal gait patterns such as step accumulation are affected. The primary purpose of this study was to compare average daily step count and step accumulation characteristics between adolescent individuals 6-months following ACLR and healthy control participants. We hypothesized that individuals with ACLR would demonstrate lower average daily step counts and minutes per day spent in step accumulation >100 steps per minute when compared to young healthy control participants.

Methods: Twenty adolescent individuals with ACLR (15 women, 5 men; age= 15.8±1.2 years; months since surgery= 6.2±0.7 months) and 11 adolescent healthy individuals (4 women, 7 men, age= 15.4±1.4 years) participated in this portion of a larger prospective cohort study. Participants reported their current activity level via the Tegner Activity Scale and wore an Actigraph Link PA monitor over the right hip for 7 days. Data were collected at 30 Hz and processed in 60-second epochs. Daily step count, mean and maximum steps per minute, and weekly minutes at 60-79 (slow), 80-99 (medium), 100-119 (brisk), >100 (moderate-to-vigorous), and >130 (vigorous) steps per minute intensities were calculated. One-way ANCOVAs determined differences in average daily step count and step accumulation characteristics between groups with total minutes of monitor wear-time utilized as a covariate. Partial η^2 effect sizes were calculated to estimate the magnitude of effect for ACLR status.

Results: Participants with ACLR (Tegner= 5 [3 to 10]) reported lower current Tegner activity level when compared to healthy participants (Tegner= 9 [6 to 10]; $p < 0.001$). Participants with ACLR displayed lesser average minute-level step accumulation ($p = 0.02$, Partial $\eta^2 = 0.99$) but groups did not differ based on average daily step count ($p = 0.55$), maximum step accumulation ($p = 0.27$), time spent in slow ($p = 0.49$), medium ($p = 0.28$), brisk ($p = 0.75$), moderate-to-vigorous ($p = 0.66$), or vigorous ($p = 0.59$) intensities of step accumulation (Table 1).

Conclusions: Six months after ACLR, adolescent individuals did not display reduced step accumulation at moderate-to-vigorous intensities as compared to healthy individuals. However, these individuals did display average daily step counts that are 12-15% less than current recommendations for healthy PA participation and significantly lesser mean step accumulation when compared to healthy controls (Table 1). The ability to integrate step monitoring and adaptive goal setting using commercially available wearable PA monitors may provide a feasible strategy for early intervention with the hope of promoting healthy PA and mitigating risks associated with reduced step accumulation characteristics.

Total Word Count: 450

209904IA

Comparison of HRQL Across Recovery Following Sport-Related Concussion or Acute Ankle Injury: A Report From the Athletic-Training Practice-Based Research Network

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Context: Evaluating patient perceptions of health status provides important insight into the patient experience following injury and useful information for driving treatment decisions. Type of injury may influence the domains of health impacted and the degree to which perceived health status changes during recovery. For example, concussion is often considered an invisible injury with little outward signs, whereas ankle sprain often results in limited weight-bearing and swelling, apparent to others. The objective of this study was to compare HRQL between adolescents with concussion and ankle injuries across their recovery to explore differences in global and domain-specific health status over time.

Methods: We retrospectively reviewed electronic medical records within the Athletic Training Practice-Based Research Network. Records were created by athletic trainers working in 32 secondary school facilities between 2009-2019. Patient cases were included if the patient was diagnosed with either a concussion or an ankle sprain and completed the Pediatric Quality of Life Inventory (PedsQL) (range: 0-100; lower scores indicate lower HRQL) at two time points (T1=0-2 days, T2=11-29 days). The PedsQL includes a total score and 5 subscales related to physical (PF), emotional (EF), social (SOF), psychosocial (PSF), and school (SCF) functioning. A two-way group by time analysis of variance was conducted for each dependent variable. Significance was set a-priori at $p \leq .05$.

Results: Records from 85 athletes who suffered either a concussion ($n=21$ males, $n=25$ females; age= 15.1 +/- 1.1) or ankle sprain ($n=21$ males, $n=18$ females; age=15.4 +/- 1.3) were included in this study. Means and standard deviations for the PedsQL total score and each subscale score are presented in the table. There was no significant group by time interaction for the total score or any subscale ($p > .05$). A significant effect for time was noted for the PedsQL total score and each subscale with higher scores at T2 compared to T1. Differences between groups were found for the PF and SCF subscales with ankle sprain patients reporting lower scores related to PF and concussion patients noting lower scores related to SCF.

Conclusions: These results indicated that in adolescents, the trajectory of domains of HRQL stemming from sport-related injury may be influenced by the type of injury. While each group (concussion and ankle) exhibited an increase in HRQL between time points indicating recovery, the domain-specific significant group differences suggested that the impacted areas of HRQL closely aligned with the most salient manifestations of the injury (ie, cognitive deficits vs. physical limitations). These differences underscore the importance of assessing the HRQL of injured patients, and clinicians can use this information to drive targeted treatment for patients to increase HRQL in specific areas throughout the recovery process.

Total Word Count: 431

209924CD

Compliance with State Law Components of Sport-Related Concussion Protocols in Pennsylvania High Schools

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Context: Developing a sport-related concussion (SRC) protocol may increase the quality of healthcare provided to athletes and protect school districts and athletic trainers from litigation. Evaluating SRC protocols in Pennsylvania high schools would provide information on care standards across the state, and determine the level to which the state concussion law is being considered. The purpose of this study was to investigate components of SRC protocols in Pennsylvania high schools, and determine compliance of all items outlined in the Safety in Youth Sports Act.

Methods: This study utilized a qualitative document analysis design. All Pennsylvania Interscholastic Athletic Association high schools (n=764) were contacted for participation via email during the 2018-2019 academic year. Schools were asked to e-mail an electronic copy of their concussion protocol to the research team if they were interested in participating. Document analyses of the collected protocols were conducted by four athletic trainers. The items included in each SRC protocol were recorded on a checklist of potential components (105 items). The sample was collectively assessed by computing the frequency of inclusion of at least one checklist item in each of the following areas: education, baseline assessment, on-field management, off-field management, follow-up care, return to learn (RTL), return to play (RTP), prevention strategies, and the concussion management team. Compliancy with the state law was measured by calculating the proportion of protocols that included all mandatory components. A mean score for the sample was also completed for the total number of state law items included (scored out of 12).

Results: There was a 51.6% (n=394/764) response rate. Of those, 18.5% (n=73) declined participation, 30.5% (n=120) responded but did not provide a protocol, 6.6% (n=26) did not have a protocol, and 44.4% (n=175) provided a protocol. The final sample of SRC protocols represented 22.8% (n=175/764) of all Pennsylvania high schools. Of the included Pennsylvania high school SRC protocols, the frequency of those that addressed each area were as followed: 42.9% (n=75) education, 52.0% (n=91) baseline assessment, 68.6% (n=120) on-field management, 32.6% (n=57) acute off-field management, 60.6% (n=106) follow-up care, 33.1% (n=58) RTL, 75.4% (n=132) RTP, 0.4% (n=6) prevention strategies, and 14.3% (n=25) the concussion management team. Only 5.7% (n=10) of SRC protocols included all the mandatory components of the Pennsylvania Safety in Youth Sports Act; 22.9% (n=40) did not include any components. The mean number of state law components included was 3.8 ± 3.7 for the sample.

Conclusions: The majority of Pennsylvania high school SRC protocols lacked one or multiple components of the concussion state law. The areas for the most growth potential within the protocols were prevention, development of a concussion management team, on-field management, and RTL. More resources are needed to aid high schools in SRC protocol development.

Total Word Count: 444

200285GD

Concurrent Validity of an Electronic Version of the Kerlan-Jobe Orthopedic Clinic Overhead Athlete Shoulder and Elbow Score in Overhead College Athletes

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Context: The Kerlan-Jobe Orthopedic Clinic Overhead Athlete Shoulder and Elbow Score (KJOC) is a reliable and valid measure of function in overhead athletes. An electronic version of the instrument (KJOce) was created using visual analogue sliders (VAS) and an automatic scoring feature to streamline administering and scoring the assessment process. The measurement properties of the KJOC may be altered in converting the instrument from a paper to an electronic medium and modifying the score mechanism from placing an “x” on a 10cm line to using a computer mouse on a VAS. Subsequently, it is important to determine the validity when modifying an instrument’s format. The purpose of the study was to validate KJOce to the original paper version of the KJOC (KJOCp) in an overhead collegiate athlete population.

Methods: After institution review board approval, the KJOCp was administered to 27 collegiate-aged athletes, 13 female volleyball players (age: 19.6 ± 1.3 years, height: 179.7 ± 8.6 cm) and 14 baseball pitchers (age: 19.2 ± 1.0 years, height: 187.5 ± 3.4 cm, weight: 98.2 ± 7.3 kg). The KJOce was administered and completed within 24-hours of the completion of the KJOCp. The 10-items of the KJOCp were hand scored and composite scores calculated for all participants. KJOce data and composite scores were extracted from survey software (Qualtrics). Mean composite scores and Pearson correlation coefficient were used to determine the relationship between the KJOCp and KJOce. Validity was assessed with interclass correlational coefficients (ICC) model (2,1), 95% confidence intervals (CI), and precision was established with the standard error of measurement (SEM), and minimal detectable change (MDC).

Results: The mean \pm SD scores for all participants on the KJOCp and the KJOce were 90.0 ± 11.9 and 88.9 ± 10.4 , respectively. There was a positive correlation between KJOCp and KJOce scores ($r = 0.81$, $n = 27$, $P < .001$, $R^2 = 0.66$), see Figure 1. Statistical analysis revealed a high level of agreement between the KJOce and the KJOCp with good precision (ICC_{2,1} = 0.89, 95% CI: (0.77, 0.95), SEM = 3.6, MDC = 9.9).

Conclusions: KJOce scores demonstrated a strong positive relationship to the KJOCp. The ICC value showed high agreement (ICC ≥ 0.75) between the two instruments indicating good high agreement between the paper and electronic version of the KJOC. Precision outcomes (SEM and MDC) indicate that KJOce composite scores demonstrated good precision. The electronic version of the KJOC may benefit clinicians, as it is automatically scored, feasible to use in a clinical setting, and valid to the paper version of the KJOC.

Total Word Count: 404

208495CD

Concussion Care Process Model Decreases Head CT Orders Among Providers in a Primary Care Setting

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Context: Treatments for concussion can vary extensively among healthcare providers, increasing healthcare costs and utilizing unnecessary imaging. Despite being highly sensitive in detecting brain injuries, CT scans expose patients to radiation, which can be harmful to health and increase healthcare costs. Care process models (CPM) have been successful by standardizing care and improving outcomes in healthcare settings. This study aimed to evaluate the effectiveness of a concussion care process model in a primary care setting.

Methods: A retrospective cohort study was used to evaluate the effectiveness of a multidisciplinary designed concussion CPM in primary care offices and acute primary care walk-in facilities. Patients reporting head injuries were given a graded symptom checklist to complete during their visit prior to evaluation by a provider. The CPM was integrated in the electronic medical record and included a Power Form derived from the SCAT-5/Child SCAT-5 tool, provider recommendations for best practice concussion management (e.g. physical exam, vestibular exam), links to return to learn/work/activity, and state concussion legislation forms. The independent variable was number of encounters in a primary care setting with a chief complaint of head injury. The dependent variable in this study was head CT orders in patients presenting with concussion ICD-10 codes within the CPM scope. Z score test for 2 population proportions was performed to examine difference in head CT orders in the populations prior to and post-CPM encounters. Fisher's exact test was also employed due to the small sample size.

Results: Charts of patients reporting a chief complaint of head injury were evaluated during the third quarter one year prior to implementation (n=181) and the third quarter after implementation (n=199). Patient selection criteria was 1) 5 years of age or older and 2) reporting a chief complaint of head injury in a primary care or walk-in acute primary care setting associated within the regional healthcare system. There was a 9.5% decrease in head CT orders per encounter (95% CI: 0.02-0.17; P=.012) from the year prior to CPM implementation. The concussion CPM compliance was higher among providers in the acute primary care walk-in facilities (87%) compared to traditional primary care offices (41%).

Conclusions: Head CT orders decreased among primary care providers treating concussions following implementation of a multidisciplinary designed concussion care process model, which, in turn, decreased costs to patients and limited exposure to radiation. Compliance among providers in the acute primary care walk-in clinics was higher than traditional primary care offices, which could mean a decrease in costs and standardized care for patients in that setting. Further research is needed to study the barriers for CPM use in the traditional primary care setting.

Total Word Count: 430

[200374JA](#)

Concussion History is Associated with Elevated Physical and Psychological Symptomology in Former Collegiate Football Players

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Context: The effects of lifetime concussion history and cumulative football participation on psychological distress in former collegiate football players is not fully understood. Previous research in this area has been primarily limited to former athletes of older age, and there is limited literature on this topic in more recently retired collegiate football players. We examined associations between current BMI, football participation, lifetime concussion history, and various dimensions of psychological distress in former collegiate football players.

Methods: Former collegiate football players (n=58; aged 37.9+1.5 years) from 16 schools completed a health-related survey and subsequent in-person evaluation approximately 15 years after finishing college football. Participants reported demographic information, participation history, and lifetime concussion history. Psychological distress was measured using the Brief Symptom Inventory-18 (BSI-18). Outcomes included the somatization, depression, and anxiety subscores, as well as the Global Severity Index obtained from the BSI-18 responses. Explanatory variables included BMI, playing experience (number of years playing football), lifetime concussion history based on tertiles (0-1/3-6/7+), and current symptom severity. Group-differences in the outcome scores across levels of lifetime concussion history were examined using Kruskal-Wallis tests; associations between continuous/ordinal explanatory variables and outcomes were examined using Spearman's rank-order correlations. Statistical significance was evaluated at the 0.05 level.

Results: On average, participants had 12.1+3.2 years of playing experience, and a BMI of 31.3+5.0 kg/m² (Table 1). Approximately 43% of participants (n=25) had < 1 concussion, and 24% of participants (n= 14) had > 7 concussions during their lifetime. We observed significant differences in the BSI-18 anxiety subscore ($\chi^2=6.5$; $p=0.04$) between participants with < 1 lifetime concussions (Mean=1.7, SD=2.9; Median=1.0, IQR=2.0), 3-6 lifetime concussions (Mean=2.2, SD=3.1; Median=1.0, IQR=3.0), and > 7 lifetime concussions (Mean=3.5, SD=3.1; Median=3.0, IQR=3.0). In post-hoc analyses of general symptomology (assessed using the Graded Symptom Checklist), we also observed a positive correlation between general symptomology and the BSI-18 anxiety subscore ($\rho=0.48$; $p<0.001$), as well as differences in general symptomology ($\chi^2=8.4$; $p=0.02$), between participants with < 1 lifetime concussions (Mean=3.4, SD=5.6; Median=0.0, IQR=4.0), 3-6 lifetime concussions (Mean=9.5, SD=20.5; Median=3.0, IQR=7.0), and > 7 lifetime concussions (Mean=16.5, SD=21.9; Median=5.5, IQR=21.0).

Conclusions: Concussion history may be related to anxiety in former collegiate football players. Given the observed associations between concussion history, current symptom severity, and anxiety, future research in a larger sample of former collegiate football players is required to fully reconcile the nature of these relationships, as well as to identify additional moderating factors. Nonetheless, clinical practice should consider assessment and intervention of anxiety symptoms in former collegiate football players with a history of remote concussions to improve patient outcomes.

Total Word Count: 419

[205054ID](#)

Conservative Management Improves Functional Movement and Clinical Outcomes in Patients with Nonarthritic Hip Pain

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Context: Femoroacetabular impingement (FAI), dysplasia, and other structural deformities can lead to chondrolabral pathology that results in functional limitations during daily and sports-related activities. It is unknown whether improvements in hip motion and muscle function can occur with conservative management and produce positive clinical outcomes in this patient population. The purpose of this study is to determine if patients with nonarthritic hip pain will improve their functional movement and clinical outcome scores following the implementation of an individualized rehabilitation plan and a standardized home-exercise program.

Methods: A retrospective, cross-sectional study evaluating prospectively collected information on consecutive patients receiving surgical consultation by an orthopedic surgeon for nonarthritic hip pain. The independent variable was the change (improved vs not improved) in functional performance during the single leg squat test (SLST) from initial to follow-up evaluation, after at least 4-weeks of conservative management. The dependent variables of interest were the evaluated patient-reported outcome measures (PROs) including: visual analog scale score for pain; Hip Outcome Score for activities of daily living and sports-related activities; global percentage rating for activities of daily living and sports-related activities; and patient satisfaction. A one-tail, independent t-test was performed to determine whether the mean change for the continuous PROs were significantly different for patients that improved, and a Fisher's exact test was performed for patient satisfaction. Forty-six patients (31 female and 15 male) with a mean age of 30 ± 12 years (mean \pm SD), height of 170.7 ± 9.2 cm, weight of 74.3 ± 14.7 kg, and BMI of 25.5 ± 4.2 were included with an average follow-up of 8-weeks from their initial evaluation.

Results: A total of 30 patients improved their functional movement during performance of the SLST. Patients that improved started with a mean of 4.5 ± 0.8 positive deviations out of 6 and demonstrated a mean of 3.0 ± 1.0 at follow-up. There was a significant increase in all PROs for patients that improved ($p < .001$) as well as a statistically significant difference between patients that improved and did not improve ($p \leq .022$) as shown in Table 1. Patient satisfaction with conservative management was significantly greater ($p < .001$) in patients that improved their functional movement.

Conclusions: The main finding from this study was that most patients referred for conservative management were able to improve their functional movement control over an average 8-week timeframe. Patients with nonarthritic hip pain who improved were more likely to report less pain and greater functional ability in their daily and sports-related activities. This study supports conservative management to acutely improve outcomes for patients with nonarthritic hip pain.

Total Word Count: 420

200335ND

Conservative Management of an Achilles Laceration in a Division I Collegiate Sprinter

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Background: A 20 y/o female division I collegiate sprinter lacerated her right achilles tendon. On June 7th, 2019, she backed into a piece of broken glass and immediately removed it from her leg. She contacted a team athletic trainer who told her to seek medical attention immediately. Due to limitations of her personal insurance, she did not seek additional care. She reported to campus on August 26th and was referred to team physician for evaluation on August 28th. She received a subsequent diagnostic ultrasound and MRI.

Differential Diagnosis: Achilles tendon laceration, achilles tendinitis

Intervention & Treatment: Following imaging, the student athlete was referred to Dr. Travis Langan, a team podiatrist for evaluation. Imaging was reviewed during her initial visit and it revealed approximately 50% of the tendon had been involved, superior to the insertion on the calcaneus. Due to the healing of the achilles with bulbous scar tissue, Dr. Langan advised that we begin therapy including strengthening, stretching, and iontophoresis and follow up in four weeks. Rehabilitation focused on eccentric strengthening of the achilles, gait normalization, foot intrinsic strengthening, and balance. During the next follow up, she was cleared to begin a supervised running progression with athletic training staff and follow up in an additional eight weeks to evaluate her readiness for the 2020 indoor track and field season. On October 30th, 2019, the student athlete was able to complete a full team practice and has returned to all sprinting activity and is increasing volume.

Uniqueness: Due to the timing of the injury, outside the competition season for this particular athlete, she was not on campus when her injury occurred. When she reported to campus for the fall semester, she was walking with an antalgic gait and was unable to wear an athletic shoe because of the friction it caused on her achilles. In five months, this athlete was able to return to full track and field activities despite her not receiving initial treatment and not undergoing a reconstructive procedure upon her return to the university. While not an achilles tendon rupture, our management of this injury utilized parameters commonly found with achilles tendon rupture in an athlete. Non-surgical management of achilles tendon rupture is uncommon, but does show promising results if cases are managed carefully. Re-rupture rates are similar between the two methods of injury management. This case is also unique because women suffer achilles tendon injury much less frequently than men.

Conclusions: A combination of eccentric exercise, gait correction, and a slow return to running progression focusing on correct running mechanics allowed this student athlete to return to sport approximately five months after sustaining an achilles laceration. If this athlete would have sought medical attention immediately, she more than likely would have undergone a reconstructive procedure and had a longer recovery period.

Total Word Count: 456

208731ED

Conservative Treatment of a Fibular Torus Fracture in a Collegiate Football Player

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Background: Level 3 CASE study focused on the diagnosis, treatment and recovery of a torus (buckle) fibular fracture. Evidence indicates that this type of fracture is more commonly found in children ages 5-10 due to the elasticity of their bones and most commonly occurs in the radius and tibia. Fibular fractures are common in the National Football League, however the form of treatment is more often surgical. Electrical stimulation device especially those that emit a low-level pulsed electromagnetic field (PEMF) can positively affect the bone healing process at several levels including molecular, cellular and tissue.

Patient: Patient is a 20-year-old, male, football player who was playing basketball at the on-campus recreation center and felt pain in right leg after jumping for the ball. The Head Athletic Trainer evaluated the patient the following day. Patient had full ankle AROM with no pain but the level of pain upon palpation over the distal fibula caused the AT to discontinue his evaluation. Patient had initial images taken at the athletic training facility via a fluoroscope, which showed a fracture in the distal fibula. Patient was referred for further imaging to decide course of treatment. There were no neurological or vascular symptoms noted. Differential diagnoses included syndesmotic sprain, lateral ankle sprain, and peroneal tendon subluxation. X-rays confirmed a diagnosis of a torus fracture of the distal fibula.

Intervention & Treatment: To minimize risks associated with surgery, conservative treatment was implemented. Patient was placed in a boot and crutches; he was to remove the boot when performing rehabilitation exercises. The first phase of treatment and rehabilitation focused on protecting the fracture site while maintaining ankle ROM. Patient was re-evaluated two weeks post injury and additional imaging determined the patient could continue with conservative treatment and began partial weight bearing. He continued treatment and rehabilitation including ROM exercises, calf exercises, and laser therapy. He discontinued the use of crutches after 3 weeks and remained in walking boot for 7 weeks post injury. Follow-up images were taken at 8 weeks post injury and displayed that a non-union fracture was still apparent. Physician prescribed a bone stimulation device to be implemented into his treatment. This second phase of treatment and rehabilitation focused on closing the non-union fracture using the bone stimulation device. The device was used 3 times a week for 2 weeks.

Outcomes or Other Comparisons: Patient returned to full team activity 13 weeks post injury. The total injury duration is atypical for a torus fracture, which generally takes 4 weeks to heal and return to activity. Patient wore a protective cover over the site of injury during both games and practices for 25 weeks post injury.

Conclusions: Patient was able to return to sport following an atypical fibula fracture that was treated conservatively. A torus fracture is not commonly seen in the fibula or in college-aged patients. Key intervention was the use of a bone stimulation device to help the healing process and to promote bone healing through energy. Electrical stimulation for bone healing was implemented because the fracture was in delayed union; it was taking longer than the physician anticipated in the healing process. Implementing electrical stimulation for bone healing and its effects on fractures and ultimately the return to sport is important in the athletic training profession especially in the prevalence of non-union fractures. The use of bone stimulation can be used as an adjunct treatment to aid in healing for delayed and nonunion fractures.

Clinical Bottom Line: Electrical stimulation for bone healing can reduce the treatment time and lead to faster return to activity in the case of non-union fractures.

Total Word Count: 584

206781GD

Conservative Treatment of Inferior Labral Tear, Chondral Defect and Non-Displaced Clavicular Fracture Following a Traumatic Shoulder Dislocation: A Case Report

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Background: This case involves a 30-year old, male, former collegiate football player, now full-time industrial-setting electrical engineer. The patient presented to the athletic training clinic 10 days following a traumatic robbery assault incident. He was knocked unconscious by a blow to the back of the head, and forcibly held prone with his arm in extension, adduction, and internal rotation. His attackers then violently forced him to a supine position, at which point the patient reports his right shoulder dislocated, and he felt immediate pain. Following the incident, the patient was immediately transported to the Emergency Room for evaluation and diagnostic imaging. During subsequent evaluation in the athletic training clinic, he presented with 6/10 pain, 20-50% decreased ROM compared bilaterally, extreme guarding of glenohumeral joint, and 0/4 (poor) patient-reported ability to perform physical activities, work-related activities and ADLs.

Differential Diagnosis: Labral tear, glenohumeral instability, clavicular fracture, supraspinatus strain, acromioclavicular joint sprain, deltoid strain, biceps strain.

Intervention & Treatment: MRI and X-ray revealed an inferior labral tear from 3 to 8 o'clock, chondral defect on the glenoid fossa with chondral fragment in axillary recess, posterior glenoid contusion, deltoid strain, and non-displaced fracture on the lateral margin of clavicle. Despite the extent of the diagnosis, the patient requested conservative treatment, due to his determination, demeanor, and previous surgical experience on the contralateral shoulder. The patient's goals for treatment were to return to full work function as an electrical engineer, recreational weight lifting, and riding motorcycles. The patient began treatment 10 days post-injury with a focus on pain control and reducing muscle loss. Low-level laser therapy (LLLT) at 1000-3000Hz, electrical stimulation, and cryotherapy were utilized to decrease pain. The patient also performed isometrics and light ROM exercises within pain-free limits. At 16 days post-injury, LLLT at 5-250Hz was utilized to stimulate healing within the glenohumeral joint capsule. The patient also began a Blood Flow Restriction (BFR) protocol at 80% occlusion in order to promote muscular hypertrophy and strength, while managing stress on the glenohumeral joint and to increase growth hormone production for additional healing properties. The patient responded well to the BFR protocol and progressed through single-plane, single-joint strengthening exercises with no symptom increase. At 6 weeks post-injury, the patient completely discontinued use of sling and NSAIDs, and reported ability to perform ADLs significantly improved. He quickly progressed to upper extremity weight bearing exercises, plyometric training, and functional bilateral BFR exercises such as standing chest press, latissimus dorsi pull-downs, and diagonal movement patterns. The patient continued to increase mobility through AROM and static stretching in all planes. At discharge 10 weeks post-injury, patient reported an increase to 4/4 (excellent) ability to perform ADLs, work-related activities, and physical/exercise-related activities. His pain reduced to 0/10, and strength increased to 5/5. The patient was cleared to return to full work functions, motorcycle riding, and independent weight lifting.

Uniqueness: The mechanism of injury from a traumatic event provided for a combination of injuries not typically occurring concomitantly. Also, the use of LLLT and BFR provided an advanced, progressive, conservative treatment instead of choosing to undergo immediate surgical intervention. Comparable Bankart lesion arthroscopic repairs have a 90% success rate on return to sport; however, a lower rate was anticipated due to the complexity of the injury. Despite the higher success rate, patient and athletic trainer decided on conservative treatment to avoid the burden of post-surgical work limitations.

Conclusions: This case demonstrates a successful conservative treatment of a traumatic injury using a progressive rehabilitation program. Especially as athletic trainers expand into more non-traditional settings, various factors may change the treatment approach regarding injury, including modalities available, and patients' values and preferences.

Total Word Count: 593

[206833EA](#)

Contralateral Sensorimotor Connectivity is Related to Postural Control in the Non-Involved Lower Extremity of Older Adults With a History of Lateral Ankle Sprain

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Context: Central nervous system portions of the sensorimotor network (SMN) are often overlooked when determining the relationship between postural control and sensorimotor function. Resting-state functional MRI is a non-invasive neuroimaging tool used to determine the temporal synchrony between functionally linked but spatially divergent brain regions, referred to as networks. The synchrony, or functional connectivity (FC), of regions comprising the SMN is an unexplored measure that may contribute to postural control. This study aimed to determine the relationship between SMN-FC and static postural control measures in the involved and non-involved limbs of older adults with a history of lateral ankle sprain (LAS).

Methods: A cross-sectional design was used to correlate FC and balance outcomes in older adults with previous history of LAS. Twenty-one older adults with a previous history of LAS volunteered (Females: $n=14$, 66.7 ± 4.5 years, 163.2 ± 8.0 cm, 73.6 ± 16.5 kg, BMI: 27.5 ± 5.5 kg/m²; Males: $n=7$, 65.6 ± 3.9 years, 178.6 ± 8.2 cm, 96.5 ± 8.5 kg, BMI: 30.5 ± 4.2 kg/m²). All neuroimaging data were acquired on a Siemens 3T TIM Trio scanner. High-resolution structural images and functional images were analyzed using Functional Magnetic Resonance Imaging Software Library's Multivariate Exploratory Linear Optimized Decomposition into Independent Components. Briefly, after identifying the SMN, 4 regions of interest (ROI) were isolated: left thalamus, left post-central gyrus, right thalamus and right post-central gyrus. The time series of activation was extracted for each ROI. Correlation coefficients between ipsilateral structures were then calculated to produce a sensorimotor FC value for each hemisphere. Higher correlation coefficients are indicative of more synchronous communication between ROIs. Balance measures for the contralateral limb were then associated with these FC values. Participants performed 3 eyes-open trials of a 20-second single-leg balance task on the involved and non-involved limbs. Center of pressure velocity (COPV) measures were sampled at 100Hz and calculated in the anteroposterior (COPV_{AP}) and mediolateral (COPV_{ML}) directions. Lower values of COPV are indicative of superior postural control. Partial correlations were used to determine relationships between SMN-FC and contralateral static postural control of the uninvolved limb. Age, sex and BMI were entered as nuisance covariates ($P<0.05$). Significance was set at $P<0.05$; and moderate ($r=0.5-0.8$) and strong ($r>0.80$) associations were documented.

Results: Contralateral SMN-FC was significantly associated with COPV_{ML} ($r=-0.627$, $P=.007$) and COPV_{AP} ($r=-0.711$, $P=.001$) in the non-involved limb of older adults with a history of LAS. No significant association was observed between involved limb balance and contralateral SMN-FC (COPV_{ML}: $r=0.190$, $P=.450$; COPV_{AP}: $r=0.356$, $P=.147$).

Conclusions: Findings suggest a dissociation between SMN-FC and balance in older adults with a history of LAS. This provides preliminary evidence that the sensorimotor system's ability to communicate with itself may have an impact on functional performance, such as balance. Future research should aim to further identify the mechanisms explaining these relationships.

Total Word Count: 439

[208453MB](#)

Current Dynamic Warm-Up Practices in Secondary Schools

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Context: Preventive training programs (PTPs) are recommended to reduce sport-related musculoskeletal injury. Despite low reported adoption of these programs in the literature, it is possible that existing team-based warm-ups may already include components of evidence-based PTPs. The purpose of this project was to evaluate the current adoption of PTP components in existing team-based warm-ups among secondary school athletic trainers (ATs).

Methods: Using a cross sectional study design, 19 secondary school athletic trainers (ATs) in North Carolina (n=12) and Connecticut (n=7) volunteered to participate in an online questionnaire. The questionnaire development was guided by the 2018 National Athletic Trainers' Association Position Statement: Prevention of Anterior Cruciate Ligament Injury. ATs were asked questions pertaining to the adoption of any team-based warm-up strategy, a dynamic team-based warm-up, a team warm-up comprised of strength and balance exercises, as well as if current warm-up routines included specific different components (i.e., strength, balance, agility, plyometrics). Frequencies and Chi-Square tests of associations were calculated to evaluate the association between each separate question. Prevalence ratios (PR) with 95% confidence intervals (CI) were also calculated to compare each question.

Results: Of the ATs included in this study, 84.2% reported that all of the teams at their school perform some type of team warm-up (table 1). ATs in our sample reported that the team warm-up includes the following components: balance 57.9% (n=11/19), strength 52.6% (n=10/19), plyometrics 47.4% (n=9/19), and agility 94.7% (n=18/19). ATs reported being more likely to have the combination of strength and balance included in their warm-up program, compared with strength only (100% v 35.7%: PR= 2.8, 95% CI= 1.39, 5.65). There were no other significant associations noted across the components included in the team warm-up program.

Conclusions: Evidence-based guidelines recommend that warm-up programs incorporate a variety of exercise modes, specifically strengthening, balance, plyometric and flexibility exercises, to reduce sport-related musculoskeletal injury. The vast majority of secondary schools in this study that do adopt a team-based warm-up report incorporating agility exercises. Including agility exercises in recommendations for PTPs may improve widespread adoption by matching perceived expectations from teams regarding what should be included within a warm-up. These results suggest that the majority of secondary school ATs report teams are already using some type of team-based warm-up. Recommending minor modifications to existing programs may be an effective strategy to improve the adoption of evidence-based PTPs.

Total Word Count: 382

209114IA

Current Health-Related Quality of Life is Lower in Former Division I Collegiate Athletes than in Noncollegiate Athletes: A Five Year Follow-up

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Context: The effect of athletic participation on lifelong health among elite athletes has received increasing attention as sports-related injuries can have a substantial impact on the long-term health of student-athletes. Therefore, the purpose of this study was to determine the current health-related quality of life (HRQoL) in former Division I athletes compared with non-athletes five-years following an initial assessment.

Methods: This study employed a prospective cross-sectional design. Participants were recruited using the existing database from a previous study of alumni from a large Midwestern university. The two cohorts in this database are 1) former Division I athletes and 2) nonathletes that participated in recreational activity, club sports, or intramurals while attending college. For the former Division I athletes, 232 were originally contacted. A total of 193 responses were received (response rate, 83.2%, 128 males, 65 females, 58.47±6.17years) for the follow-up. For the non-collegiate athletes, 225 were originally contacted, from which 169 surveys were returned (response rate, 75.1%, 80 males, 89 females; 58.44±7.28years) for the follow-up. Participants completed the Patient-Reported Outcomes Measurement Information System (PROMIS) and a demographics questionnaire online (Qualtrics; Provo, Utah). The PROMIS scales completed were sleep disturbances, anxiety, depression, fatigue, pain interference, physical function, and satisfaction with participation in social roles. The independent variables included time (baseline, 5 years post) and group (former Division I athlete and nonathlete) with the dependent variables the seven PROMIS scales. A multivariate repeated measures ANOVA was conducted for the combined dependent variables. If the overall multivariate ANOVA was significant for the main effect or interaction, follow-up univariate ANOVAs were conducted for each dependent variable. Alpha level was set at $\alpha < 0.05$ for all analyses.

Results: The multivariate repeated measures ANOVA was significant for time and time x group ($p < 0.05$). All seven PROMIS scales were significant over time ($p < 0.05$). Physical function, depression, fatigue, sleep, and pain were significant for time x group ($p < 0.05$) with the largest differences seen on physical function and pain between groups at 5 years post (22.19 and 13.99 points, respectively) with the former Division I athletes scoring worse compared to nonathletes. Additionally, former Division I athletes had worse scores on physical function, depression, fatigue, and pain between time points ($p < 0.05$) with the largest differences seen on the depression, physical function, and fatigue scales (8.33, 6.61, and 6.23 points, respectively). However, for the nonathlete group there were no significant differences on any PROMIS scale between time points ($p > 0.05$).

Conclusions: Former Division I athletes had worse HRQoL when compared to nonathletes at time point two but also had decreased HRQoL at the five-year follow-up on five scales when compared to time point one. Nonathletes who were recreationally active in college had better HRQoL and have shown can maintain that HRQoL over time.

Total Word Count: 446

[2094630A](#)

Current Practices in Acute Musculoskeletal Injury Care: A National Survey of Athletic Trainers

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Context: Caring for acute musculoskeletal injuries is an important part of the practice of athletic training. Despite the importance, there is no consensus on the current standard of care or description of most common practices in clinical use.

Methods: We used an online cross-sectional, observational questionnaire to ascertain which modalities athletic trainers are using to treat musculoskeletal injuries over the course of the disease and the rationale behind the decisions to use or not use them. The questionnaire was reviewed by 5 external content experts over 2 rounds of reviews for face and content validity and was distributed using snowball sampling via social media. We received responses from 217 individuals of which 187 (86%) met the inclusion criteria of being a BOC certified athletic trainer whose current practice includes acute care of musculoskeletal injuries. Eligible survey responses were from athletic trainers in 40 states across all ten NATA districts who have been certified for between <1 and 47 years (mean = 11.9±11.4 y). Respondents represent most major practice settings with 48% practicing in the college setting and 36% practicing in the high school setting. Counts and percentages are reported.

Results: In the immediate care of injuries, 97% of ATs are using compression, 83% use elevation, 79% are using some form of cryotherapy, 49% use electrical stimulation, and 28% use some form of manual therapy. Before therapeutic exercise, 73% of ATs are using manual therapy, 57% use electrical stimulation, 51% use ultrasound, and 49% specifically use Instrument Assisted Soft Tissue Mobilization (IASTM). After therapeutic exercise, 67% of ATs use an ice bag, 65% use some form of manual therapy, 58% use a cold and compression device, 53% use ice massage, and 44% use elevation. During the maturation/remodeling phase, 73% of ATs are treating their patients with some form of manual therapy, 61% use IASTM specifically, and 44% use some form of electrical stimulation. The most common forms of cryotherapy are, in order, ice bags, ice massage, cold and compression devices, cold whirlpool, and ice bucket. The most common forms of manual therapy, in order, are instrument assisted soft tissue mobilization, massage, active release therapy, muscle energy technique, proprioceptive neuromuscular facilitation, and joint mobilization.

Conclusions: To our knowledge, this is the first study to document patterns of modality use across the treatment continuum by ATs. The findings have meaningful implications about current practice and are helpful in forming additional questions we are now exploring in an additional project. Our most surprising finding is that although acute cryotherapy is taught almost universally, roughly 1 in 5 ATs are not using it even though they use compression and elevation. This suggests that the recent “no ice” movement may be gaining traction among ATs.

Total Word Count: 445

209914DD

Cyclops Lesion Accompanied by Pigmented Villonodular Synovitis in a Collegiate Baseball Athlete

Scott M. Freer, PhD, ATC, LAT; Matthew Santos-Vitorino, MS, ATC, LAT

Background: An otherwise healthy 21-year-old collegiate baseball athlete awkwardly rotated his (R) knee while fielding a ground ball during baseball practice. Previous medical history included an allograft anterior cruciate ligament (ACL) reconstruction approximately 4 years prior. At the initial on the field evaluation, the athlete reported significant pain (7/10) and the inability to fully extend his (R) knee stating that it feels “stuck”. Visually, the extension deficit seemed to approximately 15°-20°. Additional orthopedic tests were not performed due to pain, ROM deficit, and swelling. Conservative treatment (i.e., ice, compression, and electrical stimulation) was initiated after primary evaluation and instructed on proper use of crutches. A follow up evaluation with the athletic trainer 24 hours later yielded significant amount of joint effusion, tenderness along the medial joint line, sustained pain while weight bearing and the inability to terminally extended knee extension. Ligamentous stress tests were found inconclusive due to pain and muscle guarding.

Differential Diagnosis: ACL tear, medial meniscus tear, osteochondral lesion

Intervention & Treatment: Due to the presentation of symptoms, the athlete was referred to the team physician for further evaluation and imaging. Magnetic resonance imaging (MRI) radiology report revealed 1) a 2 cm nodular of scar tissue fixed anterior to the ACL, 2) a 4-5 cm nodular of scar tissue was found anteromedially on the joint capsule anterior to the ACL graft, and 3) a small region of synovitis posteriorly to the joint behind the posterior cruciate ligament. This inflammatory condition was noted as pigmented villonodular synovitis (PVNS). An arthroscopic surgical procedure was performed to remove the arthrofibrosis, or cyclopes lesion, and PVNS. Surgical excision and arthroscopic debridement was performed with-in 2 weeks after injury. Post-surgical rehabilitation protocol was initiated the following day. Daily therapeutic rehabilitation protocol consisted of 1) aggressive active and passive ROM exercises, 2) open and closed chain lower extremity progressive resistance exercises, 3) proprioceptive exercises, and 4) therapeutic modalities to decrease swelling and pain. A gradual return to sport specific activity began at post-operative week 6 and was cleared to participate in all sport related activities without restriction at post-operative week 12.

Uniqueness: Localized anterior arthrofibrosis, or “cyclops” lesion, has been reported in 1%–10% of patients with ACL reconstruction and are the second most common cause of terminal extension loss after graft impingement. A differential diagnosis of arthrofibrosis can include PVNS, a rare benign proliferative disease of the synovial tissue of a single joint, bursa, or tendon sheath that may invade and destroy surrounding soft tissue and bone, resulting in functional deterioration of a joint and the extremity. The estimated incidence rate of PVNS is approximately 1.8 cases per million population annually and more commonly in the age group of 40-50 years. The treatment of choice for PVNS is total resection of the affected tissues.

Conclusions: In patients that have underwent ACL reconstruction, athletic trainers should consider a PVNS pathology secondary to localized arthrofibrosis of the ACL graft in patients presenting with limited terminal extension and swelling.

Total Word Count: 484

205884QD

Delegation of Medical Authority from Supervising Physicians to Athletic Trainers in Texas

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Context: In most states, athletic trainers (ATs) are required to obtain a state license, certification, or registration in order to clinically practice. Often, this entails receiving a written delegation of medical authority from a designated supervising physician. In the state of Texas, athletic trainers have the unique opportunity to obtain an athletic training license without necessarily obtaining national certification. Thus, the purpose of this study was to determine the background of the physicians delegating medical authority to ATs, and the tasks that ATs in the state of Texas are allowed to do in their clinical practice settings.

Methods: We used a web-based survey (Qualtrics) that was distributed to 1255 certified and/or licensed ATs in the state of Texas. A total of 152 ATs accessed the survey (response rate=12.1%) and 150 ATs completed the survey (completion rate=12.0%). The survey tool included questions to gather demographic data, knowledge of state athletic training licensing regulations, involvement of their supervising physician in their clinical practice and skills and tasks permitted by the delegated authority of the supervising physician. After the collection window had closed, we calculated frequencies of participant responses.

Results: Most ATs felt that they were at least somewhat familiar with the Texas athletic training state practice act (strongly agree=17/150, 11.3%; agree=75/150, 50.0%; somewhat agree=n=48/150, 32.0%). Over half (n=86/150, 57.3%) of the participants stated that they maintained written copies of their delegation of medical authority. Only 10.7% (n=16/150) of ATs stated that they did not require delegated medical authority from a supervising physician. The most commonly reported skills and tasks allowed by supervising physicians were cryotherapy (n=139/150, 92.7%), assessment of athletic injuries (n=139/150, 92.7%), and therapeutic ultrasound (n=138/150, 92.0%). The least commonly reported skills and tasks allowed by supervising physicians were suturing (n=5/150, 3.3%), intravenous fluid administration (n=8/150, 5.3%), and femoroacetabular joint reductions (n=15/150, 10%).

Conclusions: Most certified and/or licensed ATs recognized that the state of Texas requires that ATs practice with delegated medical authority from a physician. However, there was a small population of ATs that did not appear to have knowledge of these requirements. Furthermore, despite intravenous fluid administration and suturing being allowed in the state, most ATs are unable to practice these due to a lack of delegation of these skills by their team physician. Athletic trainers must be aware of their state's practice acts and regulations to ensure that they are practicing within their scope.

Total Word Count: 392

[208574AD](#)

Demographic Characteristics and Their Association with Instantaneous Lower Extremity Injury Risk in a Division I Athletic Population

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Context: Accurate prediction of lower extremity injury risk will benefit clinicians by allowing them to better leverage limited resources and target athletes most at risk. Although predictive statistical modeling and machine learning have been recent emphases in the literature, there is first a need to characterize risk of lower extremity injury risk by demographic factors: sex, sport, body mass index, and previous injury history. We hypothesized that instantaneous injury risk will be greater in females, athletes with BMI>25, and athletes with previous injury.

Methods: This was a prospective injury tracking study. Demographic factors were obtained in an NCAA Division I athletic population concurrently with pre-participation physical exams each year from 2013-2015 (116 males, 163 females; sports: basketball, softball, soccer, tennis, volleyball, cross-country). Lower extremity injuries were tracked until each athlete's first injury, or the duration of each athlete's collegiate career, or until September 1, 2016 (median follow-up=134 days). Univariate Cox regression models investigated the independent association between time to injury and sex, BMI, sport, and previous injury history (yes/no). Cox proportion hazard regression models were used to analyze the relative risk for sustaining injury, whereas time to first injury (days) was summarized by use of Kaplan-Meier curves and log rank test analysis. Only those variables significant in univariate analysis were included in multivariate Cox regression models.

Results: Fifty-one athletes (18%) had no previous injury history or prospectively identified injury. Ninety-three athletes (33%) had previous injuries only. Fifty-one (18%) sustained prospective injuries only. Eighty-four athletes (30%) had previous injury history and prospective injuries. Including previous and prospective injury, females had 29% greater instantaneous injury risk than males (hazard ratio=1.29, 95%CI=[0.91, 1.83], p=0.16). Though not statistically significant, this result may be clinically important. Among athletes without previous injury, females had 97% greater instantaneous injury risk than males (hazard ratio=1.97, 95%CI=[1.07, 3.62], p=0.03). Overweight athletes (BMI>25) had a higher risk of injury than healthy-weighted athletes but the result was not statistically significant (hazard ratio=1.23, 95%CI=[0.84, 1.82], p=0.29). Athletes with previous injuries were not statistically more likely to sustain subsequent injury than athletes with no previous injury (hazard ratio=1.09, 95%CI=[0.65, 1.3], p=0.63). Basketball and soccer athletes had higher risk of injury than other sports. Specifically basketball players had a significantly higher risk of injuries than cross-country athletes (hazard ratio=3.11, 95%CI=[1.51, 6.44], p=0.002). The multivariate Cox regression model including previous injury status, BMI, sex, and sport as covariates was not significant.

Conclusions: In a collegiate athletic population, females are at greater risk of instantaneous lower extremity injury risk than males. This effect is more pronounced in females without previous injury history. Previous injury history was not a significant contributor to risk of future lower extremity injury.

Total Word Count: 437

[205872ID](#)

Determination of Kerlan-Jobe Orthopedic Clinic Scores in Competitive Tennis Players

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Context: The Kerlan-Jobe Orthopedic Clinic (KJOC) Shoulder and Elbow questionnaire is a patient reported outcome measure that is used in overhead sports. Normative KJOC data in tennis players may be useful for clinicians to understand how players perceive arm health during practice and competition. However, no study has sought to establish KJOC data in tennis athletes. The primary purpose of this study was to establish KJOC scores in male and female collegiate and junior tennis players. The secondary purpose was to determine if the KJOC would be able to discriminate between symptomatic and asymptomatic players.

Methods: Collegiate (20±1 years) and junior tennis players (14±2 years) enrolled in a cross-sectional study. Recruitment was from a sample of convenience. Players were considered eligible if they: (1) participated in tennis at least three times a week; (2) between 12-24 years; and (3) could speak and read English. Junior players were recruited from one tennis academy, and were eligible if participated in at least one sectional, regional, or national tournament. Collegiate players were eligible if part of an NCAA institution. Junior players completed the KJOC survey with pen and paper and collegiate players online via Qualtrics. Asymptomatic players were categorized as playing without arm pain, and symptomatic players as playing with arm pain or not playing because of arm pain. To establish KJOC scores (dependent variable) a 2x2 ANOVA was used to investigate differences in scores across sex and level of play (independent variables). To determine if the KJOC could discriminate between symptomatic and asymptomatic tennis players a Kruskal-Wallis was utilized.

Results: On average, players completed the KJOC in five minutes. A total of 178 players completed the KJOC (102 collegiate, 76 junior). A post hoc power analyses indicated strong power (0.99) given $p=0.05$, $\alpha>0.8$ and $d=0.4$. Six of the 102 collegiate surveys were incomplete and were excluded from the study. Of the 96 collegiate participants, 73% represented division I players, 24% division II, and 3% at the division III level. Seventy-six junior tennis players completed the survey. KJOC scores were lower in males than females ($P=0.02$). There was no interaction between sex and level of play in KJOC scores ($P=0.17$). The KJOC was able to discriminate ($P<0.01$) between asymptomatic and symptomatic players.

Conclusions: This study is the first to quantify normative KJOC scores in a tennis population. The data provides baseline metrics that can be used to obtain information regarding self-perceived shoulder and elbow function in a tennis population as well as determining if players are functioning at full capacity.

Total Word Count: 413

200295RB

Developing, Validating and Establishing Reliability of a Standardized Patient Evaluation Tool to Measure Healthcare Core Competency

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Context: The ability to assess continued competence of athletic trainers is imperative to ensure high quality patient care. However, no current mechanisms exist to measure the Institute of Medicines' Core Competencies including: patient-centered care, interprofessional and collaborative practice, evidence-based practice, quality improvement, and healthcare informatics. Previous medical literature has used standardized patients (SP) to evaluate competence and skill in providers of multiple levels. The purpose of this study was to develop, validate, and establish reliability of standardized patient evaluation tool (SPET).

Methods: We used five 2-member teams of educators and clinicians to create five SP cases, representative of all the core competencies, each focusing on a core competency (Case 1: patient-centered care, Case 2: interprofessional and collaborative practice, Case 3: evidence-based practice, Case 4: quality improvement, Case 5: healthcare informatics) . We used a panel of 22 experts to conduct a 4-round Delphi panel review to establish consensus on the content validity of the SPET and its ability to apply to the SP cases. To measure reliability, we then implemented the cases and SPET during six evidence-based practice approved continuing education sessions offered in five different cities. Each session included a 45-minute period of instruction, 30-minute video recorded SP encounter, and 15-minute debrief session. Three independent evaluators were recruited to view and score the video recordings of the SP encounters (n=41) using the SPET. The evaluators were trained for 30 minutes each on the SPET and its evaluative criteria. We used descriptive statistics to ensure content validity through the consensus of experts and two-way mixed effects model inter-class correlations to measure reliability (ICC).

Results: Among our Delphi panelists, we established consensus on whether the evaluative criteria was appropriate (mean=3.6±0.6, 65% strongly agree) and whether the SPET could be used across SP encounters to evaluate the healthcare core competencies (mean=3.5±0.8, 65% strongly agree). For each case, Delphi panelists came to consensus on the ability to apply the SPET to the case (Table). During the Delphi panel process, experts indicated, through open-ended responses, that quality improvement and healthcare informatics may be difficult to assess during a single SP encounter. We established moderate reliability for the measure of overall performance score (ICC=0.641). Reliability for each core competency measure demonstrated variable reliability (ICC: patient-centered care=0.778; interprofessional and collaborative practice=0.581; evidence-based practice=0.274; quality improvement=0.390; healthcare informatics=0.232). Again, raters, when viewing the SP encounters, suggested that there was no opportunity to assess quality improvement and healthcare informatics.

Conclusions: We developed and content validated a SPET, which can be applied to five cases that adequately embody the healthcare core competencies; however, single-case SP encounters may not adequately offer opportunities to enact and assess the quality improvement and healthcare informatics core competencies.

Total Word Count: 440

205764RB

Development and Initial Testing of a Theory-Based Intervention to Improve Athletic Training Students' Concussion-Related Decision-Making Intentions

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Context: Concussions are often difficult to diagnose and communicate with various stakeholders due to the lack of outward visibility. Therefore, the study objectives were to develop and pilot test an intervention targeting improved athlete healthcare through appropriate decision-making intentions. Specifically, the Communication of Healthcare decisions in Athletic Training (CHAT) program was designed to improve the preparedness of athletic training students entering autonomous clinical practice to make difficult decisions concerning concussed athlete removal and return to participation.

Methods: This study included formative cross-sectional research and a pre-test/post-test design to initially test the intervention. Theory (Integrated Behavior Model), formative research, and the PRECEDE Planning Model guided program development. Formative research (e.g., interviews, surveys) focused on concussion-related decision-making among certified athletic trainers and athletic training students guided development of program content (didactic and scenario-based learning). Thirty-seven athletic training students from two programs (1 undergraduate, 1 graduate; mean age=23.5±3.5 years) pilot-tested the CHAT program. The two institutions were selected based upon convenience, but also their different program offerings (undergraduate, graduate) and student demographics. Pilot testing occurred at each institution across two days (one week apart) to deliver both aspects of the intervention. Most students were female (70.0%) and at the "junior" or "first-year" level of training (60.0%). The sample included Caucasians (56.8%), African Americans (29.7%), Asians (8.1%), American Indian/Native Americans (2.7%), and Latinos (2.7%). Medians and interquartile ranges were used for all dependent variables [attitudes (range=14.0-98.0), personal agency (range=15.0-105.0), knowledge (range=25.0-100.0), and intentions (range=13.0-91.0)] assessed pre- and post-intervention by self-report survey assessments. Differences between program type (undergraduate vs. graduate) were assessed along with their interactions using an ANOVA with Tukey post-hoc comparisons.

Results: Overall, participants had moderate levels of knowledge (median=82.0, IQR=78.0-86.0), personal agency (median=90.0, IQR=83.0-98.0), and positive attitudes (median=86.0, IQR=59.0-98.0) toward concussion before the intervention. Participants also had relatively high intentions to remove concussed individuals from play (median=85.0, IQR=79.0-91.0) prior to the intervention. The theoretical construct of Personal Agency (overall: $p < 0.001$; perceived behavioral control: $p = 0.027$; self-efficacy: $p = 0.001$) and intentions (overall: $p = 0.001$; despite pressure: $p = 0.011$; situation: $p = 0.003$; setting: $p = 0.012$) significantly improved post-intervention (Table 1). Additionally, 100.0% of participants felt the workshop was useful and successful.

Conclusions: Overall, the CHAT program was helpful in improving the factors identified by formative research as influential to making appropriate concussion-related decisions which ultimately affect athlete healthcare and outcomes. The program provided the students with opportunities to not only learn standardized knowledge about concussion, but also the difficulties communicating and collaborating regarding their identification and care and practice making these difficult decisions through role play. Future research should examine retention of CHAT program information as well as differing delivery modes (online and virtual) on program effectiveness and employ a randomized design.

Total Word Count: 438

200501CD

Development of Vasovagal Syncope Following Sport Related Concussions in Collegiate Volleyball Player: Level Four Case Study

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Background: Patient is a 20-year-old female collegiate volleyball player who sustained three sports related concussions (SRC) in a 20 month span. The first SRC was diagnosed and resolved in November 2017; the most substantial symptom throughout recovery was a persistent headache.

The second SRC was diagnosed in March 2018, initial symptoms were reported to be more severe and had a longer duration than the previous SRC. The evening of the second SRC diagnosis, the patient was found lying unconscious and was transported to the Emergency Room (ER) where the ER physicians diagnosed her with epilepsy due to a seizure wave found on her electroencephalogram (EEG). Despite taking her seizure medication, the patient proceeded to have three more fainting episodes between March and July of 2018. In one episode, the patient was found unconscious with shallow breathing and a weak pulse after throwing up; the patient was unconscious for approximately 20 minutes and she was taken to the ER where EEG, electrocardiogram, and blood work were all negative. It was determined that she did not have epilepsy, but no new diagnosis was made. In mid-July, the patient reportedly fainted again; when she came to in the hospital, she experienced retrograde amnesia and did not recognize her teammates and she was diagnosed with dehydration by ER physicians.

Following this episode, chronic headaches persisted with intermittent memory loss. Due to a noticeable personality change the Athletic Trainer recommended the patient visit with the sport psychologist, she attended one appointment then decided not to return. In August 2018, physicians at a concussion clinic used vestibular therapy and performed a series of tests including the Table Tilt Test, which induced a syncope episode, resulting in the final diagnosis of vasovagal syncope. The patient was prescribed medication and returned to play in September 2018.

A third SRC was diagnosed in August 2019 and the decision was made to medically disqualify the patient.

Differential Diagnosis: Epilepsy, dehydration, post-concussion syndrome, and arrhythmia were all considered before the final diagnosis of vasovagal syncope.

Intervention & Treatment: The patient was prescribed seizure medication Levetriacetam and postural blood pressure medication Fludrocortisone, but has since discontinued taking these medications. She was also prescribed Amitriptyline, a daily headache medication that also works as an antidepressant and blood pressure medication; she still takes this medication and a magnesium supplement daily.

Uniqueness: The symptoms developing just after the second SRC made determining the cause of the episodes a challenge. Vasovagal syncope is caused by the sudden constriction of blood vessels, resulting in a rapid drop in blood pressure; factors leading to this drop include psychological distress or standing too quickly. Syncope episodes have been known to be caused by chemical changes in the brain and by heart events such as bradycardia. The patient did not report noticing a heart rate change before fainting. It was not determined if the patient's syncopal episodes were caused by blood pressure change or some other cause. Research behind the metabolic cascade of events such as chemical and electrical activity changes in the brain immediately following SRC is limited. The fact that the seizure wave was initially found the night of the second SRC then was not seen again is a point of interest.

Conclusions: It took collaboration of the Athletic Trainer, team physician, cardiologist, neurologist, Emergency Room physicians, Concussion Clinic specialists, and a sport psychologist to narrow down the differential diagnosis to explain the syncopal episodes, chronic headaches, and intermittent memory loss. The patient continues to suffer from chronic headaches, but has not had a syncopal episode since she began taking Amitriptyline.

Total Word Count: 584

[207743JA](#)

Differences in Current Self-Reported Physical Activity Among Females With Varying Previous Sport Participation: A Report From the Active Women's Health Initiative

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Context: Participation in physical activity (PA) is a critical component for the promotion of health and well-being, as well as preventing morbidity and mortality. While it has been demonstrated that childhood PA participation and musculoskeletal injury are related to PA levels in adulthood, these have not been thoroughly examined in adult women. The primary purpose of this study was to examine differences in current self-reported PA in women ages 18-55 years based on previous high school sport participation and current musculoskeletal injury status.

Methods: A cross-sectional, web-based survey was developed to assess previous high school sport participation (yes/no), current joint injury (yes/no) and current PA in adult women. A total of 262 participants (age:36.4±9.7years; height:164.8±20.1cm; weight:77.1±21.4kg) had complete data for analysis and met the inclusion criteria (women ages 18-55 years). A total of 139 respondents participated in high school sports (HS-YES) and 123 did not (HS-NO). A total of 96 respondents reported a current musculoskeletal injury (INJURY-YES) and 166 reported no current musculoskeletal injury (INJURY-NO). Current PA level was quantified using the International Physical Activity Questionnaire-Short Form (IPAQ). The IPAQ utilizes participant answers to produce a categorical score and continuous measure of PA (weekly metabolic equivalent of task (MET) minutes). The total moderate and vigorous MET minutes were summed for data analysis. The independent variables were current musculoskeletal injury (INJURY-YES,INJURY-NO) and HS participation (HS-YES,HS-NO). The dependent variable was weekly moderate/vigorous MET minutes. Descriptive statistics (mean±standard deviation) were calculated for each variable of interest. A Factorial ANOVA was employed to examine the interaction between HS participation and current injury status on weekly Moderate/Vigorous MET minutes. Post-hoc pairwise comparisons were performed when indicated. Statistical significance was set a priori $p<0.05$.

Results: There was a significant interaction between HS participation and current injury ($F=7.094$, $p=0.008$). Post-hoc analyses revealed participants in the INJURY-NO/HS-YES group reported significantly more moderate/vigorous MET minutes compared to the INJURY-NO/HS-NO group ($F=4.33$, $p=0.04$, Table 1). The INJURY-YES/HS-NO group reported significantly higher moderate/vigorous MET minutes compared to the INJURY-YES/HS-YES group ($F=10.58$, $p=0.002$, Table 1). Lastly, the HS-NO/INJURY-YES group reported more moderate/vigorous MET minutes compared to the HS-NO/INJURY-NO group ($F=24.65$, $p<0.001$, Table 1). No significant main effects for current joint injury ($F=1.942$, $p=0.165$) or HS participation ($F=1.541$, $p=0.216$) were identified.

Conclusions: Women who reported previous HS sport participation reported higher PA in adulthood when no injury is present. However, women with no previous HS sport participation reported greater moderate/vigorous weekly MET minutes when a current injury was reported. These findings suggest more research investigating the relationship between previous sport participation, current injury status, and current PA participation in adult women is warranted. Additional variables that could impact these relationships should be considered including motivation to exercise and severity of current injury.

Total Word Count: 445

200171MD

Differences in Perceived Sport Demands and Sport Specialization During High School Athletics in Male and Female Athletes

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Context: Adolescent sport participation in the United States has been declining and females drop out of sport at twice the rate than males by age 14. Many studies have investigated sport specialization and various factors that may moderate this decline, but few studies have examined the perceived social and travel demands of high school sport participation. Furthermore, limited research has examined if these facets of high school sport are different between males and females. Therefore, the purpose of this study was to examine how travel, training history, specialization, and social demands of high school sport are different between male and female athletes.

Methods: This study was a cross-sectional survey designed to examine the perceived demands of high school sport participation between males and females. Participants were Division I and sport club collegiate athletes at a large public university in the Midwest. Participants completed an anonymous, retrospective survey which included their high school sport participation history, demographic information, high school sport demands (travel frequency, training history, and missing time with friends), as well as a commonly used 3-point sport specialization classification system. Participants were asked to recall high school sport demands and the sport specialization classification for each high school grade (9th-12th). Chi-squared tests were used to examine associations of sex with training history, missing time with friends, traveling for sport, and sport specialization.

Results: Female athletes were more likely than males to report missing time with friends due to sport training in grades 9-12 (Female 9th=74% vs. Male 9th=59%, $P<0.001$; Female 10th=76% vs. Male 10th=60%, $P<0.001$; Female 11th=78% vs. Male 11th=64%, $P<0.001$; Female 12th=78% vs. Male 12th=65%, $P<0.002$). Female athletes reported traveling for sports more than males throughout high school (Female 9th=70% vs. Male 9th=53%, $P<0.001$; Female 10th=75% vs. Male 10th=55%, $P<0.001$; Female 11th=74% vs. Male 11th=58%, $P<0.001$; Female 12th=70% vs. Male 12th=54%, $P<0.001$). Females were more likely than males to report training for 3/4th of the year in a single sport in 9th grade (Female=69%, Male=60%, $p=0.041$), but not in any other grade. More female athletes were specialized in 9th grade than male athletes (Female=30%, Male=22%, $p=0.040$). However, specialization rates in grades 10-12th were not significantly different between males and females and continued to increase throughout high school for both sexes.

Conclusions: High school females are more likely than males to participate in sport related travel and miss time with friends. These factors may be related to sport burnout and dropout. Theoretically, these factors may increase stress, which could affect their psychosocial well-being. More research is needed to explore sex specific relationships between training load due to demands of high school sport participation.

Total Word Count: 430

209092IA

Disablement of the Physically Active in Former Division I Collegiate Athletes and Non-Collegiate Athletes

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Context: College athletes participate in high levels of physical activity that may lead to overtraining and subsequent injury that can continue to affect them as they age. Therefore, the purpose of this study was to explore the Disablement in the Physically Active Scale (DPA), and a Mock Well-Being form in Former Division I (DI) Collegiate Athletes and Non-Collegiate Athletes.

Methods: This cohort study enrolled former DI athletes and nonathlete counterparts. Individuals were recruited from databases at a large Midwestern NCAA DI University. Of the former DI athletes, 232 were originally contacted. A total of 193 responses were received (response rate, 83.2%, 128 men, 65 women, 58.47±6.17 years, 91.49±19.76kg, and 1.77±0.09m). For the non-collegiate athletes, 225 were originally contacted, from which 169 surveys were returned (response rate, 75.1%, 80 men, 89 women; 58.44±7.28 years, 79.46±20.28kg, and 1.70±0.08m). All participants, regardless of group, completed a demographic questionnaire and the DPA. Only the former DI athletes saw the Mock Well-being Self-Report Form and associated questions. The Mock Well-being Self-Report Form was based on previous literature and provided an opportunity for an athlete to rate current illness, training load, and general health. The form was strictly for former athletes to view and reflect on, and not complete. Five associated questions were constructed regarding the potential use of the form during their time as a collegiate athlete. All surveys were constructed using a web-based survey system, Qualtrics (Provo, Utah). Dependent variables included the physical, mental, and total scores on the DPA, and participant responses to the questions associated with the Mock Well-being Self-Report form. A multivariate ANOVA was used to evaluate the differences between groups on the DPA. Follow-up univariate ANOVAs were conducted for each dependent variable if the overall multivariate ANOVA was significant. An alpha level of $\alpha < 0.05$ was used for all analyses. Frequencies were calculated for the five questions regarding the Mock Well-being Self-Report Form.

Results: The overall multivariate ANOVA was significant for group ($F(2,359)=222.51, p=0.001, \eta^2=0.55, 1-\beta=0.99$). DPA physical score, mental score, and total score were all significant with the former Division I athletes scoring worse than the non-collegiate athletes (mean differences of 18.53, 4.29, and 22.81 points respectively). Forty-two percent of former DI athletes agreed that they would have better HRQoL if they had access to the Mock Well-being form. However, 64% stated they would not have been truthful on the form, and 75% did not think it would be effective in monitoring stress and overload.

Conclusions: Demands of collegiate athletics may result in injury that consequently brings lifelong limitations and lower HRQoL in multiple areas. Due to the competitive nature of sport, long term risks of diminished HRQoL need to become a priority for healthcare providers and athletes.

Total Word Count: 444

[200474LD](#)

Dis-inhibitory Interventions for Chronic Ankle Instability: A Systematic Review and Meta-Analysis

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Context: There is conclusive evidence that patients with chronic ankle instability (CAI) present decreased neural excitability in lower leg muscles, which has been clinically termed as arthrogenic muscle inhibition (AMI). Therapeutic interventions aimed at AMI (dis-inhibitory interventions) were introduced in the CAI literature. The current study was to perform a systematic review and meta-analysis to determine the efficacy of dis-inhibitory interventions for CAI.

Methods: Two independent researchers performed comprehensive literature searches using electronic databases (Web of Science, PubMed, CINAHL, and SPORTDiscus). Studies were included if they examined the effects of therapeutic interventions on neural excitability of lower leg muscles in CAI patients, and investigated neural excitability with Hoffmann reflex (H-reflex) and/or transcranial magnetic stimulation (TMS). The methodological quality of each included study was assessed using the Physiotherapy Evidence Database (PEDro) scale. Sample sizes, means, and standard deviations (SD) of H-reflex or/and TMS outcomes were extracted from included studies: these data were obtained before and after interventions: dis-inhibitory (active), sham, or/and control (no intervention). Effect sizes of Hedges's g were estimated by the mean pre-post changes in the dis-inhibitory intervention group minus the mean pre-post changes in the sham/control group, divided by the pooled pretest SD, with positive values indicating improvement. The magnitude of the effect size was interpreted as follows: $d=0.2$ small, $d=0.5$ medium, and $d=0.8$ large. When possible, a meta-analysis was performed using a fixed-effect model ($P<0.05$).

Results: A total of 9 studies were included, with dis-inhibitory interventions: ankle joint cryotherapy ($n=3$), manual therapy ($n=2$), fibular repositioning taping (FRT, $n=2$), whole-body vibration (WBV, $n=1$), and transcranial direct current stimulation (tDCS, $n=1$). The PEDro scores of these studies range from 3 to 9, with the average of 5.6. For ankle joint cryotherapy, the meta-analyses of effect sizes for Hmax:Mmax ratios, normalized H-reflex amplitudes to represent the spinal reflex excitability, concluded that Hmax:Mmax ratios significantly improve for soleus (SL: $g=0.55$, 95%CI=0.03 to 1.08, $p=0.040$) and fibularis longus (FL: $g=0.54$, 95%CI=0.01 to 1.07, $p=0.046$). However, it was not conclusive that Hmax:Mmax ratios significantly improve following manual therapy (SL: $g=0.20$, 95%CI=-0.21 to 0.62, $p=0.34$; FL: $g=0.04$, 95%CI=-0.38 to 0.45, $p=0.86$) or FRT (SL: $g=0.44$, 95%CI=-0.04 to 0.93, $p=0.074$; FL: $g=0.33$, 95%CI=-0.15 to 0.80, $p=0.179$). A meta-analysis of either H-reflex or TMS outcomes following WBV or tDCS was not performed, with effect sizes ranging from -0.17 to -0.33 and from -0.76 to 0.85, respectively.

Conclusions: There is grade B evidence that the spinal reflex excitability of lower leg muscles may moderately improve following ankle joint cryotherapy in CAI patients. Clinicians, dealing with AMI in CAI patients, should consider the application of this common modality before their exercise rehabilitation in order to make inhibited spinal motoneurons (due to CAI) available to be used during exercise.

Total Word Count: 446

[208263EA](#)

Do Individuals with Patellofemoral Pain Exhibit Pain Sensitization?: A Meta-Analysis and Systematic Review

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Context: Central sensitization challenges the concept that pain is a nociceptive response. Sensitization describes changes within the nervous system associated with persistent pain and observed in several musculoskeletal conditions. Signs of sensitization include hypersensitivity to pain, impaired pain inhibition, enhanced pain facilitation, and pain areas that increase with longer symptom duration. These signs are common among individuals with patellofemoral pain (PFP) and longer symptom duration is a consistent predictor of poor outcomes for PFP patients. Quantitative sensory testing (QST) is a test battery assessing somatosensation including: pressure pain algometry, temporal summation, conditioned pain modulation, tactile thresholds and temperature thresholds. The purpose of this study was to identify whether the current body of evidence supports sensitization (assessed with QST) in individuals with PFP.

Methods: This review is registered with Prospero (CRD42019127548). We searched 6 databases for MeSH terms for QST, pain mapping, and PFP. Data were extracted from studies comparing QST measures within a PFP sample or between PFP and pain-free groups. The modified Downs & Black was used for quality appraisal and a random-effects meta-analysis was conducted for 4 QST variables (local pressure pain thresholds, remote pressure pain thresholds, conditioned pain modulation). Remaining QST variables were descriptively analyzed in the systematic review. Evidence was classified according to van Tulder's criteria.

Results: Fifteen total studies were included in the review (13 used in the meta-analysis and all used in the systematic review). Appraisal yielded 8 high-quality, 5 moderate-quality and 2 low-quality studies. Individuals with PFP exhibit lower knee pressure pain thresholds [Strong evidence, Standardized Mean Difference (SMD)= -0.90, 95% Confidence Interval (CI)= (-0.47, 1.33)], lower remote-site pressure pain thresholds (strong evidence, SMD= -0.65, CI= (-0.98, 0.33), increased tactile thresholds (moderate evidence, SMD=2.66, CI= -3.55, 8.87) than pain-free controls. A non-significant but large SMD suggests individuals with PFP exhibit impaired conditioned pain modulation response compared to pain-free individuals (strong evidence, SMD= -0.27, CI=-0.68, 1.21). The systematic review presents conflicting evidence for a difference in temporal summation response, limited evidence for altered warm and cold detection thresholds but no difference between heat pain and cold pain between groups. Pain mapping demonstrated increased pain area and distinct patterns associated with longer symptom duration.

Conclusions: Individuals with PFP exhibit signs of central sensitization. Findings from this review and meta-analysis suggest that the nervous system may selectively process pain over other sensations (touch, temperature) in individuals with PFP. Clinicians should consider tracking pressure pain thresholds for patients with PFP to demonstrate improvement in pain with treatments, and may want to include treatment options that have been effective for patients with pain sensitization. Researchers should continue to explore treatment options that would best restore QST measures to maximize outcomes.

Total Word Count: 438

208192DD

Do Patients With Depression or Anxiety Experience Greater Levels of Pain Catastrophizing Before and After ACL Reconstruction?

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Context: Pain catastrophizing is a negative cascade of responses both cognitive and emotional in anticipation of or in response to pain. Pain is one of many symptoms associated with ACL injury. Additionally, research has shown that depression and anxiety symptoms increase after injury. However, there has been limited exploration in the relationship between depression/anxiety and pain catastrophizing after injury. The purpose was to compare pain catastrophizing scores (PCS) scores between patients with and without depression and/or anxiety. We hypothesized that patients with depression and/or anxiety would demonstrate greater PCS scores.

Methods: Consecutive patients undergoing ACLR (n=98) by a single surgeon in 2019 (Jan-Sept) were prospectively followed. Primary and secondary ACLRs were included. Prior to and following surgery, patients were administered the Pain Catastrophizing Survey (PCS). The PCS is a survey consisting of 13 questions with Likert rating scales (0-4) in which patients rate the degree to which they react to painful situations. Medical charts were reviewed for demographics and presence of depression and/or anxiety (determined via reports of medication usage). 15 patients had depression and/or anxiety (female=13 [87%]; age=41.9 ± 17.8 years; height=66.0 ± 2.6 cm; weight=161.2 ± 33.0), while 83 patients had no depression/anxiety (female=33 [40%]; age=26.7 ± 12.1 years; height=68.0 ± 5.7 cm; weight=164.0 ± 35.8). Chi square test was conducted to determine if there were significant differences in proportion of males vs. females between groups. Independent samples t-tests were conducted to determine significant differences between groups for demographics (age, height, weight) and primary outcome (PCS scores at pre- and post-surgery).

Results: There were a total of 7 patients taking medications consistent with depression, and 10 patients taking medications consistent with anxiety (2 patients taking medications for both). Patients with depression and/or anxiety were significantly older ($p < 0.001$) and predominantly more female ($p < 0.001$). There were no significant differences between height ($p = 0.188$) and weight ($p = 0.775$). Contrary to the hypothesis, there were no significant differences in PCS scores between patients with or without depression and/or anxiety at pre-surgery (8.3 ± 7.9 vs. 9.5 ± 9.1 ; $p = 0.769$) or at an average of 7 weeks post-surgery (5.4 ± 6.2 vs. 5.9 ± 7.5 ; $p = 0.826$).

Conclusions: Contrary to hypothesis, patients with depression and/or anxiety did not experience greater pain catastrophizing. Several limitations must be considered in these findings. First, reports of mental health conditions were based on medication from medical charts, while many people suffer from depression and anxiety and choose to not receive medication for their symptoms, or are even unaware that they are suffering from depression/anxiety. Additionally, our patients were unable to be matched based on age and sex due to the sample size available. Future research will be prospective and include the assessment of depression and anxiety symptoms prior to and following ACL surgery.

Total Word Count: 442

[206544CA](#)

Does Sensation Seeking Behavior Predict Collegiate Student-Athletes' Concussion Care Seeking?

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Context: The decision to seek medical care for a suspected concussion is multifactorial as many factors influence this behavior. It seems possible that sensation or thrill seeking could impact the decision to seek medical care for suspected injury. Specifically, student-athletes who are higher sensation seekers may be more willing to take health risks. Therefore, the purpose of this study was to determine if student-athlete sensation seeking behavior predicts concussion disclosure while controlling for sex and sport contact level.

Methods: The overall study design of this research included a large prospective multisite cross-sectional study. Participants included 5932 Division I, II and III collegiate student-athletes with concussion history enrolled in the Concussion, Assessment, Research and Education (CARE) Consortium (males=3546, 59.8%; females=2386, 40.2%; age=19.6±1.4years). Student-athletes completed the Brief Sensation Seeking Scale (BSSS) and demographic form at baseline between 2015-2018. The BSSS is comprised of 8-items assessing an individuals' risk-taking affinity and sensation seeking behaviors. All items were rated on a 5-point Likert-scale (1="strongly disagree", 5="strongly agree") and then averaged for a total score. Participants noted sex, and sport on the demographic form. Participants were categorized as contact, limited-contact, and non-contact based on sport. After reviewing a concussion definition, participants indicated whether or not they had sustained a previous concussion, how many, and if each of those concussions had been diagnosed or undiagnosed. We then calculated a percentage based on how many concussions were diagnosed divided by total number concussions sustained. Based on the percentage, participants that had 1+ prior undiagnosed concussions were categorized as "non-care seekers". Participants with all prior concussions diagnosed were categorized as "care seekers." We used a generalized linear model to calculate relative risk (RR) and 95% confidence intervals (CI) while controlling for sex and sport contact level to determine if the BSSS predicted participants being a "care" or "non-care seeker" ($\alpha=0.05$).

Results: We found BSSS predicted concussion disclosure while controlling for sex and sport contact level ($X^2=9.65$, $p=0.047$). Specifically, a one-point increase in BSSS resulted in a 4% decrease probability of being a "care seeker" (RR=0.96, 95%CI(RR) [0.92-1.0], $p=0.045$). Those who participated in a contact sport vs. non-contact sport were 8.3% more likely to be a "care seeker" (RR=1.08, 95%CI(RR) [1.00-1.17], $p=0.039$). Lastly, sex was not predictive of care seeking (RR=1.04, 95%CI(RR) [0.98-1.10], $p=0.211$).

Conclusions: Individuals who are high sensation seekers may engage in risky and impulsive decision making including not seeking care for a potential concussion. Clinicians should be cognizant of individuals who seek sensation or thrill experiences, understanding they may not be as forthcoming with potential concussion symptoms. Secondly, we have largely questioned if females were more truthful in their concussion disclosure, however our results indicate both sexes had similar probabilities of concussion care seeking.

Total Word Count: 444

2064020A

Dry Cupping Therapy Improves Subcutaneous Hemodynamics and Pain Associated with Nonspecific Neck Pain

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Context: Dry cupping therapy (DCT) is a complementary treatment technique often used to increase blood flow to promote tissue healing and reduce pain associated with musculoskeletal conditions such as nonspecific neck pain (NSNP). However, most of this treatment's true physiological benefits have yet to be supported. Near-infrared spectroscopy offers researchers a non-invasive method for measuring changes in local subcutaneous hemodynamics following DCT. Therefore, the purpose of this study was to determine if DCT decreases pain and increases subcutaneous blood flow compared to sham and control conditions in patients with NSNP.

Methods: Thirty-two participants (15 males, 17 females; age: 22.5 +/- 2.79 years; height: 173.3 +/- 10.11 cm; mass: 76.6 +/- 18.66 kg) with self-reported NSNP volunteered to participate in this single-blinded randomized clinical trial. Participants were randomly allocated into intervention groups: DCT, sham DCT, or a control. This study consisted of a single intervention session and a 24-hour follow-up session. For the DCT intervention, one stationary cup was placed directly over the predetermined treatment area for 8 minutes. The sham DCT intervention followed the same protocol except a sham cup was applied during the intervention. The sham cup was modified by creating a small hole at the superior portion of the cup to allow for gradual elimination of the suction effect. The control intervention received no treatment. Outcome measures included subjective pain intensity using a visual analog scale, pain-pressure threshold, and subcutaneous hemodynamics (superficial and deep oxygenated/deoxygenated/total hemoglobin levels) assessed at baseline, immediate post-intervention, and 24 hours post-intervention. Change scores were calculated for each variable between baseline and immediate post-intervention and between baseline and 24 hours post-intervention. One-way ANOVAs were used to assess between-group differences at each of these time points for all variables. Tukey's HSD post hoc testing was used to identify which interventions resulted in significant differences among groups.

Results: Statistically significant differences were found for subjective pain intensity, and superficial and deep oxygenated and total hemoglobin levels ($p \leq 0.002$) immediate post-intervention as compared to baseline. No differences were found between baseline and 24 hours post-intervention. Tukey's HSD tests revealed that participants in the DCT group experienced a greater reduction in pain than participants in the sham DCT ($p = 0.001$) and control ($p = 0.008$) groups. Participants in the DCT group also experienced a significant increase in superficial and deep oxygenated hemoglobin and total hemoglobin levels ($p \leq 0.007$) with large effect sizes as compared to those in the sham DCT and control groups. (Table 1)

Conclusions: A single session of DCT may be an effective short-term treatment method for immediately reducing pain and increasing oxygenated and total hemoglobin levels in patients with NSNP. This study provides preliminary evidence supporting the current physiological claims behind DCT.

Total Word Count: 442

207581GD

Dry-Needling of a Powerlifter With Cervicobrachial Pain Syndrome and Subscapular Nerve Impingement: A Level III Case Study

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Background: Cervicobrachial Pain Syndrome (CBPS) is considered neck pain associated with tingling, numbness or discomfort in the arm, upper back and upper chest with or without an associated headache (previously known as Thoracic Outlet Syndrome).¹ Prevalence in the United States is estimated to range from 3 to 80 per 1,000 population.²

Patient: The patient is a 41 year old male powerlifter. The patient has no history of prior shoulder injury or pre-existing conditions. Patient reported an insidious onset of pain, paresthesia, instability, and weakness in the right extremity. He described pain in the posterior rotator cuff with numbness extending down the medial forearm into the fourth and fifth digits. His bench press dropping over one hundred pounds in a week prompted an evaluation by a certified athletic trainer. Initial examination revealed minimal point tenderness, normal AROM, RROM at 5/5 except for the subscapularis at 3/5. Due to lack of improvement after two weeks of manual release therapy, massage, electrical stimulation and ultrasound, and therapeutic exercises for a possible rotator cuff strain, the patient was referred to a chiropractor. In this examination, palpation showed atrophy in the right triceps and pectoralis major, and significant tightness of the latissimus dorsi. The patient also had bilateral diminished deep tendon reflexes of the biceps and triceps. Cervical AROM was slightly limited and thoracic rotation was significantly limited. RROM was at 5/5 for all shoulder motions, except 4/5 for abduction and internal rotation. Sensory testing showed hypersensitivity of C6 in the right extremity. Trigger points were found in the upper trapezius, scalenes, sternocleidomastoid, and the pectoralis minor. The patient had positive Jackson's, cervical distraction, Apley's, and empty can tests.

Intervention & Treatment: The patient was diagnosed with cervicalgia, CBPS, and segmental dysfunction of cervical and thoracic spine. His treatment consisted of dry needling for his trapezius, scalenes, pectoralis major and minor, one session of manipulation of the cervical spine, two sessions of manipulation of the thoracic spine, and therapeutic exercises. One treatment of cervical manipulation restored pain-free AROM. Following one week of chiropractic care, the athletic trainer's treatment consisted of therapeutic exercises, manual release, shoulder stretching, and electrical stimulation and ultrasound. The patient refrained from lifting for one week and then progressively returned to normal lifting within four weeks.

Outcomes or Other Comparisons: In patients who have persistent neurologic symptoms, muscle atrophy, or a progressive deficit, surgery is warranted.³ In this case, however, dry needling decreased neurological symptoms quickly and prevented the possibility of persistent symptoms. Initially the patient's Pain Disability Questionnaire score was a 22, however after two chiropractic visits his score was a 3. Research supports the use of manipulation and manual therapy such as dry needling for pain relief in upper quadrant pain syndromes.⁴ This case reiterates findings that a treatment based classification approach places greater emphasis on matching the patient to optimal interventions based on signs and symptoms collected during the evaluation rather than the pain generator.⁴ This treatment approach resolved the patient's symptoms without expensive diagnostic testing.

Conclusions: This case demonstrates a quick referral for chiropractic care which diminished the time away from sport. Interprofessional collaboration fostered efficient and effective healthcare by integrating specialty services like dry needling and manipulation. The initial release of the subscapular nerve and manual therapy treatment by the chiropractor coupled with the strengthening program established by the certified athletic trainer allowed the athlete to return to competition more quickly than typical CBPS cases and thus far has prevented long term neurological and pain management issues.

Clinical Bottom Line: In states where certified athletic trainers are restricted from performing dry needling, this type of interprofessional collaboration is paramount for quality patient care.

Total Word Count: 593

[208932FA](#)

Dual Cognitive-Tactical Performance on Knee Kinematics and Kinetics

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Context: The addition of cognitive loading can impair motor performance. Military personnel experience cognitively taxing environment that can lead to potential injury. Understanding the interaction between increased cognitive complexity and lower extremity mechanics during tactical performance may indicate novel areas for injury prevention. Thus, the objective of this study was to investigate lower extremity biomechanics of amateur marksmen when completing cognitive-tactical shooting task.

Methods: This cross-sectional study enrolled 24 Reserve Officer Training Corps (ROTC) members (20.42±1.28 years; 174.54±10.69cm; 78.11±14.96kg, 2.13±1.60 hours shooting per month, 18 male and 6 female). Participants were excluded if they suffered a lower extremity injury or underwent lower extremity surgery in the past 12 months, were diagnosed with ADD or ADHD, and if they were colorblind. All participants completed a rifle shooting task by jump landing off a 31cm box onto two force plates (Bertec, Columbus, OH) under two conditions (baseline and cognitively loaded) using a Laser Ammo system (Great Neck, NY). For baseline, the participant shot six numbers in a straight line on a screen. For the cognitive load the participant shot the same six targets but attended to an auditory cue to indicate the correct target order with response inhibition similar to a Stroop test. Three trials were performed for each condition. All procedures were performed in a research laboratory. The independent variable was baseline and cognitive load. The dependent variables were dominant leg peak vertical ground reaction force (vGRF), knee flexion at initial contact, maximum knee flexion, knee flexion displacement, knee abduction at initial contact, maximum knee abduction, and knee abduction displacement. A multivariate repeated measures ANOVA was conducted with the within subjects factor condition (baseline and cognitively loaded). Follow-up univariate repeated measures ANOVAs were conducted for each dependent variable if the multivariate ANOVA was significant. Alpha level was set at $\alpha < 0.05$ for all analyses.

Results: The multivariate repeated measures ANOVA was significant for condition ($F(5,19)=105.25$, $p < 0.01$, $\eta^2=0.97$, $1-\beta=0.99$). Follow-up univariate repeated measures indicated that peak vGRF, knee flexion at initial contact, knee flexion displacement, knee abduction at initial contact, and maximum knee abduction were significantly different between conditions ($p < 0.05$). Specifically, the cognitively loaded condition increased vGRF (baseline: 2.76±0.54 body weight units (bw) and cognitive: 3.57±0.63 bw), decreased knee flexion at initial contact (baseline: 14.76±4.90° and cognitive: 8.69±4.29°), increased knee flexion displacement (baseline: 55.03±6.46° and cognitive: 61.81±6.78°), increased knee abduction at initial contact (baseline: -2.13±2.54° and cognitive: -4.43±2.21°), and increased maximum knee abduction (baseline: -4.91±3.36° and cognitive: -7.95±3.68°). All other comparisons were not significant ($p > 0.05$).

Conclusions: The addition of a cognitive load increased key knee biomechanical injury risk mechanics relative to baseline. These data indicate that tactical specific functional assessment and rehabilitation needs to consider both the physical and cognitive demands related to performance and potential injury risk mechanics.

Total Word Count: 446

205164ED

Early Sport Specialization and Subjective Hip & Groin Dysfunction in Collegiate Ice Hockey Athletes

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Context: Sport specialization is a popular trend among youth athletes that has been associated with an increased risk for developing overuse lower extremity injuries. Early ice hockey specialization may contribute to the high rates of non-contact and overuse hip & groin injuries in collegiate ice hockey athletes. The purpose of our study was to compare subjective hip & groin dysfunction in collegiate ice hockey athletes that were highly, moderately, and lowly specialized in ice hockey prior to high school.

Methods: Our study used a retrospective cohort design. We collected survey data at a local ice hockey arena during mid-season of the 2018-2019 hockey season from a convenience sample of women's and men's ice hockey players from mid-western colleges (n = 187, 81 female, 106 male, 20.8 ± 1.9 years). Participants completed a 3-point sport specialization questionnaire and were stratified into specialization groups: high (3 points), moderate (2 points), low (0-1 points). The questionnaire asked the following three questions about ice hockey participation prior to high school and each "yes" answer was awarded 1-point: 1) Did you quit other sports to focus on ice hockey? 2) Did you train for more than 8-months out of the year in ice hockey? 3) Did you consider ice hockey more important than other sports? Current subjective hip & groin dysfunction was assessed based on participants' responses on the six subscales of the Hip and Groin Outcome Score (HAGOS) questionnaire (Symptoms, Pain, Activities of Daily Living, Sports & Recreation, Physical Activity, Quality of Life). Each subscale was scored on a normalized 0-100% scale, with a lower score representing greater hip and groin dysfunction. We compared each HAGOS subscale between the high, moderate, and low specialization groups using Kruskal-Wallis tests (P<.05) and post-hoc Mann-Whitney U tests with a Bonferroni correction (P<.017). Central tendency data is presented below as median[interquartile range].

Results: The high specialization group reported lower scores than the low specialization group on the Symptoms (High=71.4[32.1], Low=85.7[28.5], P=.001), Pain (High=88.8[30.6], Low=95.0[15.0], P=.003), Activities of Daily Living (High=95.0[25.0], Low=100.0[10.0], P=.001), Sports & Recreation (High=84.4[34.4], Low=93.8[18.7], P=.014), and Quality of Life subscales (High=80.0[43.8], Low=95.0[20.0], P=.002). The moderate specialization group reported lower scores than the low specialization group on the Symptoms (Moderate=75.0[31.3], Low=85.7[28.5], P=.015) and Activities of Daily Living subscales (Moderate=95.0[20.0], Low=100.0[10.0], P=.006).

Conclusions: College ice hockey athletes that were highly specialized prior to high school reported greater hip & groin pain and symptoms, greater hip & groin dysfunction during activities of daily living and sport & recreation, and lower hip & groin related quality of life compared to ice hockey athletes that were lowly specialized. Early ice hockey specialization prior to high school may contribute to greater long-term hip & groin dysfunction in collegiate ice hockey athletes.

Total Word Count: 446

206043MB

Educational Factors, Facilitators and Barriers Associated With Implementation of the NATA-IATF Heat Acclimatization Guidelines

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Context: Evidence suggests that state mandates of the National Athletic Trainers' Association (NATA) Inter-Association Task Force (IATF) preseason heat acclimatization guidelines are associated with reductions in exertional heat illness (EHI) events in secondary school football. However, the extent of compliance with the guidelines varies. This study aimed to understand the educational factors, facilitators, and barriers associated with properly implementing the NATA-IATF guidelines in secondary school football settings.

Methods: Single semi-structured phone interviews were conducted with secondary school football athletic trainers (ATs) throughout the US who had previously participated in a survey study on compliance with the NATA-IATF guidelines. The 33 ATs (16 males; 17 females; age=36.4±12.5) originated from schools that had both high (n=15) and low (n=18) compliance with the NATA-IATF guidelines (according to data from the previous survey study). Interviews were transcribed verbatim; four progressive stages in the consensual qualitative research tradition were utilized to create a codebook. Study personnel coded each interview; consensus meetings were held to resolve coding discrepancies.

Results: Interviews highlighted educational factors. Participants described perceptions of ATs (themselves and others) working diligently to implement guidelines, noting their educational backgrounds, previous training, and continuing education opportunities through the NATA as helpful. However, they also expressed that more could be done to enhance AT education surrounding the topic, including specific topics (e.g., EHI in general, NATA-IATF guidelines), the delivery mode (e.g., hands-on educational experiences), and building self-efficacy (to aid confidence in implementing the NATA-IATF guidelines). Participants also noted the need for similar educational opportunities for other stakeholders (e.g., coaches, athletic directors) to facilitate the necessary support for implementing the NATA-IATF guidelines. Interviews also highlighted facilitators and barriers associated with implementation. These included school norms (e.g., hesitation by school to usurp coach jurisdiction), lack of on-site resources, funding, and logistical support (e.g., indoor facilities and scheduling), and physical environment (e.g., schools in "colder" states less concerned about EHI, physical access to medical care). Participants expressed concerns regarding stakeholder access to EHI-related information, particularly at those schools without AT access, and accountability when best practices were not enforced. They noted their own capability and capacity, as they wanted to do more but faced time constraints; also, athletes were outside of their care jurisdiction when not in the school setting. Last, participants expressed the need for consistency among standards of care, state-specific mandates, and EMS system protocols to ensure optimal patient care.

Conclusions: Our findings provide strategies to increase implementation of the NATA-IATF guidelines. There appears to be a need for more educational opportunities surrounding EHI incidence and prevention for ATs and additional secondary school football stakeholders. It is also important to consider situational factors that may influence local implementation, such as education, geographical location, school-based resources, and experience.

Total Word Count: 445

207703QB

Educator and Preceptor Roles in Athletic Training Student Development

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Context: Health care professions education programs use a unique learning pattern in which students are educated both didactically and clinically. Previous research has focused on preceptor selection and training to promote quality clinical education experiences for students, but there has been limited emphasis on perceived roles of didactic and clinical educators. Identifying potential discrepancies in perceived roles may help improve athletic training student education through a shared understanding of role delineation. Therefore, the purpose of this study was to explore didactic educators' and preceptors' perceptions regarding their respective roles in athletic training student development.

Methods: This study used a consensual qualitative research design and consisted of 6 focus groups (2 didactic educator-only, 2 preceptor-only, 2 dual-role educator/preceptor) via Webex (Cisco Systems, Inc, San Jose, CA). A total of 22 participants representing CAATE-accredited professional athletic training programs participated (8 faculty, 7 preceptors, and 7 dual role educator/preceptor) and data saturation guided the number of focus groups conducted. Semi-structured focus group interviews were conducted and transcribed verbatim. Four researchers used a consensus process to analyze data, identify emergent themes, and create a codebook independently. Once completed, a consensual codebook was created with all identified themes and subgroups. Credibility was established by use of an external auditor to finalize the codebook and confirm representativeness of the findings.

Results: Three themes emerged from the data: (1) contributors to role achievement, (2) challenges to role achievement, and (3) perceived Improvements. Participants indicated that positive relationships (between preceptors and faculty), effective communication (between faculty and preceptors), role development (opportunities to grow professionally within each role), student development (in the form of the rewarding aspect of seeing students develop and mature under mentorship and education), and socialization (socialization of students to the profession) all contribute to role achievement for both faculty and preceptors. Our participants felt challenged in the successful achievement of desired role because of a lack of student commitment, their own personal role strain, ineffective communication between preceptors and educators, lack of preparation for the role expectations, and having to create authentic learning experiences for students. Educators were also challenged to find preceptors who were willing to accept all the other challenges. Suggestions for perceived improvements included concept integration and application between clinical and didactic learning, more understanding programmatic leadership, and culture shift to encourage mutual respect between those in either role.

Conclusions: Persistent ineffective communication between educators and preceptors may be due to unclear role delineation. Educators and preceptors disagree over what communication they perceive is effective. Future research should examine strategies to improve communication and help bridge the gap between didactic and clinical educators relative to their respective roles in student development.

Total Word Count: 435

[206344QD](#)

Educators' Perceptions of Student Competence in Athletic Training Education: A Report from the Athletic Training Clinical Education Network

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Context: Competency-based education (CBE) has emerged as a model for developing clinicians capable of delivering high quality patient care. Although CBE has existed in medical education for many years, its role in athletic training programs is still emerging. Before CBE can be established in the profession, it is important to understand educators' perceptions of student competence. Therefore, the purpose of this study was to explore educators' perceptions of student competence in athletic training education.

Methods: We used the consensual qualitative research (CQR) approach to establish a framework of educators' perceptions and assessment of student competence. CQR emphasizes collaborative analysis to encourage differing perspectives. A Qualtrics survey composed of five demographic questions and five open-ended questions was distributed to athletic training educators by the National Athletic Trainers' Association. Four members analyzed the first 20 responses and developed a consensus codebook. The codebook was confirmed through analysis of the next 20 responses. Two members then coded the remaining responses. All analysis procedures were audited by a fifth research team member, including themes and categories that resulted from the analysis.

Results: Of the 1,577 educators that received the survey, 368 accessed it (23.3% access rate), with 352 completing at least one open-ended question. During data analysis, 25 respondents were removed because they did not serve as athletic training educators during the time of data collection. Therefore, responses from 327 educators were included in the final analysis. Respondents represented athletic training educators from 47 states and their average age was 41.5 +/- 9.4 years. A majority of respondents (70.3%, n=230) served as an educator in a professional program, while the remaining 29.7% of respondents served as an educator in a post-professional program (master's degree, clinical doctorate, academic doctorate), or more than one type of program. Following analysis, four themes emerged: meaning of competence, characteristics of competence, achievement of competence, and assessment of competence. Each theme contained multiple categories. Educators felt competence meant meeting a standard, having knowledge, being able to perform/apply a skill, and/or analyze/reflect in their practice. Competence was characterized as being time-based, student-based, or skill-based, and educators perceived that competence is achieved when the student is ready to practice autonomously. Various assessment strategies were discussed to determine students' competence, including knowledge-focused (written examinations), skill-focused (practical examinations), and clinical experience (preceptor evaluations) techniques.

Conclusions: Educators varied in their perceptions of student competence, its assessment, and when or how it is achieved. Educators primarily relied on evaluations from both preceptors and students regarding student performance during clinical experiences as measures of competence, yet the 2020 CAATE Standards require didactic and clinical opportunities to assess competence. This highlights the need to establish consensus regarding student competence before CBE can be established in athletic training education.

Total Word Count: 446

[208883ED](#)

Effect of Ankle Braces on Dynamic Balance in Individuals With and Without Chronic Ankle Instability: A Systematic Review

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Context: Ankle braces are commonly used to reduce the risk of ankle injury during physical activity. A proposed mechanism for this risk reduction is an effect on balance ability. Multiple studies have examined the effects of ankle braces on dynamic balance but it is difficult to draw clear conclusions from the literature. Therefore, the objective was to systematically summarize the available literature assessing the effect of ankle braces on dynamic balance in individuals with and without chronic ankle instability (CAI).

Methods: Electronic databases (Pubmed, MEDLINE, CINAHL, and SPORTDiscus) were searched from inception to October 2019 using combinations of key words related to dynamic balance, ankle braces, Star Excursion Balance Test (SEBT), Y-Balance Test (YBT), and Time to Stabilization (TTS). Search limits were set to full-text publications written in English. A hand search of references was also conducted. Inclusion criteria required that studies examined the effects of ankle braces on dynamic balance. Studies were excluded if they evaluated other conditions besides CAI, did not assess dynamic balance, or did not use an ankle brace. Two investigators independently assessed methodological quality with the Physiotherapy Evidence Database (PEDro) scale. Studies were considered low quality if <60% of the criteria were not met. The level of evidence was assessed using the Strength of Recommendations Taxonomy. Brace and no-brace means and standard deviations of balance outcomes were extracted from included studies. Magnitude of brace to no-brace balance differences were examined using calculated Cohen's d effect sizes (ES). Positive ES values indicated greater dynamic balance during the braced condition. Individual ES point estimates were summarized by calculating means, median, minimum, maximum, and z-skewness for each outcome measure.

Results: Seven studies were included that had a median PEDro score of 60% (range 50-60%) and 4 were classified as high-quality. Four studies evaluated dynamic balance using the SEBT/ YBT and three using TTS. Five studies included healthy participants and four CAI participants. Three studies examined soft braces, five studies examined semi-ridged braces, four studies used lace-up braces. The systematic review revealed low summary ES for SEBT/YBT (ES: Mean=0.21, Median=-0.08, Minimum=-0.32, Maximum=1.21, Z-Skewness=1.57; Lower Bound: Mean=-0.41, Median=-0.54, Minimum=-0.91, Maximum=0.43, Z-Skewness=1.32; Upper Bound: Mean=-0.81, Median=0.60, Minimum=0.28, Maximum=1.93, Z-Skewness=1.56) and TTS (ES: Mean=0.21, Median=0.21, Minimum=0.05, Maximum=0.46, Z-Skewness=1.04; Lower Bound: Mean=-0.50, Median=-0.48, Minimum=-0.78, Maximum=-.28, Z-Skewness=-0.89; Upper Bound: Mean=0.92, Median=0.92, Minimum=0.57, Maximum=1.34, Z-Skewness=0.67). These data indicate there is grade B evidence that ankle braces do not affect dynamic balance in individuals with or without CAI.

Conclusions: This systematic review indicates that individuals with or without CAI do not have improved dynamic balance when wearing ankle braces compared to no-braces. Thus, dynamic balance alterations may not be a contributing factor to the reduction of ankle injuries due to prophylactic ankle brace application.

Total Word Count: 445

209604PD

Effect of Forearm Ice Towels on Cooling Rates Following Exercise-Induced Hyperthermia

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Context: Forearm ice-water immersion, often used in settings where protective clothing requirements impede whole-body cooling (e.g., firefighting), is theorized to be an efficient means of removing body heat due to the vascularization of the arms and hands. However, due to the method of applying this cooling modality, immersion of the hands and forearms in ice water, it may not be feasible or practical in settings such as sport. In this proposed study, we aimed to examine the cooling rates of rotating forearm ice towels compared to passive cooling.

Methods: Twelve recreationally active males (mean \pm SD; age, 25 \pm 5 y; height, 178.6 \pm 8.3 cm; body mass, 82.3 \pm 13.5 kg; body fat %, 14.8 \pm 6.6 %; VO₂max, 55.6 \pm 8.5 mL \cdot kg⁻¹ \cdot min⁻¹) participated in this randomized cross-over design. Participants completed two experimental exercise and cooling trials in a climate-controlled chamber (40.0 \pm C, 30% relative humidity); exercise followed by passive cooling (PCOOL) and exercise followed by forearms ice towel cooling (TCOOL). Exercise consisted of 5 min walk at 5% incline at 30% VO₂max, followed by a 15 min jog at 1% incline at 70% VO₂max until rectal temperature (TREC) reached 39.99 \pm C or 60 min of exercise elapsed. Cooling was initiated upon cessation of exercise and ceased once TREC reached 38.25 \pm C. For PCOOL, participants sat in a comfortable position on a chair. For TCOOL, participant's forearms were wrapped with towels that were stored in ice water (1-3 \pm C) with towels being replaced with fresh ice towels every three minutes. Trial x time repeated measures ANOVAs and a one-way ANOVA were utilized to determine differences in TREC during cooling and overall cooling rate between PASS and T, respectively. Significance was set a-priori: p<0.05.

Results: TREC at the end of exercise and at the initiation of cooling was similar between PASS (39.51 \pm C and 39.47 \pm C) and T (39.38 \pm C and 39.41) (p>0.05). There were no differences in TREC between PASS and T throughout the duration of cooling (p=0.385). Furthermore, there were no differences in cooling rates between PASS (0.03 \pm C \cdot min⁻¹) and T (0.02 \pm C \cdot min⁻¹) (p=0.136).

Conclusions: The utilization of forearm ice towels to promote body cooling following exercise-induced hyperthermia offers no advantage over that of passive rest. In situations where the implementation of body cooling may provide either an ergogenic or safety benefit, selecting a cooling modality that maximizes the extent of body surface area being cooled is warranted.

Total Word Count: 375

[206984NC](#)

Effectiveness of In Vivo Exposure Therapy on Decreasing Injury-Related Fear in Patients Post ACL Reconstruction: An Exploratory Study

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Context: One of the primary barriers for return to sport after ACL reconstruction (ACLR) is injury-related fear. In vivo exposure therapy (IVET) exposes patients to fear-eliciting tasks (i.e. hopping) and has been used by rehabilitation specialists to address injury-related fear in other musculoskeletal populations. The purpose of this exploratory study was to examine the effectiveness of IVET on decreasing injury-related fear in individuals after ACLR. We hypothesized that participants who underwent IVET would exhibit decreased injury-related fear when compared to the control group.

Methods: A randomized controlled trial was used to examine the effectiveness of a 5-week IVET on individuals with a history of ACLR. A convenience sample of 12 female participants (age=22.5±4.6yrs, height=166.6±9.6cm, mass=67.2±9.7kg) with a history of ACLR (≥ 1 year post-operative) reported to the laboratory and were randomized into an intervention group (n=6) or control group (n=6). Participants in the intervention group completed 5-weeks of IVET, 3 times per week for 20 minutes. A hierarchy of 3 fear-eliciting situations (i.e. pivoting, jumping, and cutting) was developed based on individual scores on the Photographic Series of Sports Activities for ACLR (PHOSA-ACLR). The most fearful task was addressed during week 1, and subsequent fearful tasks were addressed over the 5-week intervention. Participants in the control group monitored their physical activity via a pedometer for 5-weeks. No participants were lost to follow-up. The independent variables were Group (intervention, control) and Time (pre-test, post-test). Dependent variables were scores on the Fear-Avoidance Beliefs Questionnaire (FABQ), Tampa Scale of Kinesiophobia-11 (TSK-11), Anterior Cruciate Ligament Return to Sport after Injury Scale (ACL-RSI), and PHOSA-ACLR. A Group x Time repeated measures two-way analysis of variance was completed for each dependent variable. Partial η^2 effect sizes (ES) were used to examine clinically meaningful differences for Group and Time; interpreted as small (0.01-0.08), medium (0.09-0.24) and large (>0.25). A priori p-value was set to $p \leq 0.05$.

Results: Means and standard deviations for each dependent variable are located in Table 1. The PHOSA-ACLR exhibited a significant main effect for Time ($F_{1,10}=9.92$, $p=0.01$, partial $\eta^2=0.50$), however a main effect for Group was not observed ($F_{1,10}=0.21$, $p=0.659$, partial $\eta^2=0.02$). No other statistical significance was observed for the FABQ, ACL-RSI, or TSK-11; however, the FABQ-Sport subscale and the TSK-11 exhibited medium ES for between Group differences (Table 1).

Conclusions: Both groups exhibited decreases in injury-related fear for specific functional tasks as measured by the PHOSA-ACLR. Physical activity monitoring may have encouraged control participants to engage in more physical activity, indirectly exposing this group to similar functional tasks completed by the participants undergoing IVET. Future research should further examine the effectiveness of physical activity monitoring on decreasing injury-related fear in patients after ACLR.

Total Word Count: 438

205805ED

Effectiveness of Talocrural and Fibular Mobilizations With Movement to Increase Ankle Joint Motion in Individuals With Chronic Ankle Instability

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Context: Past research reports that talocrural joint mobilizations using the Mulligan mobilization with movement (MWM) technique are effective at increasing ankle dorsiflexion range of motion (DFROM) in individuals with chronic ankle instability (CAI). Recent case studies have reported that fibular MWM may also be effective at improving DFROM post ankle sprain. Originally proposed to increase ankle inversion ROM, there is limited evidence to support the effectiveness of fibular MWM for any motion. Therefore, the purpose of the current study was to compare the immediate effectiveness of fibular MWM and talocrural MWM at increasing ankle inversion ROM and DFROM in individuals with CAI.

Methods: Thirty-nine individuals with CAI were enrolled in this randomized trial (male=9, female=30, age=20.6±2.9years, height=1.70±0.07m, weight=78.7±17.9kg, Cumberland Ankle Instability Tool [CAIT]=16.1±5.4). CAI was defined as a history of at least 1 lateral ankle sprain, a CAIT score of <26, and ≥2 episodes of giving-way in the past 6 months. In a single laboratory visit, each participant completed baseline assessment of DFROM using the weight bearing lunge test and inversion ROM using a standard handheld goniometer (the average of 3 measurements were recorded for each direction). Participants were randomized into one of three treatment conditions: fibular MWM, talocrural MWM or control. Both intervention conditions received 2 sets of 10 repetitions of the assigned MWM by an athletic trainer. The fibular MWM involved application of a posterior and superior force on the lateral malleolus while stabilizing the tibia, followed by active ankle inversion, then clinician overpressure at end ROM for 10 seconds. The talocrural MWM involved application of anterior-to-posterior glide on the talus while stabilizing the tibia, followed by active ankle dorsiflexion, then clinician overpressure at end ROM for 10 seconds. The control condition sat quietly for 10minutes. Immediately after the allocated intervention, baseline ROM measurement was repeated. Two separate 2 (time) by 3 (intervention) repeated measures ANOVAs were utilized to test for differences in DFROM and inversion ROM. Paired t-tests were used for post hoc comparisons.

Results: For DFROM there was a significant interaction between group and time ($F_{2,36}=3.699$, $P=0.035$). Post hoc analysis showed that the control group did not significantly increase DFROM ($t=0.444$, $df=12$, $P=0.665$, pre=14.7±2.5cm, post=14.6±2.7cm), nor did the fibular MWM despite a trend in that direction ($t=-2.009$, $df=12$, $P=0.068$, pre=13.7±2.6cm, post=14.2±2.7cm). Only the talocrural MWM significantly increased DFROM post-intervention ($t=-3.599$, $df=12$, $P=0.004$, pre=14.4±3.0cm, post=15.0±2.7cm). There were no significant time or group differences in inversion ROM (all $P>0.05$; pre=30.8±6.6°, post=31.2±6.4°).

Conclusions: The current study does not support the use of fibular MWM to increase either DFROM or inversion ROM in individuals with CAI. Talocrural MWM are more likely to affect small increases in DFROM.

Total Word Count: 433

209062EA

Effects of a Cognitive Load on Marksmanship Performance in ROTC Members

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Context: Military personnel experience situations in combat that are cognitively taxing that can potentially lead to injury or marksmanship decrements. Therefore, the purpose of this study was to determine the effects of a cognitively loaded task on marksmanship performance.

Methods: A cross-sectional study enrolled 32 members of the Reserve Officer Training Corps (ROTC) (24 male, 8 female, 20.47 ± 1.24 years, 174.95 ± 10.58 cm, 77.99 ± 13.90 kg). Participants were excluded if they suffered a lower extremity injury or underwent lower extremity surgery in the past 12 months, diagnosed with ADD or ADHD, or colorblind. Participants completed four rifle shooting tasks that were randomized (180-degree spin, gait interruption, weighted landing, and unweighted landing). Tasks were performed under a baseline and cognitive load using a Laser Ammo system (Great Neck, NY). For baseline the participant shot six numbers in a straight line on a screen. For the cognitive load the participant shot the same six targets but attended to an auditory cue to indicate the correct target order with response inhibition similar to a Stroop test. Three trials were performed for each condition for each task. The time to begin the task (time to first rifle shot), time to completion (time to last rifle shot), and number of misses were recorded for each trial as the dependent variables with the independent variable condition (baseline and cognitively loaded). A multivariate repeated measures ANOVA was conducted for each task with the within subjects factor condition (baseline and cognitively loaded). Follow-up univariate repeated measures ANOVAs were conducted for each dependent variable if the multivariate ANOVA was significant. Alpha level was set at $\alpha < 0.05$ for all analyses.

Results: The multivariate repeated measures ANOVAs were significant for condition for 180-degree spin, gait interruption, weighted landing, and unweighted landing ($F(3,29)=22.09$, $p < 0.001$; $F(3,29)=25.23$, $p < 0.001$; $F(3,29)=92.56$, $p < 0.001$; $F(3,29)=78.32$, $p < 0.001$, respectively). For time to first shot and time to last shot there was a significant increase in time for the cognitive condition for all tasks ($p < 0.05$). Specifically, cognitive loaded increased first time 0.80s and last shot 2.12s, for the 180 task; 1.17s (time to first shot) and 1.56s (time to last shot), for the gait interruption task; 2.12s (time to first shot) and 3.59s (time to last shot), for weighted landing; and 1.89s (time to first shot) and 3.05s (time to last shot), for the unweighted landing. Number of misses was not significant for any task by condition ($p > 0.05$).

Conclusions: Cognitive loading can increase the time it takes to commence and complete a tactical motor task. This decrease in efficiency may lead to injury in combat for military personnel, indicating injury risk assessment and prevention should consider the physical as well as cognitive demands of tactical performance.

Total Word Count: 435

2051510D

Effects of Blood Flow Restriction on Ratings of Perceived Exertion During Dynamic Balance Exercises in Individuals With Chronic Ankle Instability

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Context: Dynamic balance exercises, such as the star excursion balance test (SEBT), are used during ankle rehabilitation in patients with a history of chronic ankle instability (CAI). Blood flow restriction (BFR) is a therapeutic modality that involves the application of a tourniquet to occlude blood flow to-and-from exercising muscles that has been shown increase perceived exertion during ankle resistance exercises in individuals with CAI. The ability of BFR to enhance patient's perceived exertion during dynamic balance exercises has not been examined. Therefore, the purpose of our study was to examine the effects of BFR on ratings of perceived exertion (RPE) during SEBT exercises in individuals with CAI.

Methods: We utilized a crossover design with randomized order of conditions. Data were collected in a laboratory setting over two visits. We recruited twenty (n=20) young adults with a history of CAI (20.6±2.1 years, 74.2±13.1 kg, 1.70±0.12 m, 4.8±3.5 ankle sprains) using convenience sampling. Our independent variable was condition, BFR or control, and our dependent variable was participants' RPE following SEBT exercises in the anterior, posteromedial, and posterolateral reach directions. During each visit, participants performed three trials of SEBT exercises, one trial for each SEBT direction. For each trial, participants performed four sets (15x-15x-15x-15x) of SEBT reaches in each direction. The order of the SEBT directions was randomized for each participant. For each repetition, participants balanced on their CAI limb, reached in the appropriate direction with their contralateral foot, and touched a target placed at 80% of their maximum reach distance. SEBT exercises were performed with the BFR condition at one visit and with the control condition at the other. For the BFR condition, we secured a pneumatic cuff around the thigh and inflated the cuff to 60% of the participants' limb occlusion pressure. For the control condition, the cuff was not applied. We recorded participants RPE after the final set of each SEBT direction using the OMNI Perceived Exertion Scale (1-10). We compared RPE between conditions for each SEBT direction using separate paired samples t-tests and Cohen's d effect sizes with 95% confidence intervals.

Results: Participants reported greater RPE during the SEBT exercises with the BFR condition in the anterior (BFR=4.4±1.6, Control=2.4±1.3, P<.001, d=1.4[0.7 to 2.1]), posteromedial (BFR=4.8±1.6, Control=2.7±1.5, P<.001, d=1.4[0.7 to 2.0]), and posterolateral (BFR=5.2±1.8, Control=3.4±1.6, P<.001, d=1.1[0.4 to 1.7]) directions compared to SEBT exercises with the control condition.

Conclusions: Individuals with CAI reported greater perceived exertion during dynamic balance exercises with BFR. Additional research is needed to determine whether these BFR induced increases in perceived exertion could translate into greater improvements in clinical outcomes over the course of ankle rehabilitation with BFR.

Total Word Count: 428

206193CD

Effects of Concussion History on Baseline Balance and Vestibular/Ocular Motor Assessment

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Context: Evidence for whether a history of concussion affects baseline concussion assessment measures remains inconclusive, with limited research examining differences on balance and vestibular/ocular motor assessment. Therefore, the purpose of this study was to examine differences between prior concussion and baseline performance on the modified Balance Error Scoring System (mBESS) and Vestibular/Ocular Motor Screening (VOMS). It was hypothesized that no differences would occur between individuals with and without a concussion history on both assessments.

Methods: A retrospective, cross-sectional design was used for this study. Prior to the start of their season, 132 collegiate club sport athletes, ages 18 to 23 years old (mean=20.2±0.9; male: n=72, 54.5%; female, n=60, 45.5%) across 7 sports, were administered a baseline mBESS and VOMS assessment in an athletic training research laboratory. Participants were either divided into a self-reported concussion history (n=26) or control (no history) group (n=106). Due to unequal sample sizes and non-parametric data, a series of Mann-Whitney U tests were used to compare mBESS errors per stance (double leg, single leg, tandem, total errors) and individual VOMS item symptom provocation scores (smooth pursuits, saccades, convergence, vestibular ocular reflex (VOR), visual motion sensitivity (VMS) and near point of convergence (NPC) distance (cm) between groups. The mBESS has been reported to have sensitivity of 71.4%, while the VOMS has a high internal consistency (Cronbach α =0.97). Statistical significance was set a priori at .05.

Results: Significant differences were observed between groups, with worse performance in the concussion history group on mBESS tandem stance scores (2.04±2.8 vs. 0.78±1.1 errors, p=.02) and greater VOMS NPC distance (2.71±2.8 vs. 1.52±2.18cm, p=.01) than controls. No differences existed between the concussion history and control group on double leg (0.08±0.3 vs. 0.01±0.1, p=0.27), single leg (3.23±2.5 vs. 2.68±2.3, p=0.23), or total error score (5.35±5.1 vs. 3.47±2.8, p=0.09) of the mBESS. Further, no differences existed on VOMS item symptom scores, including smooth pursuits (0.04±0.1 vs. 0.02±0.1, p=0.55), saccades (horizontal: 0.08±0.3 vs. 0.02±0.1, p=0.12, vertical: 0.08±0.3 vs. 0.03±0.2, p=0.12), convergence (0.04±0.2 vs. 0.01±0.1, p=0.27), VOR (horizontal: 0.19±0.5 vs. 0.12±0.4, p=0.37, vertical: 0.12±0.3 vs. 0.06±0.3, p=0.12), and VMS (0.23±0.6 vs. 0.10±0.4, p=0.15).

Conclusions: This study suggests that collegiate club sport athletes with a history of concussion significantly differ from controls at baseline on the mBESS tandem stance and VOMS NPC distance. No other components of the mBESS or VOMS differed between groups. Clinicians should consider concussion history when interpreting baseline assessments. Future research is needed to evaluate the influence of a dose-response of multiple, prior concussions on multifaceted assessment.

Total Word Count: 411

208435FD

Effects of Psychological Readiness on Biomechanics in Adolescent Athletes During Jump-Landing at Time of Return-to-Sports Following Anterior Cruciate Ligament Reconstruction

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Context: Lower psychological readiness measured with the Anterior Cruciate Ligament-Return to Sport after Injury (ACL-RSI) has been associated with higher risk of second ACL injury. However, our understanding of the relationship between the lower ACL-RSI score and the subsequent higher risk of second anterior cruciate ligament (ACL) injury is unclear. Therefore, the purpose of this study was to examine the effects of psychological readiness on lower extremity biomechanics and muscle strength in young athletes with ACL reconstruction (ACL-R) during jump-landing at time of return to sport (RTS).

Methods: A cross-sectional study design was used in the clinical laboratory. Sixty participants (Male: N=25, Age=16.00±1.25 yrs, Ht=177.71±7.83 cm, Mass=81.10±17.00 Kg; Female: N=35, Age=15.39±1.33 yrs, Ht=165.69±7.84 cm, Mass=66.23±11.53 Kg) between 12-17 years of age with unilateral ACL reconstruction surgery volunteered. At time of RTS, eight 3-dimensional cameras and two force plates collected kinematics and ground reaction forces while participants performed 3 separate jump-landing (JL) tasks. Bilateral frontal and sagittal plane knee moment at time of initial contact (IC) and energy absorption of the knee joint (KnEA) were calculated during the loading phase (IC to maximal knee flexion). Moment and KnEA were collected from involved limb (Inv), normalized to the participants' height and weight, and averaged across trials. Peak vGRF was normalized to participants' weight and the lower extremity symmetry index (LSI=Involved limb/Uninvolved limb*100) was calculated. Five consecutive Isokinetic knee extension strength (QUADS) were collected at 60°/sec on each limb using Biodex Multi-joint system and normalized to participants' body weight and averaged across trials. ACL-RSI was completed to quantify the psychological readiness. Male and female participants were grouped into RSI-High (>76.6) and RSI-Low (<76.6), based on published cut-off score that predicts second ACL injury for active young individuals. Separate independent t-tests were performed to examine biomechanical and QUADS differences between RSI-High and -Low in the male and female groups ($\alpha \leq 0.05$).

Results: For the adolescent males, the High-RSI group had greater LSI-QUADS (High-RSI=80.68±16.46; Low-RSI=64.33±18.43; N/Kg; p=0.05), and LSI-vGRF (High-RSI=85.44±29.05; Low-RSI=60.19±13.96; p=0.01) compared to the Low-RSI group. No other significant differences were observed (p>0.05). For the adolescent females, there were no significant differences observed in any of the dependent variables (p>0.05).

Conclusions: Adolescent males and females had different biomechanical and QUADS profiles based on the High- and Low- RSI scores. Adolescent males demonstrate that High-RSI group had better peak vGRF and QUADS LSI compared to the Low-RSI group, while females did not demonstrate any alterations. This indicates that improving peak vGRF and QUADS LSI may help to improve psychological readiness in males, but not for females. Different approach should be considered for males and females to improve psychological readiness.

Total Word Count: 431

[208563AA](#)

Emergency Medical Services Exertional Heat Stroke Protocols Across the U.S.

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Context: Exertional heat stroke (EHS) is 100% survivable when recognized and treated within 30 minutes of collapse. A recent consensus statement outlining the pre-hospital care for EHS notes best-practice for EHS as obtaining a rectal temperature, treating with cold-water immersion (CWI), and cooling the patient first prior to transport to the hospital. The purpose of this study is to compare emergency medical services (EMS) protocols to best-practices for recognizing and treating EHS.

Methods: Using a cross-sectional study design, individuals (n=1,350) serving as an EMS Medical or Physician Director were invited to complete a survey. The survey was created by experts in the field of EHS. Participants were asked questions related to the EHS management protocols for their EMS service, including EHS diagnosis and treatment protocol. A total of 145 individuals completed the survey (response rate=10.74%). We summarized the responses of the questions through frequency distribution. Chi-Squared Tests of Associations with 95% confidence interval's (CI) were calculated. Further, prevalence ratios (PR) with 95% CI were calculated to determine the prevalence of implementing best-practice based on location, working with an athletic trainer, number of EHS cases, and years of directing. All PRs whose 95% CIs excluded 1.00 were considered statistically significant; Chi-Squared values with P values <0.05 were considered statistically significant.

Results: Respondents reported working in 4 regions: South (n=51, 35.17%), Midwest (n=43, 29.66%), West (n=26, 17.93%), and Northeast (n=25, 17.24%). Almost a third of respondents were an EMS director for less than 5 years (n=43, 29.66%). A majority of the respondents reported not using rectal thermometry for the diagnosis of EHS (n=102, 77.93%) and not using cold water immersion for the treatment of EHS (n=102, 70.34%). The northeast location was more likely to use best-practice (defined as rectal temperature, CWI, cool-first transport-second) for EHS than other locations (20.0% v 7.5%; PR=2.34; 95% CI=1.04, 5.26). Respondents reporting the use of rectal temperature, were more likely to implement CWI and cool-first transport-second (43.8% v 8.0%, $\chi^2=23.929$, $p < 0.001$, PR=4.13, 95% CI=2.41, 7.06). If working with an athletic trainer, EMS is more likely to implement best-practice treatment (i.e. CWI & cool-first transport-second) (69.6% v 36.9%, $\chi^2=8.480$, $p < 0.004$, PR=3.15, 95% CI= 1.38, 7.18).

Conclusions: These findings demonstrate a lack of implementation of best-practice standards for EHS by EMS. Given EHS is 100% survivable with prompt recognition and care, it is imperative that EMS providers be delivering the best-practice for EHS management. The findings of this study suggest a lack of EMS compliance with these recommendations. However, working with an athletic trainer appears to increase the likelihood of follow best-practice. Efforts should be made to improve EMS providers implementation of best-practice standards for the diagnosis and management of EHS to optimize patient outcomes.

Total Word Count: 446

206071CD

Emergency Medical Technicians' Beliefs and Knowledge on Impact Related Concussions and Athletic Trainers' Duties

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Context: Often during athletic events, emergency medical technicians (EMTs) and athletic trainers (ATs) both provide coverage without interacting. Managing the medical emergencies that occur on field can be vital to the future health of patients. It is important to see how confident EMTs are with the recognition and treatment of sports-related concussions, especially for schools that lack the care of an AT. It is also vital to determine the opinions of EMTs towards the ATs they work beside because collaboration may be necessary to improve patient outcomes.

Methods: This study was an online survey of EMTs (N=63; males=53, females=10; age =46±13 years; experience=21±12 years) within the 5 states of the Mid-Atlantic Athletic Trainers' Association and District of Columbia. After retrieving email addresses from state and county websites, we sent recruitment emails with the link to the survey to all state or county EMT directors and chiefs. One initial email was sent with 2 follow-up emails. The survey consisted of 27 questions including demographic information, Likert scale, true or false, and open-ended to determine EMT knowledge and perceptions regarding concussion care and ATs. The survey was validated through peer review and pilot testing. We calculated descriptive statistics for true or false and Likert scale questions. Likert scale questions were compared across level of training using a Kruskal-Wallis test. The open-ended questions were analyzed using a general inductive approach and credibility was maintained using multiple analyst triangulation and peer review.

Results: All seven of the true or false questions were answered with over 80% responder accuracy. Three of the seven questions were answered with 100% accuracy while the two questions pertaining to concussion symptoms and symptom severity scores were the lowest scoring questions at 88% and 83%. Likert scale data revealed mixed perceptions and confidence in concussion care (Table). There was no significant difference between the level of training (basic, advanced, paramedic) and responses to any Likert scale questions ($p > 0.05$). Participants were confident in ATs' abilities in sport-related concussions at a rate of 82% (n=41). Themes that emerged from the qualitative data include that EMTs 1) understand the AT profession in that EMTs know typical AT roles and responsibilities but have 2) inaccurate perceptions of ATs in the areas of educational background, emergency care, and knowledge of non-sports related injuries. We also found that EMTs view themselves as having 3) typical roles and responsibilities on sidelines such as emergency care and transportation.

Conclusions: EMTs are not confident in their ability to identify and care for sport-related concussions. EMTs generally understand the athletic training profession, but additional efforts are needed to improve full understanding. Improving relationships between ATs and EMTs may assist in improving patient care when collaboration is required.

Total Word Count: 445

209694QD

Emotional Intelligence Among Athletic Trainers

Radtke SR, Harris AM

Context: Emotional Intelligence (EI) in the literature has been correlated with appropriate bedside manner in medical professionals such as nurses, physical therapists and physicians and has also been shown to have a positive influence on the careers of both coaches and athletes. Currently, there is a lack of research on EI among athletic trainers.

Methods: A total of 5,667 athletic trainers were emailed a request to participate in the survey. A total of 657 (11.59%) agreed to participate. After removing all incomplete surveys, a total of 505 (9%) respondents were used for this study. The study collected demographic information, years practicing as a certified athletic trainer, their job setting, and their managerial level. The study also collected emotional intelligence using the Emotional Intelligence Scale (EIS). The 33-item instrument measures an individual's perceptions of the extent to which they can appraise and regulate emotions of themselves and others and utilize those emotions for problem solving. The authors of the instrument report an acceptable internal consistency reliability at .87 and an acceptable test-retest reliability at .78. Prior to data collection, our study received institutional IRB approval. We compared differences between groups using analyses of variance (ANOVAs) with planned Post Hoc Tukey testing to account for standard error associated with analysis. Statistical significance was considered $< .05$.

Results: Results of this study showed that athletic trainers reported an average emotional intelligence score of 128.37 ($sd= 11.98$) on the EIS scale. Multivariate ANOVA lacked significance at the $p= <.05$ for many of the comparison factors considered. We found no significant differences between age, managerial level, ethnic background, years of experience as an athletic trainer, highest degree earned, or work setting. The main significant difference that was noted within the results was for gender ($p= >.01$). The results show that female athletic trainers ($m= 130.07$, $sd= 11.21$) have higher self-reported levels of emotional intelligence than their male counterparts ($m= 125.70$, $sd= 12.75$).

Conclusions: Athletic trainers possess an average that places them in the medium level of emotional intelligence according to the scoring of the EIS scale. Female athletic trainers had significantly higher scores than their male counterparts. Unlike what has been seen in the reported emotional intelligence results for other health care professionals in current research, athletic trainers show no increase in levels emotional intelligence with age or years of experience. Inequality in numbers of participants self-identifying on multiple factors can be considered a limitation of this study. While some comparison takes place when discussing our results, future research should consider direct comparisons of the emotional intelligence of athletic trainers to their health care counterparts as well as ways to incorporate emotional intelligence training into continuing education.

Total Word Count: 438

206224AD

Epidemiology of Boys' Club Lacrosse Injuries During the 2018 Summer Lacrosse Season

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Context: In the past 10 years, participation in youth and high school boys' lacrosse has increased by 33%. Within this population, a large number of club teams and tournaments exist where athletes may or may not have access to on-site medical care. Additionally, these club athletes potentially face a higher volume of play than traditional scholastic sport settings, as they participate in 4 to 5 games over the course of a weekend. The purpose of this study was to describe injury characteristics of non-scholastic youth and high school aged boys' club lacrosse athletes over the course of a summer tournament season.

Methods: A descriptive epidemiological research design was used to examine injury characteristics of non-scholastic youth and high school aged club lacrosse athletes. For the tournaments in question, athletic trainers were staffed at a rate of one athletic trainer for every two fields of play. Athletic trainers were stationed at medical tents spread throughout the venue and called to specific fields for help via radio when necessary. Athletic trainers were given standardized injury report forms to document injuries that they encountered. At the end of each tournament, the injury reports were collected by the medical director and entered into the Datalys Injury Surveillance Tool. At the end of the summer season, Datalys generated a de-identified report of injury characteristics.

Results: The total injury rate for the summer was 2.13 per 1000 AE (95% CI, 1.87, 2.42). The most frequently injured body parts were the head/face (22%, n = 51), arm/elbow (15%, n = 34), and hand/wrist (12%, n = 29). The most frequently reported injury diagnoses were contusions (n = 63, 27%), concussions, (n = 44, 19%), fractures (n = 39, 17%), and sprains (n = 35, 15%). The most frequently injured position was midfielders (n = 65, 41%) followed by defense (n = 48, 30%), attack (n = 36, 23%), and goalie (n = 9, 6%). The concussion rate was 0.4 per 1000 AE.

Conclusions: The injury rate experienced by non-scholastic boys' club lacrosse athletes was similar to their high school counterparts as well as school sponsored football and wrestling. Because of the risk of injury, the authors recommend that athletic training services be available for youth and high school club lacrosse tournaments. Club lacrosse athletes are injured at a similar rate to individuals who participate in school sanctioned sports. At present, however, it is unclear what proportion of club athletes have regular access to medical care during practice and competition. It is important that athletic trainers and other healthcare professionals advocate for the presence of medical professionals for these athletes participating in high risk sports.

Total Word Count: 433

207273AD

Epidemiology of Dance-Related Injuries Presenting to Emergency Departments in the U.S., 2014-2018

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Context: The presence of an athletic trainer is becoming more common in the performing arts. While dance is perceived as a relatively safe activity, previous findings indicate that dance injuries are on the rise and warrant attention. Our purpose was to describe the rates and patterns of dance-related injuries reporting to emergency departments (EDs) from 2014-2018.

Methods: In October 2019, we abstracted data from the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS). The NEISS database consists of de-identified, publicly available, nationally representative patient data collected from a probability sample of 100 EDs located in the U.S. Variables abstracted included injury year, sex, age, body part, diagnosis, and disposition (eg, treated and released, admitted). Only injuries that occurred during a structured event (eg, dance class, dance competition) were included. Injuries occurring during unstructured events (eg, dancing at a wedding) were excluded. Each patient case was associated with a weight to provide national estimates. Descriptive statistics were used to summarize counts, percentages, and rates. For incidence rate (IR) calculations, we abstracted U.S. population estimates for males and females from the U.S. Census Bureau for 2014-2018 by age group. Incidence rates were calculated as the number of cases per 100,000 people.

Results: Between years 2014-2018, 4152 patients reported to the NEISS EDs with a dance-related injury. Most injuries occurred in females (83.3%, n=3459) and between 10-18 years old (76.2%, n=3164). The injuries occurred most commonly at the knee (22.5%, n=935), ankle (15.7%, n=650), and foot (10.2%, n=424), and were diagnosed as sprain/strain (42.6%, n=1767), fracture (10.3%, n=428), or contusion (8.1%, n=336). The most common injuries were ankle sprain/strain (12.7%, n=527), knee sprain/strain (10.4%, n=431), and knee dislocation (4.3%, n=179). Almost all patients were treated and released (97.1%, n=4033), and a small percentage were admitted to the hospital (1.6%, n=67) or left the ED before being seen by a healthcare provider (1.0%, n=41). These data yielded population-weighted estimates of 138,659 injuries for the study period, with an increasing trend over time (22.5% increase over five years). Incidence rates were over four times higher for females (12.4) than males (3.0), and highest in the 10-18 years old age group (IR=46.4). IRs in the other age groups were: 19-30 years=7.4, 31-60 years=2.1, and 61+ years=1.7.

Conclusions: Our findings suggest that dance-related injuries reporting to EDs are increasing over time. Nearly half of the patients reported to the ED with a sprain/strain, and almost all patients were treated and released. Future investigations should aim to better understand the role athletic trainers play in managing these patient cases to help address global healthcare concerns such as overall demands and costs.

Total Word Count: 432

208051CD

Evaluation and Treatment of a Closed Temporal Fracture With Subsequent Hearing Loss in a Division II Collegiate Baseball Player

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Background: An 18-year-old Division-II collegiate baseball player sustained a head injury during the 8th inning of a game. The patient was hit with a 90+ mph pitch on the left side of his head while wearing a helmet. On-field assessment determined no visible deformities or obvious signs of concussion. The patient complained of feeling fluid in his ear, muffled hearing, and “not feeling right”. Patient presented with swelling and point tenderness over the mastoid process, and a positive tuning fork test over the mastoid process. He was referred to the Emergency Department (ED).

Differential Diagnosis: mastoid process fracture, occipital bone fracture, dislocated ossicle, temporal fracture, concussion.

Intervention & Treatment: Patient received an MRI in ED, revealed closed fracture of the left temporal bone and blood in the ear canal. Patient complained of muffled hearing and referred to an ear, nose and throat (ENT) physician. Patient started a daily concussion symptom log to rate and track symptoms and based on the log, concussive symptoms were present. Patient followed up with the ENT 3 days post-injury and received an audiogram and a tympanometry test. The audiogram determined the patient’s left ear had mild hearing loss (-56 daPa, 1.57 mL). The tympanometry test demonstrated negative pressure in left ear (-55 daPa); indicating eustachian tube dysfunction, fluid buildup in the ear, and possible conductive hearing loss. The physician concluded hearing loss was due to swelling in his ear from the trauma. Twelve days post-injury, patient reported symptom free and was cleared by ENT 14 days post-injury and the patient began a concussion return to play (RTP) protocol. Patient followed up 19 days post-injury with ENT to receive another audiogram and tympanometry test. Results showed that the patient’s hearing had improved (-10 daPa), but risk of potentially permanent conductive hearing loss remained. Patient completed the concussion protocol and was cleared to RTP 20 days post-injury.

Uniqueness: Temporal fractures with subsequent hearing loss is rare in college athletics. Most cases are reported in motor vehicle accidents or gunshot wounds. This case is unique due to the mechanism of injury, presence of concussion symptoms, and the RTP protocol when compared to the previous reported cases. Literature examining this injury and concurrent symptoms focused on structural repair of the bone and ear structures, however, this case is unique in that the temporal fracture did not cause structural deformity in the head, face or ear canal, and hearing loss was minimal, which allowed for conservative/non-invasive treatment. Secondly, the concussion RTP progression turned to be advantageous because it allowed the patient to safely RTP compared to protocols from surgical interventions.

Conclusions: Temporal bone fractures are serious injuries and can lead to long-term complications such as facial paralysis and permanent hearing loss. It is important for AT to promptly identify, treat, and refer this injury to emergency medical care to ensure the reduction of any permanent long-term complications. Temporal bone fractures are not common by ATs and this case can be used as a resource for clinicians experiencing similar cases to be aware of the gravity of not only concussions, but also other emergency medical situations including brain and skull traumas.

Total Word Count: 512

200073MD

Examination of Eating Disorder Risk Among University Marching Band Artists

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Context: Athletic trainers (AT) providing medical services in the performing arts, including marching bands (MB), is emerging. MB artists are a physically active population, composed of approximately 27,000 people in the United States. In university MB, members face many of the same physically active demands and mental stressors as student-athletes, potentially predisposing MB artists to injury, illness and risk for disordered eating (DE)/eating disorders (ED). The purpose of this study was to examine the prevalence of ED risk across sex in female and male university MB artists.

Methods: We utilized data from a larger cross-sectional study. A convenience sample of MB artists [n=150; (female: n=84, male: n=66, age=19.9±1.1 years) from 3 NCAA Division I university MB participated in the study. Participants completed basic demographic survey, the Eating Disorder Inventory-3 (EDI-3), and the EDI-3 Symptom Checklist (SC). Basic descriptive statistics were used for demographic information. Cross-tabulations and Chi-square analyses were used to examine the proportion of participants classified as “at risk for EDI-3 and EDI-3 SC” across sex.

Results: EDI-3 risk was significant across sex [All: 46.7% (n=70); females: 31.3% (n=47); males: 15.3% (n=23); $X^2(1, n=150) = 6.614, P=0.01$]. No significant differences were found for EDI-SC risk across sex [All: 54% (n=81); females: 31.3% (n=47); males: 22.7% (n=34)] or type of overall risk across sex [EDI-3 only: 16.7% (n=25); females: 10% (n=15); males: 6.7% (n=10)]; [EDI-SC only: 24.7% (n=37) females: 10.7% (n=16); males: 14% (n=21)]; [Both EDI-3 and SC: 29.3% (n=44); females: 20.7% (n=31); males: 8.7% (n=13)]. Overall, significant differences were found between pathogenic behaviors and sex for purging to control weight [All: 12% (n=18); females: 9.3%: (n=14) and males: 2.7%: (n=4); $X^2(1, n=150) = 3.94, P=0.047$]. No significant differences were found in dieting [All: 48% (n=72); females: 28.7% (n=43); males: 19.3% (n=29)]; exercise [All: 20.7% (n=31); females: 12% (n=18); males: 8.7% (n=13)]; binge eating [All: 18.7% (n=28); females: 10.7% (n=16); males: 8% (n=12)]; diet pill use [All: 4.7% (n=7); females: 2.7% (n=4); males: 2% (n=3)]; and diuretic use [All: 2% (n=3); females: 1.3% (n=2); males: 0.7% (n=1)].

Conclusions: ED risk was highly prevalent for both female and male MB artists, only approximately one-third of the population was not at risk, and females displayed higher risk for ED than males. It is a concern that both female and male MB artists are engaging in pathogenic behaviors to control their weight, with females displaying higher risk for purging. AT working in this setting should be aware of the risk factors displayed in MB artist, and provided education, prevention, and clinical interventions to MB artists. Additionally, MB administrators should be aware of all medical risk factors and the benefit of having an AT to oversee the healthcare and wellness of MB artists.

Total Word Count: 445

200192JD

Examination of Energy Needs and Dietary Prolife Among Male and Female Athletic Trainers

Kacey Ohlemeyer, Toni M. Torres-McGehee, Erin M. Moore, Taylor Lyles, Greg Wakefield, Dawn M. Emerson, Kelly Pritchett, Ally Smith

Context: High occupational demands expose Athletic Trainers (AT) to negative health outcomes including decreased dietary and exercise habits leading to energy imbalances. The purpose of this study was to examine the energy needs and macronutrient intakes (protein [PRO], carbohydrate [CHO], and fats) differences between gender (females and males) and job status (Full-Time vs. Part-Time) in ATs.

Methods: We utilized a cross sectional study design that was part of a larger study. Independent variables were gender and job status and dependent variables consisted of resting metabolic rate (RMR), energy intake (EI), exercise energy expenditure (EEE), total daily energy expenditure (TDEE), energy balance (EB) and macronutrients. Athletic trainers (females: n=23; age: 28.9±7.9yrs; height: 164.1±6.3cm; weight: 66.6±10.7kg; males: n=23; 29.1±7.9yrs; height: 179.6±7.1cm, weight: 88.3±15.5kg) participated in the study. Employment varied for occupational settings (e.g., secondary, collegiate/university, hospital/clinic, etc.) and represented both part-time (n=23) and fulltime (n=23) employment status. Data collection consisted of demographic and anthropometric data, RMR, 7-day online dietary and exercise logs to measure EI and EEE. Basic descriptive statistics were used to analyze demographic and anthropometric data, ANOVAs, Chi-squares, and cross-tabulations were used to examine the proportion of participants classified as negative energy balance (EB) and those that have compromised macronutrient profiles across either gender or job status.

Results: Overall, 82.6% (n=38) ATs demonstrated negative EB (-555.3±518.2; females:-655.6±535.5kcal; males:-455.1±491.5) with no significant differences across gender and job status. Energy assessment including: EEE (females:384.5±254kcal, males:584.2±284.7kcal), EI: (females:1698.3±554.1kcal, males:2223.1±469.4kcal), and TDEE: (females:2353.9±127.6kcal, males:2737.7±260.1kcal). Specific pathogenic behaviors demonstrated 78.3% (n=36) engaged in dieting, and 28.3%, (n=13) participants exercised to lose weight 25-50% of the time and 21.7% (n=10) exercised 50-100% of the time. Macronutrient profiles demonstrated increased intake of PRO above 1.0 g/kg (F:39.1%, n=9, M:78.3%, n=18), decreased CHO below 3 g/kg (females:52.2%, n=12; males:65.2%, n=15) and increase in fat consumption >30% of total kcal (females:82.6%, n=19; males:78.3%, n=15). There were no significant differences between gender and job status, except PRO consumption and job status (p=0.04). Alcohol intake was high between genders for drinks per week (females:39%, n=9; males:47.4%, n=9) and 3+ drinks at one time (females:60.8%, n=14; males:47.4%, n=9).

Conclusions: Athletic Trainers are at risk for negative health habits, between inappropriate EI and macronutrient consumption, EB, pathogenic dietary behaviors, and alcohol consumption. Most of these ATs demonstrated compromised low CHO intake compared to the recommendation, and despite -EB, over 73.9% of the ATs overconsumed fat. As healthcare professionals, it is recommended ATs use their nutritional education for their own health and wellbeing. This may have major impacts on reducing negative health consequences and stabilize mental health and physical wellbeing.

Total Word Count: 422

206203AA

Examination of Referral Patterns During Army Basic Combat Training

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Context: Most Soldiers have at least one medical encounter with a healthcare provider during basic combat training (BCT), and nearly half are due to orthopedic injury. Injuries sustained during BCT lead to substantial medical costs for the United States Army and may result in medical discharge. Athletic trainers (ATs) have reduced Soldier referrals for orthopedic conditions in other military branches, but the inclusion of ATs in the Army BCT environment has not been examined.

Methods: A prospective cohort study over an 11-month period in 2008 during BCT at the Fort Jackson Army Training Center. Battalions were assigned to one of three conditions: control (CON), full-time medic (FTM), or part-time athletic trainer (PAT). For each condition, a part-time medic was present for sick call, but in the FTM and PAT conditions, the aforementioned provider was present during and after sick call as hours allowed. The PATs were limited to 20 hours per week whereas the full-time medic worked 40 hours per week. The healthcare provider would determine if the Soldier could return to duty (RTD) or refer them to the Troop Medical Center (TMC). The dependent variable was Soldier disposition (i.e., RTD or referred to the TMC). The independent variables were Soldier demographics (i.e., sex, age), condition, visit reason, and provider impression. Frequencies and proportions were calculated for each variable. Logistic regression compared conditions while considering the other independent variables.

Results: There were 14,304 sick call visits documented. Females accounted for most visits (n=7650, 53.5%). The average age of Soldiers reporting to sick call was 22.4±5.0 years. Musculoskeletal injuries accounted for 55.4% (n=7926) of sick call visits. Overall, 52.2% of Soldiers evaluated at sick call were referred to the TMC and 33.3% were RTD. Commonly referred TMC injuries were blisters/wound care, stress reaction/fracture and “other”. Injuries commonly RTD were chronic/overuse, contusions/bruises, ligament sprains, muscle strains and malingering. Compared to the CON condition, the FTM condition resulted in 30.3% higher odds of RTD (95% CI: 1.187, 1.430; p<0.001). The PAT condition resulted in 21.9% higher odds of RTD (95% CI: 1.103, 1.348; p<0.001). When limited to musculoskeletal injuries, the FTM condition had 39.3% higher odds of RTD (95% CI: 1.236, 1.570; p<0.001) and the PAT condition had 60.3% higher odds (95% CI: 1.407, 1.825) than the CON condition.

Conclusions: Musculoskeletal injuries were common during BCT. Over half of sick call visits resulted in TMC referral. Soldiers in both the FTM and PAT conditions were more likely to be RTD compared to the CON condition. However, the PAT condition had a greater reduction in musculoskeletal referrals even within part-time hours compared to both the FTM and CON conditions. However, it is unclear if full-time ATs would provide even greater benefit.

Total Word Count: 442

207455MD

Examining ATC's Perceptions of Their Role in Athlete's Mental Health

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Context: Mental health (MH) issues are becoming more prevalent in athletes at the high school and collegiate setting¹. Athletic Trainers (ATs) who are working in these settings are addressing not only physical but mental aspects of the injured patient as increased attention is being placed on the importance of psychological issues². Therefore, the purpose of this study was to assess ATs, who were also preceptors, perceptions of their role in MH of their student athletes.

Methods: A qualitative research design was implemented. Sixteen preceptors (4 male; 12 female; mean age = 32.6; mean years of experience = 9.4) who supervise athletic training students enrolled in a CAATE accredited athletic training program were recruited through convenience sampling. Semi-structured interviews were conducted over the phone or in person. The interview guide, designed for the purposes of this study, consisted of 11 questions (4 background questions, 7 regarding perceptions, opinions and experiences with athletes' MH). The interview was recorded and transcribed verbatim. Two of the investigators completed independent data analysis. A general inductive approach was utilized to reveal dominant themes that related to our purpose. We achieved data credibility through multiple analyst triangulation, peer review, and member checks.

Results: The following themes were identified: 1) Varied Understanding of MH, 2) Managing a "Changing Landscape", 3) Responsibility, 4) Preceptor Challenges, and 5) Need for Support, Training, and Education (see Figure 1). Participants had a range of definitions and understanding of MH that ranged from clinical to more holistic. All participants felt that MH issues have increased and that ATs are dealing with more complex issues than ever before; the "landscape" is changing. This was supported by the experiences that participants shared related to managing the MH of their athletes. Participants felt they had a responsibility to address MH issues as long as it was within their scope of practice, as well as promoting MH with their athletes. However, they reported the need for training and ongoing support for both their role as an AT and preceptor. Participants discussed challenges related to educating and exposing AT students to MH issues. This is further compounded by the reported lack of training and education in both AT programs and in professional development.

Conclusions: ATs are increasingly dealing with MH issues and believe that they have a responsibility to address the MH of athletes both by being able to manage, and also educate about MH. However, they face challenges in their role as an AT and preceptor due to a lack of education and training. There is a need for CAATE programs to better prepare students to address MH and a need for increased professional development to help clinicians increase their competence and confidence to address these issues.

Total Word Count: 446

209221PB

Exertional Heat Stroke Policy Adoption Across the Socio-ecological Framework

Kuczo AL, Scarneo-Miller SE, Register-Mihalik JK, Malone ZC, Kryzanski EE, Kay MC, Vander Vegt CB, Casa DJ, DiStefano LJ

Context: The adoption of written policies and procedures can significantly contribute to positive outcomes for patients suffering from exertional heat stroke (EHS). Communication across the socio-ecological framework (e.g. interpersonal and organizational relationships) between athletic trainers (ATs) and athletic directors (ADs) may influence policy and procedure adoption. The purpose of this project was to evaluate the current policy adoption reported by ATs and ADs related to EHS. Secondly, we aimed to compare responses within a school across ATs and ADs.

Methods: Athletic trainers (80% female, age=29±10 years) and ADs (73.3% male, age=44±8 years) from 19 high schools in Connecticut (n=7) and North Carolina (n=12) were invited to participate in this study. An online questionnaire was distributed to all participants (ATs and ADs) in the fall of 2018. The questionnaire aimed to identify EHS diagnosis and management best-practice policy adoption as delineated in the National Athletic Trainers Association Position Statement: Exertional Heat Illnesses. The questions were framed using the Precaution Adoption Process Model (PAPM). The PAPM is a health behavior model aimed to identify the readiness to act for the adoption of policies (Table 1). Within the PAPM model there are 8 stages, which are outlined in the table, that identify what stage of adoption the AT and AD are in. For example, if the AT is “considering,” they are aware that they need that policy, and considering adopting it. Frequencies were tabulated for each of the stages of the PAPM within each question, with 95% confidence intervals (CI) calculated around the proportion. McNemar’s test was performed to determine the level of disagreement between AT and AD responses.

Results: The highest proportion of AT responses for a written policy to diagnose EHS via rectal thermometry was “decided not to act” (n=5, 26.3%), whereas the highest proportion of AD responses was “Unaware of the need for this policy” (n=6, 40.0%) (Table 1). The McNemar’s test demonstrated significant disagreement between the proportion of ATs and ADs with more ATs reporting “decided not to act” for the adoption of a rectal temperature policy than ADs (p=0.01). A majority of ATs and ADs report “acting” or “maintaining” for a written policy related to cold-water immersion for the management of EHS (AT= 13/18, 66.7%; AD=12/15, 73.3%).

Conclusions: Overall, the findings suggest a lack of adoption of rectal thermometry for the diagnosis of EHS, however, a majority of respondents reported adoption of cold-water immersion and “Cool First, Transport Second” for the management of EHS. ATs and ADs demonstrated disagreement among PAPM stages suggesting a lack of communication across the socio-ecological framework. ATs and ADs should communicate regularly on the state of policy adoption and implementation to ensure best practices are followed for diagnosis and management of EHS.

Total Word Count: 444

206715RD

Experiences of Athletic Training and Emergency Medical Service Students After Participating in an Interprofessional Mass Casualty Simulation

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Context: Interprofessional education (IPE) is a collaborative approach to learn about, from, and with healthcare providers to improve collaboration, communication, and patient care. Communication is inherent in providing collaborative care, as effective communication enhances the healthcare team's function and ability to organize and share information with patients. As educators, it is imperative to provide students opportunities for engaging in interprofessional practice in a non-threatening environment. The purpose of this study was to understand the experiences of professional athletic training and emergency medical services students after participating in an interprofessional mass casualty simulation.

Methods: We employed a phenomenological design utilizing post simulation debriefing. 18 professional athletic training students (8 bachelor's and 10 master's level, 11 females, 7 males, 22.1 + 0.69 years old) and 21 first year emergency medical services students (17 males, 4 females) engaged in a mass casualty simulation with multiple standardized patients involved in a bicycle accident during a triathlon. Participants were divided into teams of 4, with 2 students from each discipline per team providing collaborative care. The participants completed a primary assessment and triage, provided immediate care, and prioritized patients for referral via ambulance. Following the simulation, participants participated in a group debrief session, following a structured debrief guide. The debrief was audio recorded and transcribed verbatim. Data were initially read independently by the researchers for understanding and then coded into meaning units. These meaning units allowed the data to be organized into emerging themes. Trustworthiness was established through peer and external review, and multiple analyst triangulation.

Results: Overall, participants reported developing an understanding of skills and professional expertise of the other discipline. Three themes emerged from participant comments including 1) importance of communication, 2) managing multiple patients, and 3) knowledge of the other healthcare profession. For importance of communication, participants described the need for preparation and pre-brief to understand individual strengths and the equipment available before providing care. Additionally, the struggles in communicating across professions were shared. Participants outlined the strategies used for patient triage and prioritizing the order of care provided to patients. Through prioritization, participants expressed a variety of methods used for determining which patient needed immediate care. For knowledge of the other healthcare profession, participants detailed how they delineated roles while providing collaborative care. Additionally, participants described learning about the scopes of practice and the skill sets of each discipline.

Conclusions: As emphases continue for interprofessional patient care experiences, simulations provide real-time patient experiences in a non-threatening environment for students to engage in interprofessional practice. Facilitated debrief allowed the participants to reflect on their own actions and clinical decisions while collaborating interprofessionally. These encounters allow for further understanding of different healthcare practitioners and the collaborative care that can optimize patient care.

Total Word Count: 445

206183CD

Exploring the Relationship Between Premorbid Depression or Anxiety and Baseline King-Devick Performance

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Context: Consensus statements have suggested the inclusion of vestibular and ocular motor assessments for sport-related concussion (SRC) management. The King-Devick (K-D) test is a validated and accessible assessment tool utilized for dysfunctioning within the vestibulocular system. To best utilize the K-D test, we must understand how premorbid factors may influence performance. This study aimed to examine the relationship between premorbid depression or anxiety and baseline K-D reading performance.

Methods: This study utilized an observational design. A total of 1139 collegiate and high school athletes participated in this study. Depression and anxiety diagnosis status, and a K-D baseline were collected as components of athletes' preseason pre-participation physical examination. Depression and/or anxiety diagnoses were self-reported on pre-participation health history questionnaires. A total of 36 athletes self-reported having been diagnosed with depression and 48 athletes self-reported having been diagnosed with anxiety. K-D reading times were completed individually with an athletic trainer. K-D baseline tests were completed using test card booklets, and participants were given uniform instructions prior to test administration. A stopwatch on a smartphone was used to record each participant's cumulative reading time. The fastest of 2 trials was recorded as the athlete's baseline score. K-D reading time was the dependent variable, and self-reported depression and/or anxiety were the independent variables. Data were analyzed using descriptive statistics and a multiple linear regression using SPSS. Statistical significance was set a priori $p \leq .05$.

Results: The mean K-D scores for the cohort of athletes that reported having depression was 49.7seconds versus 49.2seconds among athletes that did not report having depression. The mean K-D scores for the cohort of athletes that reported having anxiety was 47.1seconds versus 49.3seconds among athletes that did not report having anxiety. The results of the multiple linear regression suggest that anxiety is a significant predictor of baseline K-D performance ($p=.03$) whereas depression is not a significant predictor ($p=.06$) of baseline K-D performance. Although anxiety was a significant predictor, the model explained very little variance in scores ($R^2=.01$).

Conclusions: Athletes with self-reported anxiety averaged faster cumulative K-D reading times in comparison to those that did not report a premorbid diagnosis. Anxiety triggers the sympathetic nervous system, putting the body on high alert with increased heart rate and breathing, muscle tensing and more blood flow directed to the brain. This physiological response could account for increased focus on the K-D task and faster reading times. Because SRCs can present with a myriad of signs and symptoms, clinicians should be cognizant of premorbid diagnoses of depression or anxiety, and how those factors may influence performance on concussion assessments such as the K-D.

Total Word Count: 424

208012DD

Exploring Time between Primary and Subsequent ACL Reconstructions: A Preliminary Analysis

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Context: Although much is known regarding risk factors of subsequent ACL injuries (e.g., young age), there is a paucity of information on predictors of the time between a subsequent ACL reconstruction (ACLR) and the previous ACLR. The objective of this study was to determine predictors available from medical record (age, sex, body mass index [BMI], type of ACLR [revision or contralateral]) of time between ACLRs.

Methods: This was a preliminary analysis of a retrospective study of medical records of patients (n=230; female=60%; age=25.5 ± 11.1 years; BMI=24.6 ± 4.8 kg/m²) who underwent ACLR between 2015 and 2018. 194 patients had primary ACLRs (female=50%; age=25.0 ± 10.9 years; BMI=24.3 ± 4.6 kg/m²), 36 patients had revision ACLR (female=59%; age=28.4 ± 12.2 years; BMI=24.8 ± 3.3 kg/m²), and 24 patients had a previous ACLR on the contralateral limb (female=83%; age=25.0 ± 10.7 years; BMI=26.3 ± 7.2 kg/m²). For those that had ≥2 ACLRs, time between ACLRs was calculated as date of most recent ACLR minus date of previous ACLR. Time between ACLRs was the dependent variable, while age, sex, BMI, and type of ACLR (revision or contralateral) were the independent variables. Multiple linear regression was run to determine which independent variables were significant predictors of time between ACLRs.

Results: There were no significant differences in age between patients with primary ACLR (25.0 ± 10.9 years) and revision (28.4 ± 12.2 years; p=0.078) or contralateral ACLRs (25.0 ± 10.7 years; p=0.980). Time between ACLRs was 4.1 ± 4.3 years for patients who underwent revisions and 5.1 ± 6.0 years for patients who underwent contralateral ACLR for the subsequent ACLR. Age, sex, BMI, and type of ACLR significantly predicted time between ACLRs (R² = 0.366, p<0.001). However, age was driving the model with the largest association with time between ACLRs (r=0.559, p<0.001).

Conclusions: Younger age predicted shorter time between ACLRs. It is plausible that older individuals are more likely to delay surgical intervention than younger individuals. They also may be engaged in less physical activity than younger individuals. One of the limitations includes not recording activity levels. These findings can help guide athletic trainers in educating young and older patients on expectations, particularly when discussing surgical versus conservative management of subsequent ACL injuries.

Total Word Count: 365

209514CA

Factors Influencing Energy Expenditure and Energy Balance in Acute Sport Concussion.

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Context: Sport concussion (SC) is characterized by a neurometabolic cascade that results in an increased intracranial energy demand. Little is known about the whole-body metabolic response following SC. We examined whole-body resting metabolic rate (RMR) and energy balance (EBal) acutely following SC in student-athletes, and examined factors that may influence energy expenditure after SC.

Methods: In this case-control study, high school and collegiate student-athletes diagnosed with SC (n=28, 50% female, aged 18.4±1.83 years, BMI=20.3±4.13 kg/m²) were assessed within 72 hours of concussion and matched with control participants (n=28, 50% female, aged 19.4±2.90 years, BMI=18.8±4.79kg/m²). Each participant completed questionnaires that included demographics, concussion history, and symptom experience within the past 24-hours (both total duration and total severity). Concussion history was categorized into four groups for regression analyses: 0, 1, 2, and 3+ prior concussions. Next, RMR was measured via indirect calorimetry and was also normalized to body mass (RMR/kg) to account for the influence of body mass on energy expenditure. Participants reported physical activity and dietary intake for three consecutive days starting with the day of assessment. Physical activity was measured via Fitbit and utilized to estimate total daily energy expenditure. Energy consumption was estimated with MyFitnessPal software based on diet records. EBal was the ratio of total energy consumed to energy expended. Between group (SC vs. control) comparisons were made for RMR, RMR/kg, total energy expenditure, energy consumption and EBal using independent t-tests. Age, sex, concussion history, total symptom duration, and total symptom severity were then regressed onto RMR, RMR/kg and EBal in the SC group using backwards stepwise multiple regression models. Analyses were performed with a-priori $\alpha=0.05$.

Results: Group comparisons are presented in Table 1. RMR, RMR/kg, and energy consumption did not differ between groups, but total daily energy expenditure and EBal were higher in the SC group (p<0.02). Higher RMR was associated with older age and being male (adjusted R²=0.37; standardized betas=0.28 & 0.55, respectively). Higher RMR/kg was associated with more prior concussions (unadjusted R²=0.134; unstandardized beta=0.65). Higher EBal (consuming more energy than expended) was associated with younger age, fewer prior concussions, greater symptom duration, and lower symptom severity (adjusted R²=0.48; standardized betas=0.58, 0.28, 1.89 & 1.83, respectively).

Conclusions: Athletes diagnosed with a SC reported consuming more energy than they expended, while the control group was at a relative energy balance. Moreover, we observed a relationship between prior concussion history and whole-body energy expenditure in participants with acute SC, suggesting that a history of concussion may alter the physiologic response to a new SC. Our study was the first to assess factors influencing whole-body energy expenditure in student-athletes with SC; and future studies should examine the relationships between past and new concussions from a whole-body physiologic perspective.

Total Word Count: 445

200575AD

Factors Influencing Stress and DS Among Collegiate Student-Athletes

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Context: Athletic trainers are responsible for advocating for their patient's physical and psychological health. Research has shown that collegiate athletes experience unique stressors contributing to greater levels of psychological distress, specifically depressive symptoms (DS). Conversely, additional studies have shown various levels of athletic participation to be protective against DS. Alongside these contradictory findings, the influence of physical injury on psychological health warrants further examination. The purpose of this study was to describe the relationship between injury history (IH), varsity athletic participation (AP), and DS among college students.

Methods: A paper-and-pencil survey was administered to college students in classrooms and athletic training settings. The sample was composed of 515 undergraduate students (age = 20.4 ± 1.2 years, gender = 70% female, varsity athlete = 21%) from a large, private university in the Southwestern region of the United States. The survey response rate was 94%. The 36-item survey was developed by utilizing several previously validated instruments. Depressive symptoms were measured by the revised version of the Center for Epidemiological Studies Depression Scale (CESD-R). Additional survey items were included to assess IH and AP. Injury history was defined as a personal injury or illness that occurred within the previous 12 months. Athletic participation was defined as participation in varsity, Division I athletics in the previous 12 months. Participant recruitment took place in classrooms on campus as well as several athletic training facilities; however, students could only participate once. The primary outcome variable was DS, measured as a composite score of 20 items from the CESD-R. Poisson regressions were used to evaluate the effect of IH and AP on the outcome variable.

Results: Reported DS scores were significantly higher among student nonathletes ($m=20.3$, $SD=15.8$) than varsity athletes ($m=14.4$, $SD=13.7$; $F=12.86$, $p < .01$). Students who reported varsity athletics participation were at significantly greater odds of reporting history of personal injury than nonathletes ($OR=2.96$, $p < .01$). In the multivariate model, IH ($B=2.91$, $p < .01$, 95% $CI= 1.21, 7.92$) and gender (female; $B=4.34$, $p < .01$, 95% $CI=1.33, 7.35$) were significant predictors of DS in this sample. Conversely, AP ($B=-1.43$, $p < .001$, 95% $CI= -2.10, -.756$) and GPA ($B=-2.91$, $p < .001$, 95% $CI= -4.46, -1.36$) were protective factors against DS.

Conclusions: In this study, IH was a significant predictor of DS in college students. In contrast, it appears AP was a protective factor against DS in this sample. Consistent with previous research, female participants experienced DS at a greater rate than males. Additional research exploring how injury-specific factors (e.g. type, severity) contribute to DS among student athletes is needed.

Total Word Count: 416

[206945GD](#)

Forearm Rotational Strength Characteristics Among Collegiate Baseball Players Using Hand-held Dynamometry

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Context: When throwing a baseball, valgus forces imposed on the medial elbow exceed anatomical limits of the ulnar collateral ligament. This leaves the flexor-pronator mass as the main provider of medial elbow stability and attenuation of valgus force. As such, clinicians necessitate clinically relevant and evidence-based methods for assessing flexor-pronator mass strength in their prevention, detection, and management of injury among baseball athletes. No studies, however, have documented normative forearm rotational strength characteristics among competitive baseball players using clinically relevant instruments. This study provided a normative data profile of forearm rotational strength among collegiate baseball players using a hand-held dynamometry technique.

Methods: A cross-sectional design was used to examine a convenience sample of 32 asymptomatic collegiate baseball players (17 pitchers: age = 20.2 ± 1.3 years, height = 188.7 ± 6.9 cm, mass = 95.5 ± 7.7 kg; 15 position players: age = 20.5 ± 1.4 years, height = 185.4 ± 4.6 cm, mass = 90.2 ± 4.5 kg). Bilateral forearm pronation and supination strength were measured in newtons (N) within a sports medicine clinic. Strength was measured using an ergoFET 2 hand-held dynamometer (Hoggan Scientific LLC., Salt Lake City, UT) (Figure 1). Intra-rater reliability and standard error of measurement (SEM) for measuring dominant pronation (PronationDom), non-dominant pronation (PronationND), dominant supination (SupinationDom), and non-dominant supination (SupinationND) strength were .79 (SEM = 4.8 N), .85 (SEM = 3.6 N), .91 (SEM = 3.0 N), and .83 (SEM = 3.8 N), respectively. Separate one-way ANOVAs were used to compare pronation and supination strength between pitchers and position players. Paired t-tests were used to compare strength bilaterally. Statistical significance was set a priori at $P < .05$.

Results: Preliminary comparison of group means for pitchers' and position players' PronationDom ($F(1, 30) = .04, P = .84$), PronationND ($F(1, 30) = .52, P = .48$), SupinationDom ($F(1, 30) = .08, P = .78$), and SupinationND ($F(1, 30) = .30, P = .59$) strength revealed no differences between groups. Consequently, pitchers' and position players' data were aggregated to compare forearm rotational strength between dominant and non-dominant limbs. Paired t-tests demonstrated no significant difference between PronationDom (46.0 ± 10.6 N) and PronationND (45.3 ± 9.25 N), $t(31) = .55, p = .58$ (95% CI [-1.9, 3.4]). Participants, however, had significantly more strength in SupinationDom (37.3 ± 10.0 N) compared to SupinationND (34.2 ± 9.2 N), $t(31) = 3.3, p = .002$ (95% CI [1.2, 5.1]).

Conclusions: Findings demonstrated no statistical and/or clinically meaningful differences in forearm rotational strength between pitchers and position players or between dominant and non-dominant limbs. The findings provide clinicians evidence-based, normative ranges to consider when examining and managing forearm rotational strength among symptomatic and asymptomatic baseball players.

Total Word Count: 443

205202EA

Functional Balance Measures in Ballet Dancers With Varying Visual Input

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Context: Ballet dancers are expected to flawlessly complete choreography regardless of if they are in class, rehearsing for an upcoming ballet, or performing. These activities, however, occur in three diverse environmental settings. Currently, there is a void in the literature examining how balance might vary between these settings during functional ballet movements.

Methods: Testing was completed in three ballet environments: studio facing the mirror (SM), studio facing away from the mirror (SNM), and stage (ST). Healthy, college-aged female dancers majoring in ballet performance in a Bachelor of Science program from a large Midwestern university volunteered to participate in this study. Participating dancers (n=25) were 19.79±1.44 years old, 164.49±7.34 cm tall and weighed 56.64±4.68 kg. Dancers participated in 24.38±3.12 hours of ballet training per week, had 15.21±2.11 years of total dance experience, and 10.25±3.03 years of formal ballet training. Postural sway was measured during three ballet tasks: passé en relevé (PER), double pirouette (DP), and fouetté turns. The dependent variables varied depending on the ballet task. For PER, time in balance (seconds) was captured. For DP, 95% ellipse area (cm²) was captured. During fouetté turns, the maximum number of rotations (count) were captured. A Tekscan plantar pressure mat (HR Mat Pressure Measurement System, Boston, MA) was used to capture and record time in balance and 95% ellipse area. The independent variable was environment at three levels: SM, SNM, ST. Three separate Repeated Measures Analysis of Variance (RMANOVA) were conducted for each dependent variable. A priori alpha level was set p < .05. Significant differences were further analyzed with Tukey post hoc testing.

Results: Change in environment elicited statistically significant changes in all dependent variables (Table 1). Tukey post hoc testing revealed that performing on stage negatively impacted balance time, 95% ellipse area, and fouetté rotations. Time in balance during PER decreased on stage compared to both studio conditions (mean difference=0.61 seconds [SM], 0.72 seconds [SNM]). 95% ellipse area during DP was larger on stage compared to studio without mirror (3.86 cm² larger). Number of fouetté rotations was lower on stage compared to studio with mirror (1.43 rotations fewer).

Conclusions: This study identified deficits in balance and turning performance on the stage compared to the studio. This may be due to the dramatic transition that occurs between studio and stage environments without allowing proper acclimation. Ballet dancers may need to alter their training strategies to incorporate different visual inputs. Increased training opportunities on the stage should also be integrated into daily schedules and prior to performances to maximize performance abilities on stage.

Total Word Count: 416

[206924FC](#)

Gait Biofeedback and Impairment-based Rehabilitation for Chronic Ankle Instability: A Randomized Controlled Trial

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Context: Individuals with chronic ankle instability (CAI) walk with a more inverted foot position than ankle sprain copers and healthy controls throughout the gait cycle and have deficits in ankle dorsiflexion range of motion (ROM), eversion ankle strength and postural control compared to healthy controls. Gait training has been recommended to address gait alterations, however, the use of visual biofeedback to accomplish this goal has not been previously examined.

Methods: We performed a single-blinded randomized controlled trial in a laboratory setting to analyze the effects of 4-weeks of visual gait biofeedback and impairment-based rehabilitation on gait biomechanics, clinical measures, and patient-reported outcomes (PRO) in individuals with CAI. Twenty-seven individuals with CAI participated. Both groups received 8 sessions of impairment-based rehabilitation and one group received biofeedback (14 no biofeedback (NBF), 13 gait biofeedback (GBF)). The GBF group received visual biofeedback to reduce ankle frontal plane angle at initial contact (IC) during walking. The NBF group walked for equal time during rehabilitation but without biofeedback. Three-dimensional kinematics and kinetics at the ankle, knee, and hip, and sEMG amplitudes of 4 lower extremity muscles were analyzed. Clinical measures included ankle ROM (dorsiflexion, plantarflexion, inversion, eversion), isometric strength for ankle (dorsiflexion, plantarflexion, inversion, eversion), toes (flexion: 1st toe, toes 2-5), and hip (extension, abduction), and static and dynamic balance. PROs included the Foot and Ankle Ability Measure Activities of Daily Living (FAAM-ADL), FAAM-Sport, Tampa Scale of Kinesiophobia (TSK), and Global Rating of Change (GROC).

Results: The GBF group significantly decreased ankle inversion at IC (pre:4.2±4.6°, post:-3.1±4.1°, g=1.6) and throughout the stride cycle (peak inversion: pre:6.7±5.0°, post:0.8±4.3°, g=1.2) (Figure 1). No changes were identified for gait biomechanics for the NBF group. While accounting for baseline measures, the GBF group had greater improvements in FAAM-ADL (GBF:97.1±2.3%, NBF: 92.0±5.7%), TSK (GBF:29.7±3.7, NBF:34.9±5.8), and GROC (GBF:5.5±1.0, NBF:3.9±2.0) scores. The GBF group significantly increased plantarflexion ROM (pre: 74.1±6.9°, post: 82.2±7.4°) compared to the NBF group (pre: 72.3±7.8°, post: 72.3±10.0°). Greater strength improvements (N/kg) were found in the GBF group for ankle inversion (GBF: pre: 2.3±0.6, post: 3.4±0.7; NBF: pre: 2.6±0.4, post 3.1±0.5), 1st toe flexion (GBF: pre: 1.1±0.3, post: 2.1±0.3; NBF: pre: 1.2±0.3, post 1.8±0.4), and hip abduction (GBF: pre: 1.9±0.5, post: 2.7±0.5; NBF: 2.3±0.5, 2.5±0.5) compared to the NBF group. There were no significant differences between groups for balance measures.

Conclusions: The GBF group successfully decreased ankle inversion angle during walking and had greater improvements in PRO's after the intervention. Impairment-based rehabilitation in combination with visual biofeedback resulted in greater improvements in strength and ROM compared to the no biofeedback group. Impairment-based rehabilitation without biofeedback improved PRO's but did not impact gait biomechanics. Visual biofeedback during gait combined with impairment-based rehabilitation is recommended for individuals with CAI.

Total Word Count: 445

206425CD

Gender Differences in Discussions and Reporting about Concussions

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Context: Between 1.6 and 3.1 million concussions related to sports and recreation related injuries occur per year¹. The aim of the current analysis was to determine collegiate student-athletes' experiences with concussions, who they were talking with about their experiences, and rates of concussion reporting by gender.

Methods: As part of a large, multi-site randomized, controlled study of a novel peer concussion education program, n=815 collegiate student-athletes serving as control participants from all three NCAA divisions in sports with high concussion likelihoods reported on their experiences with concussions including a) whom they discussed concussions with, b) whether they suspected concussions in themselves or a teammate, and c) whether they reported their concussion or their teammates' concussion. Chi-square tests were used to determine differences in these three experiences by gender with appropriate follow-up analysis.

Results: The average age of student-athletes was 19.73 (SD 1.2) years with most being in their first (37.2%), 2nd (27.4%), and 3rd (25.2%) year of school respectively. Overall student-athletes seemed to be reporting concussions at a fairly high rate, providing a self-reported rate of 65.9% with 91 of 138 student-athletes who suspected a concussion indicating that they reported their own concussion and 54.6% indicating they reported a teammates' concussion over the previous month. There was a significant gender difference in discussing concussions with a coach ($X^2(1, n=808) = 7.9, p=.005$) with males being 1.62 (Odds Ratio, OR) times more likely to discuss concussions with their coach than females. Only 25% of females discussed concussions with a coach compared to 35% of males who reported discussing concussions with a coach. No gender difference was found in discussions with athletic trainers or teammates. There were no significant gender differences in sustaining or reporting one's own concussion. However, there was a significant gender difference in suspecting a concussion in a teammate, ($X^2(1, n=804) = 7.0, p=.008$). Males were 1.83 (OR) times more likely to suspect a concussion in a teammate than females with 18.4% of males suspecting a concussion in a teammate compared to 10.9% of females. However, there were no significant gender differences in reporting a suspected concussion in a teammate, ($X^2(1, n=545) = 1.15, p=.29$).

Conclusions: Overall the findings suggest that patterns of discussions about concussions among student-athletes are influenced by gender and play an important role in how concussions are discussed. In addition, the findings indicate that male athletes may be aware of injuries and concussions in their teammates and likely to discuss these with their coaches. These findings highlight the importance of coaches and peers in the concussion and injury reporting process.

Total Word Count: 418

[209364LA](#)

Gluteal Activation and Discomfort During the Superimposed Burst Technique Between Healthy Males and Females

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Context: Gluteal muscle dysfunction is commonly observed among individuals with knee pathologies. Strength is the most common objective measure of gluteal function, yet this measure does not adequately represent neuromuscular function. The superimposed burst (SIB) technique is one method used to assess gross neuromuscular function by quantifying the central activation ratio (CAR). However, only one investigation has recently applied SIB to the gluteal muscles. The technique is reliable for both the gluteus maximus (GMax) and gluteus medius (GMed); however, gender differences are unknown. The SIB has been reported to result in increased participant discomfort, yet the discomfort using this technique on the gluteals is also unknown between males and females. Therefore, our objective was to compare gluteal CAR and discomfort during the SIB technique between healthy males and females.

Methods: Twenty healthy participants (9 males; 21.87±1.12 years, 98.7±24.03 kg, 183.51±10.49 cm and 11 females; 22.41±1.62 years, 75.48±13.35 kg, 166.58±4.39 cm) completed this descriptive laboratory study. Gluteal muscle activation was assessed using the SIBT and quantified with the central activation ratio. GMax was assessed in a prone hip extension position and GMed was assessed in a standing hip abduction position using a stationary dynamometer. CAR for each muscle was averaged over 3 trials for data analysis. Participant discomfort was recorded with separate visual analog scales after the third trial for both the GMax and GMed. Independent sample t-tests were used to compare gluteal CAR and discomfort between males and females, alpha set a priori $p < .05$. Cohen's d effect sizes with 95% confidence intervals (CI) were calculated to assess the magnitude of gender difference.

Results: Males were heavier ($p=0.045$) and taller ($p<0.001$), but did not differ by age ($p=0.423$). There were no differences in gluteal CAR between males and females for GMax (Males: 84.62±7.88%, Females: 87.30±7.18%, $p=0.440$, $d=-0.35$, 95% CI [-1.24, 0.53]) or GMed (Males: 96.29±2.01, Females: 97.22±2.78, $p=0.799$, $d=-0.37$, 95% CI [-1.26, 0.51]). Females self-reported higher discomfort scores during the GMax assessment (Males: 3.21±1.12cm, Females: 5.58±2.36cm, $p=0.017$, $d=-1.24$, 95% CI [-2.20, -0.27]) and GMed assessment (Males: 2.61±1.73, Females: 4.70±2.42, $p=0.049$, $d=-0.97$, 95% CI [-1.90, -0.04]) compared to males.

Conclusions: No differences in gluteal activation were seen between males or females when assessed by the SIB, suggesting it is an appropriate measure for men and women. The data provided are the first healthy data for GMax and GMed CAR between males and females. Females reported greater patient discomfort during both gluteal assessments than their male counterparts, on average 2.2 points greater on the visual analog scale, which could influence the CAR outcome. Future research should evaluate differences in the gluteal central activation ratio between healthy and pathological populations.

Total Word Count: 432

[209802EB](#)

Gluteus Maximus Corticomotor Excitability of Individuals With Chronic Ankle Instability: A Pilot Study

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Montgomery, Montgomery AL

Context: Individuals with CAI exhibit gluteal neuromuscular impairments attributed to CNS alterations. However, CNS changes affecting gluteal excitability have not been directly examined in those with CAI. Additionally, the influence of gluteal excitability on hip strength, balance, and self-reported function remain unexplored. Therefore, the purpose of this study was to compare gluteus maximus (GM) corticomotor excitability between individuals with and without CAI. Additionally, we aimed to examine associations between GM corticomotor excitability and hip strength, balance, and self-reported function. We hypothesized that individuals with CAI would have reduced GM corticomotor excitability compared to ankle sprain copers (COP) and healthy controls (CON). Additionally, we hypothesized that reduced GM corticomotor excitability would equate to lower hip strength, balance, and self-reported function.

Methods: We used a case-control design for this study. Thirty participants separated into CAI (F:7,M:3, 22.6±2.9yrs, 170.0±8.8cm, 69.3±12.6kg), COP (F:9,M:1, 23.2±2.6yrs, 165.1±4.0cm, 60.7±7.4kg), and CON (F:4,M:6, 22.7±2.3yrs, 173.1±8.4cm, 75.9±12.3kg) groups reported to the laboratory for a single session. Transcranial magnetic stimulation was used to collect GM corticomotor excitability measures of active motor threshold (AMT) and motor evoked potential (MEP). AMT represented the lowest TMS intensity required to evoke a measurable (>100 μ V) EMG response in 5/10 stimulations. After AMT was established, 5 stimulations were delivered at an intensity of 100% and 120% of AMT. Peak-to-peak EMG response represented the MEP (μ V). We assessed isometric hip extension, abduction, and external rotation strength with a hand-held dynamometer; balance via the SEBT; and self-reported function with the Foot and Ankle Ability Measure ADL (FAAM-ADL) and sport (FAAM-S) subscales. One-way ANOVAs tested group differences in AMT, MEPs, SEBT, and FAAM scores. One-way ANCOVAs controlling for sex tested group differences in hip strength. Associations between corticomotor excitability and hip strength, SEBT, and FAAM scores were tested with Pearson product moment correlations.

Results: CAI did not differ in AMT compared to CON (P=0.14) or COP (P=0.19). COP had an increased AMT compared to CON (P=0.04,d=1.77[0.31,2.96]). No groups differed in MEPs or hip strength. CAI had lower SEBT anterior (P=0.03,d=-1.33[-2.24,-0.31]), posterolateral (P=0.02,d=-1.59[-2.51,0.52]), posteromedial (P=0.02,d=-1.44[-2.36,-0.41]), and composite (P<0.01,d=-1.94[0.53,-2.90]) scores compared to COP. CAI had lower FAAM-ADL than COP (P = 0.05,d=-0.91[-1.79,0.00]) and CON (P=0.03,d=-1.02[-1.91,-0.05]) and lower FAAM-S scores than COP (P<0.01,d=-1.27[-2.17,-0.26]) and CON (P<0.01,d=-1.73[-2.67,-0.64]). There was a small correlation between AMT and SEBT-composite (r=0.47, P=0.04).

Conclusions: Individuals with CAI did not differ in GM corticomotor excitability compared to individuals without CAI. Ankle sprain copers' reduced corticomotor excitability might indicate that they limit excitability of the gluteals to promote usage of lower leg musculature. The lack of correlations between corticomotor excitability and clinical outcomes suggests that common measures of hip strength, dynamic balance, and self-reported function may not be representative of GM excitability alterations.

Total Word Count: 441

[207044ID](#)

Greater Helplessness and Lower Self-Efficacy are Associated With Deficits in Physical Function Across Recovery After ACLR

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Context: Learned helplessness (LH) is a psychological paradigm that develops in response to traumatic injury and neural reorganization^{1, 2}, such as after anterior cruciate ligament reconstruction (ACLR). LH is unique in that it proposes a physiological link between psychological and physical function, whereas other theoretical paradigms, such as self-efficacy, focuses on perceived abilities to successfully complete tasks.³ Both LH and self-efficacy have the ability to influence physical function; however, the relationship between LH, self-efficacy and physical function after ACLR remains unclear. To identify treatment approaches that clinicians can utilize to maximize physical performance after ACLR, a more thorough understanding of these psychological barriers to recovery is needed.

Methods: Ten individuals with a history of unilateral ACLR participated (age: 21.2±6y; height: 1.72±0.11m; mass: 76.88±13.74kg; gender: 6 males, 4 females; months post-surgery: 7.46±1.5) in a longitudinal study that took place at three time points after ACL injury (prior to surgery but after ACL injury, 3-months post-ACLR, time of clearance to return-to-play [RTP]). LH was measured using the ACL-helplessness index (ACL-HI) and self-efficacy was measured using the Knee Self-Efficacy Scale (K-SES). Quadriceps strength was assessed using maximal voluntary isometric contractions normalized to body mass (MVIC). Strength limb symmetry indices were calculated for clinical relevance. Hop distance on the triple hop (TrH) task was assessed at the RTP test session as a measure of clinical function. Pearson product moment correlations were used to determine associations between testing time points and self-reported measures of LH and self-efficacy, quadriceps function, and hop distance. An alpha level was set a priori at $P \leq 0.05$.

Results: Greater pre-surgical helplessness (ACL-HI) was associated with lower quadriceps strength at pre-surgery ($r = -0.70$, $p = 0.02$) and shorter hop distances ($r = -0.74$, $p = 0.03$) at RTP. Greater 3-month helplessness on the ACL-HI was also associated with lower quadricep strength ($r = -0.87$, $p = 0.005$) and less strength limb symmetry ($r = -0.92$, $p = 0.001$) at RTP. Lower pre-surgical self-efficacy was associated with greater pre-surgical helplessness (ACL-HI, $r = -0.86$, $p = 0.001$). Lastly, lower self-efficacy at 3-months was associated with worse strength ($r = 0.78$, $p = 0.01$) at 3-months and worse strength ($r = 0.74$, $p = 0.04$) and strength limb symmetry ($r = 0.82$, $p = 0.013$) at RTP.

Conclusions: Perceived helplessness and self-efficacy evaluated prior to surgery and at a clinically meaningful time point (3-months) after ACLR are strongly associated with future quadriceps strength and physical function. The relationship between LH and self-efficacy may further inform clinical practice. Those with lower self-efficacy (i.e. perceiving themselves as less able to successfully complete certain tasks) may go on to develop greater feelings of helplessness (i.e. persistent perception due to physiological changes that outcomes are not within their control). Reducing helplessness and improving perceived self-efficacy using cognitive behavioral therapies that emphasize learning goals, imagery and mindfulness early in recovery may help to promote improved physical outcomes after ACLR.

Total Word Count: 447

[209534LD](#)

Hamstrings-to-Quadriceps Strength Imbalance Associates With Coactivation During Walking Gait in Healthy Females

Norte GE, Gregoire M, Murray AM, Bouillon L, Glaviano NR: University of Toledo, Toledo, OH

Context: Thigh muscle imbalance is reported to affect knee injury risk by increasing shear loading at the joint. Healthy females with lesser hamstrings-to-quadriceps (H:Q) strength ratios are specifically vulnerable to knee joint injury. Coactivation of agonist and antagonist muscles occurs about any joint to provide dynamic stability and limit aberrant loading patterns, yet may be detrimental to long-term joint health if excessive. Our objective was to assess the relationships between the H:Q strength ratio and H:Q coactivation during walking gait in healthy females. We hypothesized that greater strength imbalance would associate with greater coactivation.

Methods: This descriptive laboratory study was performed in a university laboratory. Ten physically active, healthy females (age: 22.4 ± 1.2 years, height: 168.5 ± 5.1 cm, mass: 69.9 ± 6.6 kg) participated. The H:Q strength ratio was quantified using peak isokinetic hamstrings and quadriceps torque (5 repetitions at $60^\circ/\text{s}$). Surface electromyography (EMG) recorded vastus lateralis (VL), vastus medialis (VM), semitendinosus (ST), and biceps femoris (BF) activity during treadmill walking (1.34 m/s). Mean EMG amplitudes of each muscle were averaged from 15 strides over the first 15% of the gait cycle to represent the loading response, and normalized to their respective maximal voluntary isometric contraction amplitudes recorded prior to walking. Normalized EMG amplitudes were used to calculate coactivation indices: medial (ST/VM), lateral (BF/VL), and total (ST+BF/VM+VL). Pearson's r correlations were used to assess the relationships between H:Q strength ratio and coactivation indices. As an exploratory analysis, participants were stratified into HIGH (≥ 0.53) and LOW (< 0.53) groups using gender-normative H:Q strength ratio data, and coactivation indices were compared using independent t-tests and Cohen's d effect sizes.

Results: One participant was identified as an outlier (coactivation indices >10 SD above sample mean), and was removed from analysis. Lesser H:Q strength ratio associated with greater lateral coactivation ($r = -.66$, $p = .05$). Relationships were not observed for the medial ($r = .36$, $p = .34$) or total coactivation ($r = -.26$, $p = .51$) indices. Once stratified, participants with LOW H:Q strength ratios ($n = 5$) demonstrated greater lateral coactivation (0.96 ± 0.31 vs. 0.34 ± 0.38 , $p = .03$, $d = -1.8 [-3.4, -0.3]$) compared to those with HIGH H:Q strength ratios ($n = 4$) (Figure 1). No differences were observed between groups for the medial ($p = .37$) or total ($p = .36$) coactivation indices.

Conclusions: Healthy females with greater H:Q muscle imbalance (more quadriceps dominant) demonstrated greater coactivation in the lateral knee compartment during the loading response of walking gait. Females who fell below the gender-normative H:Q strength ratio demonstrated greater lateral coactivation. Increased compressive loading in the lateral compartment may suggest a compensatory strategy to counteract shear loading, which could be detrimental to joint health when extrapolated to steps taken over the lifetime.

Total Word Count: 445

205704CD

Head Acceleration in Collegiate Divers

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Context: Increased head acceleration at impact is related to concussion risk in collision sports. Yet much less is known about number of head impacts and head acceleration in non-collision sports, such as diving. Thus, the purpose of this study was to quantify the number of head impacts and magnitude of head acceleration during 1m and 3m dives in collegiate divers.

Methods: Three collegiate female divers (each 18 years old) from a NCAA Division I diving team underwent data collection at 10 off-season practices. During each practice, divers wore an instrumented latex swim cap capable of measuring acceleration in 3 dimensions (GENEActiv Action Accelerometer, Activinsights, Cambridgeshire, UK). The divers completed their normal practice routine on 1m and 3m springboards. At each practice session, a trained researcher recorded the number of dives, the springboard distance, the time of each dive, and the type of dive completed. A custom MATLAB code (Mathworks, Natick, MA), based on previous literature was developed. The MATLAB code created three-dimensional vector sum of the linear acceleration. Visual inspection of the timing of the recorded head impact was compared to the peak acceleration values. Once, the accuracy of the visualization was established, the code identified peak accelerations greater than 7g and separated by 30 seconds. The head impact accelerations were grouped based on dive type and springboard distance.

Results: 1271 dives were recorded and analyzed. Head acceleration at impact ranged from 24.1g to 33.3g for 1m dives and 31.6 g to 38.4g for 3m dives. A two-way ANOVA revealed no statistically significant interaction between dive type and distance on head acceleration at impact ($F(4,1261)=2.038$, $p=0.087$), yet simple main effects were observed for dive type ($p>0.001$) and distance ($p>0.001$). Overall, it was found that twisting and 3-meter dives had greatest head acceleration at impact.

Conclusions: The current data suggests diving athletes experience considerable amount of head impacts and head acceleration. The current results are based on 10 days of off-season practice. It would be of interest to examine how impacts change as a function of practice type and competition. These results indicated a need for more research examining head impact and head acceleration in non-collision sports and to understand the potential long-term effects of head impact in diving.

Total Word Count: 364

208972IA

Health Related Quality of Life in Adolescent Athletes Pre and Post and Musculoskeletal Injury

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Context: The impact an injury has on an adolescent athlete's health-related quality of life (HRQoL) is an important consideration during rehabilitation and in determine return-to-play readiness. Therefore, the purpose of this study was to measure HRQoL pre-injury, post-injury, and return-to-play.

Methods: This prospective cross-sectional study occurred in a high school athletic training facility in the Midwest. A convenience sample of 46 uninjured (26 males, 20 females, 15.20±0.96 years) adolescent athletes were recruited pre-injury. The 46 individuals were followed prospectively until a time-loss musculoskeletal injury was sustained. Fourteen individuals (9 males, 5 females, 15.71±0.82 years, 7.71±4.26 days missed from sports participation, 8 lower extremity injuries, 6 upper extremity injuries) participated in the injury portion of the study. All participants complete the Disablement in the Physically Active (DPA) at pre-injury. Those in the injury portion of the study completed the DPA at time of injury and return-to-play. The DPA has two sub-scales (mental and physical), and an overall score. For the injury portion of the study a multivariate repeated measures ANCOVA was conducted for the dependent variables DPA-mental, DPA-physical, DPA-total, the independent variable time (baseline [pre-injury], time of injury, and return-to-play), and the covariate days missed from sports participation. Bonferroni post hoc testing was used as needed to determine significant differences between time points. Alpha was set at $\alpha < 0.05$ for all analyses. Additionally, at the individual level a change score was calculated from baseline to time of injury and time of injury to return-to-play to compare to established minimally clinically important difference (MCIDs) for the DPA-total score.

Results: For individuals enrolled in the injury portion of the study the multivariate repeated measures ANOVA was significant for time ($F(2,12)=47.36$, $p=0.001$, $\eta^2=0.92$, $1-\beta=0.99$) but not the covariate days missed from sports participation ($p>0.05$). Follow-up univariate ANOVAs indicated that DPA-physical and DPA-total were significant for time ($p<0.05$). Post-hoc testing for the DPA-physical revealed a significant difference between baseline and time of injury (mean difference=21.14 [95% CI 16.08, 26.28], $p=0.001$) indicating worse scores following an injury. From time of injury to return-to-play the DPA-physical score returned to baseline levels (mean difference=20.36 [95% CI 14.44, 26.28], $p=0.001$) indicating no difference from baseline to return-to-play ($p>0.05$). Similar results were seen for the DPA-total. At the individual level, MCIDs for the DPA-total score, 100% ($n=14$) exceeded the MCID of 9. From time of injury to return-to-play 86% (12/14) exceeded the MCID of 9 indicating that these individuals had a true change from the treatment and/or rehabilitation of their injury.

Conclusions: A time-loss musculoskeletal injury reduced adolescent athlete HRQoL at the time of injury compared to baseline. However, following rehabilitation and treatment from an athletic trainer most athletes had a clinically meaningful improvement at return-to-play.

Total Word Count: 441

209324PA

Heat Tolerance Test Results Following A Runners First and Second Exertional Heat Stroke Episodes

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Background: A 62 year old male runner was diagnosed with a second exertional heat stroke (EHS) 4 years after his initial EHS, both occurring within the same 11.3km road race. This road race is renowned for the incidence of EHS (about 2 per 1,000 entrants) and history of a 100% survival rate for those treated at the medical tent, suggesting that this race may have a heat stress that is unique to most road races in the United States. His first EHS occurred at 59 years of age, with a finish time of 1:15 (h:mm), peak wet bulb globe temperature of 26.7°C, peak rectal temperature (Tr) of 41.78°C with mental status dysfunction. He was cooled immediately in a cold-water immersion tub for 16 minutes, until Tr reached 38.9°C and was discharged from the medical tent later that day. He continued to participate in this race for the next 3 years without incident. Four years later, at the age of 62, his second EHS occurred at the same race. He had a finish time of 1:11, peak wet bulb globe temperature of 25.1°C, peak rectal temperature (Tr) of 40.06°C with mental status dysfunction and was cooled in a cold-water immersion tub for 10 minutes, until Tr reached 38.5°C. In both instances the runner reported no use of any drugs or supplements. He also reported no history of EHS at any other time in his life. He has no personal or family history of malignant hyperthermia.

Differential Diagnosis: Hyponatremia, heat exhaustion, post exercise related syncope.

Intervention & Treatment: A heat tolerance test (HTT) and VO₂max assessment were performed 51 days following the first and 58 days following the second EHS episode. Results of these tests can be found in the table. The rate of Tr rise was over 3 times as fast in the second HTT than the first, leading ultimately to the failure of the HTT for the second test. The runner reported mental cognition returning to normal after 24 hours of recovery from the first EHS. After the second EHS he was having instances of sudden heat sensations, similar to the sensation of a fever, during daily life that was still ongoing.

Uniqueness: Repeated incidences of EHS are rare and sparsely documented in the literature. Additionally, these two EHS episodes occurred at the same event, within a relatively short period (4 years apart) and represent the only EHS episodes this athlete has experienced. Similarly, in depth documentation of repeated EHS incidences, treatments and recoveries within an individual has not been previously reported. This case study suggests that EHS victims who suffer multiple EHS events may require addition time for recovery. This is true even though this runner was treated with the gold standard of care, demonstrated success at returning to life and sport following his initial EHS for a significant period (3 years) and had a similar level of fitness for both EHS episodes.

Conclusions: This case report documented an inability to recover in a similar time course following a second EHS episode. Interestingly, the second EHS was diagnosed at a lower Tr, but at a time the athlete had a slightly higher fitness level. These data support the need to further investigate and understand the future heat illness risk for EHS victims, incidence of repeat EHS episodes and its implications on recovery, and examine the applicability of the HTT for runners and victims of multiple EHS episodes.

Total Word Count: 560

209435ED

History of Ankle Sprain and Functional Instability in U.S. Officer and Enlisted Service Members at Entry to Secondary Training

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Context: Ankle sprains (AnkSp) and residual instability in U.S. Service Members (SM) threaten military readiness. Identifying the incidence of previous AnkSp and residual symptoms in officer and enlisted populations can provide insight into susceptibility to future injury and dysfunction, and help inform injury risk mitigation strategies for these populations. The purpose of this study was to investigate the incidence of self-reported history of AnkSp (H-AnkSp) in SM entering secondary training (ST), and assess whether commissioning status (i.e. officer vs. enlisted), age, and previous participation in sports and/or organized physical activity (OPA) were associated with history of self-reported H-AnkSp. A secondary purpose was to assess whether service entry route, age, and previous OPA participation were associated with self-reported ankle “giving-way” episodes among individuals who reported a history of AnkSp.

Methods: Male U.S. officer and enlisted SM (n=771) were surveyed upon entry to their respective ST. Officers (n=296, age=25.5±2.5 years) and enlisted personnel (n=475, age=19.8±1.7 years) from similar entry-level training settings completed a questionnaire regarding their lifetime H-AnkSp and history of OPA participation. They were also asked the question “Within the past 6 months, have you felt that your ankles are not supporting you or are giving way?” Logistic regression was applied to investigate the influence of service entry route, age, and previous participation in OPA on H-AnkSp and on giving way episodes among individuals reporting H-AnkSp.

Results: 53.7% (n=159/296) of officers and 28.8% (n=137/475) of enlisted personnel reported previous AnkSp. Likewise, 53.7% (n=159/296) of officers and 70.1% (n=333/475) of enlisted personnel reported participating in OPA during college or high school. SM who were older (odds ratio: OR=1.1; 95% CI=1.02, 1.2; p=0.02), entered service as an officer (OR=1.9; 95% confidence interval [95% CI]=1.2, 3.2; p=0.01), and/or previously participated in OPA (OR=1.6; 95% CI=1.2, 2.3; p=0.004) were more likely to have reported an H-AnkSp prior to starting ST. Among officers with H-AnkSp, 18.9% (n=30/159) reported episodes of giving way. Among enlisted personnel with previous H-AnkSp, only 6.6% (n=9/137) reported episodes of giving way. Entering service as an officer (OR=5.9; 95%CI=1.8, 19.0; p=0.003) was associated with a greater likelihood of giving way episodes, but increasing age (OR=0.90; 95% CI=0.8, 1.1; p=0.20), and previous participation in OPA (OR=1.0; 95%CI=0.5, 2.1; p=0.99) were not.

Conclusions: H-AnkSp and giving way episodes prior to ST may influence likelihood of sustaining AnkSp and subsequent “giving way” during ST and/or throughout a military career. Implementing interventions to reduce functional deficits in individuals with H-AnkSp or giving way, such as balance training, may reduce incidence of AnkSp and/or giving way during and after ST. Such interventions may be of added importance in an officer population where H-AnkSp and giving way were more frequently reported than among enlisted personnel.

Total Word Count: 443

207985PB

Hydration and Physiological Measures of Heat Stress in High School Football Preseason Practice in the Heat

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Context: Despite the increased risk of heat illness in football players, data on physiological measures of heat stress and hydration in high school football players in hot, humid environments is scarce. The purpose of this study was to examine thermoregulatory and hydration measures of high school football players during preseason practices in a hot, humid environment. We hypothesized heat strain would be greater during initial practices and with the addition of equipment.

Methods: This observational field study took place at a local high school. A convenience sample consisted of 31 varsity football players (15.8±1.0y; 85.7±19.1 kg; 181.2±12.0cm). Data were collected across the first two weeks of preseason practices. Participants completed single practices on days 1-6, 8, 10 and 11 and twice daily on days 7 and 9. Data are presented for practices that occurred outside (Days 2, 6, 7AM, 7PM, 8, 10 and 11). Main outcome measures included: Gastrointestinal temperature (TGI), heart rate (HR), percent body mass loss (%BML), sweat rate (SR) urine color (Ucol), and urine specific gravity (Usg). Repeated measures ANOVA with Bonferroni post-hoc tests were performed for each dependent variable. Pre- to post-practice differences were compared with two-tailed paired samples t-tests. Significance was set at P<0.05.

Results: Mean wet bulb globe temperature (WBGT) was 31.3±1.8°C with a WBGTmax of 34.0±1.6°C. Day 11's early morning WBGT (28.4±2.5°C) was significantly lower than days 2 (33.1±0.9°C; P=.005), 7PM (32.3±2.0°C; P=.010), 8 (31.8±2.2°C; P=.040) and 10 (32.8±1.1°C; P=.006). Equipment worn varied by day (Table 1). Mean TGI (38.2±0.2°C) and TGImax (38.8±0.2°C) were significantly different across days (P=0.004). Maximum TGI on Day 2 (no equipment) was significantly lower than days where equipment was worn (6, 7AM, 7PM). Mean HR (127±5bpm) and HRmax (151±6bpm) were significantly different across days (P<.001). Mean and maximum HR on Day 10 was significantly lower than all other practices (P<.001). Percent BML was lower on the days with no equipment compared to practices with full equipment (P<.001) but similar to days in uppers (P>.05). Mean %BML (0.9±0.04%) ranged from 0.7-1.5%BML. Sweat rate (1.1±0.2L/h) was significantly different over time (P<.001). Day 7AM SR was significantly higher than all other days (P<.001) except Day 10. Pre-practice urinary measures indicated football players were not well hydrated at the start of practice with a mean Ucol of 4±1 and Usg of 1.020±0.005. Pre-practice mean Usg ranged from 1.018-1.023 across practices.

Conclusions: To our knowledge, this was the first study to report thermoregulatory and hydration responses in high school football players in a hot, humid environment. Although many of the athletes arrived at practice in a hypohydrated state, most were able to maintain <2%BML. The amount of equipment worn and variations in WBGT impacted physiological measures of heat strain. Practice activities should be modified based on environmental conditions, and physiological and hydration measures should be monitored when feasible to ensure football player safety in hot, humid environments.

Total Word Count: 444

[205083CA](#)

Identifying Effects of Concussion on Behavioral and Hemodynamic Changes Using Functional Near-Infrared Spectroscopy

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Context: Clinical post-concussion changes have been well-established using previously validated questionnaires and cognitive assessments, however the underlying neural deficits are not well understood. The purpose of this study was to measure differences in mean reaction time, mean accuracy, and hemoglobin response in acutely concussed participants (CON) compared to healthy controls (CTL) using functional near-infrared spectroscopy (fNIRS). We hypothesized that CON participants would demonstrate decreased accuracy, increased reaction time, and attenuated hemoglobin oxygenation levels compared to the CTL group.

Methods: Participants (CON: n=9, age=18.44±1.51 years, sex=66% female) who were diagnosed with a concussion at a Midwestern emergency department were recruited to participate in our study from 2018-2019. Exclusion criteria included study assessment >72 hours after injury, history of neurological disorders or brain surgery, learning disabilities, or opioid prescription/usage. CTL participants (n=22, age=23.63±4.55 years, sex=54% female) were recruited through electronic postings, flyers and classroom announcements. Upon the first lab visit, participants completed a demographic questionnaire, symptom severity inventory, and an attention assessment. Participants were then fitted for a silicon headband with two fNIRS diode arrangements consisting of eight emitters and ten detectors over each hemisphere's temporal and frontal cortices (Brodmann Area [BA] 38, 44, 45), superior and middle temporal regions (BA 21, 22, 21, 42) and parietal cortex (BA 40). During fNIRS neuroimaging, participants completed a computerized behavioral attention assessment as quickly and accurately as possible. Mean accuracy (%) and mean reaction time (s) were recorded for overall, congruent and incongruent trials, while changes in hemoglobin response during the attention task were recorded with fNIRS. Neuroimaging and behavioral data were analyzed using independent t-tests, and alpha threshold was set a priori at p<0.05.

Results: Preliminary analyses of behavioral data revealed significantly lower accuracy in the CON relative to the CTL groups (-1.885±0.554%, p=0.01), yet there were no significant group differences in the reaction time (0.059±0.049s, p=0.27). Analysis of fNIRS data indicated a significant increase in hemodynamic response during the attention task relative to the resting baseline in both groups (ps<0.05). However, this response was attenuated in the CON participants relative to the CTL group, especially in the left hemisphere's temporoparietal region (q<0.05, false discovery rate [FDR] corrected), and the right hemisphere's frontotemporal region and frontal lobe (qs<0.05, FDR corrected).

Conclusions: Consistent with previous literature, the CON group performed with less accuracy than the CTL group on the behavioral attention task, but maintained overall reaction time. Findings from fNIRS neuroimaging suggest the biological underpinnings may be related to altered hemodynamics. The hemodynamic response once symptoms resolve is unknown and warrants further investigation.

Total Word Count: 415

[206294ED](#)

Iliac Crest Apophysitis in a Female Collegiate Distance Runner

Merritt, NC: Furman University

Background: The subject is an 18-year-old, division one, female, distance runner (152.4cm, 48.99kg), with history of poor nutrition and right snapping hip syndrome, who experienced right glute and hip pain during her winter training. The patient contacted the athletic trainer over the winter break with pain in her right anterior and lateral hip forcing discontinuation of running and ambulation favoring her right lower extremity. The patient was prescribed rest, ice, and NSAIDs. Three days later, she could ambulate without pain in her right glute but had not returned to land running. When seen five days after injury, she reported pain in her right glute radiating down into her posterior right thigh. Upon evaluation, she was tender to palpation over the right gluteus maximus, gluteus medius and piriformis, and right proximal sartorius tendon. The patient presented with positive c-sign (complaints of pain deep in her right hip), pain when performing resisted external rotation (MMT: 4/5) and pain with right hip flexion past 110°.

Differential Diagnosis: Gluteus maximus strain, piriformis syndrome, proximal sartorius tendinitis, tensor fascia latae strain, acetabulum labral tear, stress fracture.

Intervention & Treatment: The patient was diagnosed with right piriformis tightness and right hip flexor strain and treated conservatively with ROM exercises, manual therapy, stretching, ice, therapeutic ultrasound, and therapeutic exercises to address ROM and strength deficits. This resulted in increased hip ROM to equal movement bilaterally without pain. Twelve days after first evaluation the patient reported a shooting pain from her right glute into her right posterior thigh, increasing with impact activities and hip flexion. X-ray imaging by team orthopedist revealed growth plates still present along the iliac crest with a slight area of fragmentation on the right vs. left. The physician diagnosed the patient with right iliac crest apophysitis, noting she was skeletally immature. The patient was instructed to cease athletic activity for 6 weeks. With oversight of the athletic trainer, the patient was consistent with therapeutic ultrasound and ROM exercises. At 6 weeks follow-up with the orthopedist, the patient still had tenderness to palpation of right iliac crest, and was advised to rest for 2 more weeks, with isometrics and core stability as tolerated. After 2 weeks, she progressed to 6 weeks of non-impact cardio in the pool, elliptical, and bike, discontinuing if she felt pain. Prior to summer vacation, the patient began running on the anti-gravity treadmill biweekly but continued with intermittent pain, ultimately resulting in her medical release from participation.

Uniqueness: The iliac crest apophysis is one of the last to close, with the average age of closure being age 16 in males and age 14 in females. Thus, the occurrence of apophysitis in late adolescence is rare. Iliac crest apophysitis results from repetitive activities of the muscles attached to the hip and is associated with runners, sprinters, dancers, soccer, and ice hockey players. Inflammation may resolve with proper rest and healing time, but additional stressors may prolong inflammation and damage the bony tissue. In this case, fragmentation of the iliac crest was noted on the radiology image. Nutritional problems in this patient may have predisposed her to this condition, resulting in late fusion of the apophysis.

Conclusions: Once diagnosed with iliac crest apophysitis, the patient rested, received treatment, and slowly returned to athletic activity as tolerated. She currently has no issues with ADL's and is pursuing competition in triathlons. Iliac crest apophysitis is difficult to diagnose and can be easily overlooked without radiographic imaging. This condition needs to be higher on the athletic trainer's differential diagnosis when there is not a specific mechanism of injury and the patient continues to have recurrent intermittent hip pain.

Total Word Count: 594

209762EA

Impact of Turnout Variance on Static Balance in Collegiate Classical Ballet Dancers

Ramos MA, McPherson AM, Docherty CL: Indiana University, Bloomington, Indiana.

Context: Research on classical ballet dancers has identified forced turnout as a possible risk factor for injuries, however little to no research has been conducted on how turnout (TO) affects balance. Therefore, the purpose of this study is to determine if the degree of TO impacts balance ability during classical ballet movements.

Methods: Twenty-two female ballet dancers volunteered to participate in this cross-sectional study (age: 19.86 ± 1.67 years; height: 167.91 ± 5.06 cm; weight: 55.79 ± 7.84 kg). Dancers were asked to perform three 30-second balance trials in three different classical ballet positions: first position, single leg passé, and single leg arabesque. Each of these ballet positions were completed in two different TO angles: 150 degrees and 130 degrees. Balance was measured using an AccuGait force plate (Advanced Mechanical Technology Inc, Watertown, MA). Degrees of TO were marked directly on the plate in protractor-like fashion. Center of pressure was captured during each balance task and 95% ellipse was calculated (NetForce Software [v.3.05.00], Advanced Mechanical Technology Inc, Watertown, MA). Each subject completed a post-participation questionnaire rating their perceived balance in each position and each TO level on a 5-point Likert scale (1 = least balanced, 5 = most balanced.) Two separate repeated measures analysis of variance were calculated, one for each dependent variable (95% ellipse data and balance perception). Tukey's post hoc test was applied to significant findings. Alpha level was set a priori at $p < 0.05$.

Results: Means and standard deviations are displayed in Table 1. Tukey post hoc analysis of 95% ellipse data revealed that dancers had better balance in 130° of TO compared to 150° while performing both passé ($p = .001$) and arabesque ($p = .039$). There was no significant difference in balance ability between the different degrees of TO in first position. For balance perception, Tukey post hoc analysis revealed that dancers perceived having better balance in 130° of TO compared to 150° for both first position ($p = .009$) and arabesque ($p < .001$). There was no significant difference in balance perception between the two levels of TO in passé.

Conclusions: Results of this study indicate that utilizing a higher degree of turnout negatively impacts a classical ballet dancer's balance. Few dancers can obtain 180 degrees of TO. Therefore, it might not be realistic to train and perform in such a high degree of TO. Instructors and choreographers should consider decreasing reliance on extreme levels of TO in order to increase the overall safety and longevity of the dancer.

Total Word Count: 407

205891BD

Incarcerated Umbilical Hernia in a Female Volleyball Athlete

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Background: The patient is a healthy 19-year-old collegiate volleyball athlete with no pertinent previous medical history. The patient reported to the athletic training staff on the afternoon of the first day of preseason practice with an unusual mass that presented as a small, firm, visible protrusion about 4 centimeters in diameter above her umbilicus. The patient denies the existence of this mass before practice that day. The patient reported that she felt a sharp pain in the midline of her upper abdomen during lumbar hyperextension of her serve. She continued practice without significant pain but returned two hours later, unable to flex or extend her spinal column without pain and was tender to palpate around and over the mass.

Differential Diagnosis: rectus sheath hernia, abdominal hematoma, incarcerated hernia, strangulated hernia, abdominal strain.

Intervention & Treatment: Due to the severity of the case, the patient was referred within 30 minutes to the team physician. The physician attempted to manually reduce the hernia but was unsuccessful due to the patient's increased pain. The tissue in the hernia needed to be identified that day in order to determine the threat that it posed to the patient. Since the hernia was not reduced and there was a chance that it could be strangulated intestine, the patient was then referred to the emergency department. Incarcerated hernias indicate tissue that is trapped outside of the abdominal cavity; these can become strangulated if the blood supply to the contents of the hernia becomes restricted, leading to intestinal perforation or other serious conditions. At the hospital, the hernia was evaluated using diagnostic ultrasound and CT scan to determine the contents. Intestine was ruled out indicating the probability that it was adipose tissue. The patient was diagnosed with an incarcerated umbilical hernia. Because the hernia was incarcerated, surgery was necessary to reduce it. The patient was taken to the emergency department on the same day of her injury and stayed that night in the hospital for surgery the next morning. Surgical intervention involved a small incision below the umbilicus and the removal of the herniated tissue. Mesh reinforcement was added to the site of the hernia to prevent re-occurrence. Due to the nature of the injury, the patient did not participate in any type of physical activity for the next four weeks and avoided contraction of the abdominal muscles. It was another six weeks before she was allowed to dive on the floor.

Uniqueness: Ventral hernias in the athletic population are uncommon. Of all hernia injuries in athletes, epigastric ventral hernias are one of the least common. Increased intra-abdominal pressure is recognized as a possible etiology of these injuries, but this mechanism is not commonly seen in sports not requiring heavy lifting.

Conclusions: A collegiate volleyball athlete presented with acute abdominal pain and was diagnosed with an incarcerated umbilical hernia. Early recognition and referral were key to a positive outcome for this patient. Although sports and inguinal hernias are fairly common injuries in the athletic population, ventral hernias are not. Knowledge and recognition of non-inguinal hernias is imperative for the evaluation of indeterminate abdominal pain. It is important that health care professionals are aware of the risk of strangulation resulting from abdominal hernias and act quickly to ensure the safety of their patients.

Total Word Count: 536

207371QD

Incoming Cadets Perception of Athletic Training

Cunningham, K., Nelson, S., Green, A.: Tarleton State University, Stephenville, Texas

Context: The purpose of this study is to identify cadets' knowledge about athletic trainers (AT's) upon entering the program. This study consisted of 84 incoming cadets at Tarleton State University, 6 participants were excluded due to being minors. Out of 78 participants, 47 were male and 31 were female.

Methods: Participants completed a 20 question survey. 15 out of the 20 questions were multiple-choice (yes, no, uncertain). 2 multiple-choice questions consisted of 4 answer choices (0-2, 3-4, 5-6, 7 or more injuries), and 3 questions were open ended.

Results: The frequencies of answers for each question were compared. Select questions were further analyzed by using an independent t-test or ANOVA. 100% of the cadets' answered "yes" to "I take the certified athletic trainer's recommendation seriously in regards to the recovery period of injuries." 87% of the cadets' answered "yes" to the statement "I perceive a certified athletic trainer as an appropriate or effective source for injury prevention." There was no significant difference in an independent t-test when comparing previous experience with an AT and the cadets' perception of AT as an effective source for injury rehabilitation, p-value of .257(95%CI [-.146, .504]). There was no significant difference in an ANOVA when comparing injuries that would have been seen by a medical professional and cadets' perception of AT as an effective source for injury examination and diagnosis, p-value .324 and was confirmed when using a Bonferroni post-hoc analysis. Similar analysis of other paired questions demonstrated no significant statistical difference between prior experience and cadets' current perception of ATs.

Conclusions: These results suggest that incoming cadets have a positive outlook of ATs. This study can lead to further investigation of corps of cadet perception of ATs and the use of ATs in military settings.

Total Word Count: 287

208343QD

Indiana Secondary School Athletic Directors Perceptions of Athletic Training Services and Influences on Hiring Athletic Trainers

Greffly TJ, Rivera MJ, Eberman LE: Indiana State University, Terre Haute, Indiana

Context: Research indicates that only 37% of secondary schools have access to full-time athletic trainers. Athletic directors (ADs) in the secondary school setting have a unique role in hiring athletic trainers (AT). Previous qualitative research identified barriers to hiring ATs in this setting; however, there is no research examining these findings on a larger scale. The purpose of this investigation was to examine ADs' perceptions on satisfaction of current care provided, factors influencing the hiring of ATs, and the roles and responsibilities of ATs.

Methods: We used a mixed methods design with an online survey (Qualtrics®, Provo, UT), which we distributed to Indiana secondary school ADs (n = 410) with publicly available emails. The survey remained open for 5 weeks with reminder emails sent weekly. We used a panel (n=2) with experience in survey research and/or the secondary school setting. The survey included both quantitative (7 items) and qualitative (8 items) data. Participants were asked to share their perceptions on the roles/responsibilities of ATs as well as experiences with the challenges, barriers, and benefits of hiring ATs in open-ended questions. We used Kruskal-Wallis one-way ANOVAs to compare employment status, type of employer, and school size on satisfaction. We coded the open-ended responses using inductive coding with multi-analyst triangulation and auditing to establish trustworthiness.

Results: A total of 72 ADs responded to the survey, of which 63 (16.5%) completed the questionnaire in its entirety (Table). We identified significant differences relative to employment status of the AT on satisfaction with overall care ($\chi^2=9.160$, $df=2$, $P=0.010$), whereby those with full-time athletic training services (mean=4.82±0.58) were more satisfied with care than those with per-diem (mean=4.40±0.55) or part-time services (mean=4.30±0.95). We also identified a significant difference in satisfaction of overall care between employer type ($\chi^2=9.798$, $df=2$, $p=0.007$), with ADs who have an AT hired by a hospital/clinic or a school system were more satisfied with overall care (mean=4.86±0.35). There was a significant difference between classifications of enrollment ($\chi^2=10.497$, $df=3$, $p=0.015$), where the smaller schools were least satisfied (n=7, mean=4.00±1.00). When asked about factors influencing the decision to provide services ADs reported liability, cost, and workload as major considerations. ADs stated that the roles and responsibilities of the AT included concussion management, rehabilitation, first aid, and the overall safety of the students.

Conclusions: ADs indicated ATs were well qualified to provide athletic healthcare and were satisfied with the care provided. As is consistent with previous research, financial challenges continue to play a role in the hiring of ATs. Access to qualified athletic healthcare continues to be a public health concern in America and all stakeholders should reconsider how to offer both a comprehensive athletics program and the healthcare needed to ensure safety in that participation.

Total Word Count: 445

[207553DD](#)

Individuals With ACL Reconstruction Spend Fewer Weekly Minutes in Moderate-to-Vigorous Intensity Step Accumulation Compared to Healthy Participants

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Context: Individuals with anterior cruciate ligament reconstruction (ACLR) are at elevated risk for knee osteoarthritis (OA). Minute-level step accumulation refers to the number of steps completed in a minute and is used to measure the intensity of ambulatory activity in free-living conditions outside of the clinical setting. Middle-aged individuals at high risk for OA who develop knee-related disability spend less time in moderate-to-vigorous intensity step accumulation compared to those who do not. It is unclear if ambulation intensity is diminished in individuals with ACLR despite their greater risk for OA development. Therefore, the purpose of this study was to compare step accumulation outcomes between individuals with and without ACLR.

Methods: This multisite, cross-sectional study in free-living conditions included participants with ACLR (N=57, age=20.9±3.2 years, BMI=24.4±3.6 kg/m², months since surgery=28.7±17.7) and without knee injury history (N=44, age=20.7±1.7 years, BMI=23.5±2.3 kg/m²). All participants were included if they were between the ages of 18 and 35 and had no history of lower extremity injury within 6 weeks. Participants with ACLR were excluded if they were more than 5 years after surgery or had a history of bilateral ACLRs. Participants were instructed to wear a physical activity accelerometer on the right hip during all waking hours for 7 days. Data were valid if monitor wear time spanned at least 10 hours/day over 4 days. Data were collected at 30 Hz and processed in 60 second epochs. We extracted mean steps/day, mean steps/minute, and maximum steps/minute. Steps/minute categorized from 60-79, 80-99, and 100-119 are associated with slow, medium, and brisk ambulation speeds, respectively. Additionally, steps/minute ≥100 and ≥130 are associated with achieving moderate-to-vigorous (3-6 METs) and vigorous (6 METs) of ambulation activity intensity. We calculated weekly time spent at each ambulation speed or intensity. Separate one-way ANCOVAs, controlling for participant height and wear time, were used to assess for significant differences and partial eta effect sizes were used to assess magnitude of effects between groups. Alpha was set to ≤0.05.

Results: Means, standard deviations, and partial eta effect sizes for each step accumulation outcome are reported in Table 1. Participants with ACLR took fewer mean steps/day (p=0.005) mean steps/minute (p=0.047) and spent less weekly time in moderate-to-vigorous step accumulation intensity (p=0.048) compared to healthy participants. Maximum steps/minute (p=0.995), and weekly time spent at slow (p=0.884), medium (p=0.564), brisk (p=0.182), or vigorous (p=0.095) step accumulations did not differ between groups.

Conclusions: Participants with ACLR participate in 40 minutes less moderate-to vigorous intensity step accumulations per week compared to those without knee injury history. After ACLR, less time spent in moderate-to-vigorous step accumulation may be a risk-factor for knee OA disability development. Diminished ambulatory activity intensity may be targeted with clinical interventions through consumer-grade activity monitoring technology.

Total Word Count: 446

207121MA

Individuals With Previous Exposure to Injury Prevention Programs Have More Positive Attitudes Towards Participating in Injury Prevention Programs than Those With No Previous Exposure

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Context: Past research has indicated that individuals with previous exposure (PE) to an Exercise-Related Injury Prevention Program (ERIPP) found it to be less challenging, more enjoyable, and beneficial than those with no previous exposure (NPE). Therefore, there is potential that there are differences in attitudes towards ERIPP participation between those with PE and those with NPE. If differences do exist, they may impact the implementation strategy for ERIPPs. Therefore, the purpose of this study was to determine if attitudes towards ERIPPs are different in participants who have had PE to ERIPPs and those who have NPE to ERIPPs.

Methods: The study design was cross-sectional where paper surveys were administered to the participants on one occasion. Fifty-five high school athletes (Male/Female: 36/19; Age=15.40±1.28years; Height: 166.29±10.17cm; Mass: 78.90±21.38kg; PE/NPE: 14/41) volunteered to participate in the study. Participants completed a paper version of the Theory of Planned Behavior Scale (TPBS) during pre-participation physical exams. The TPBS is used to assess attitudes towards participation in an ERIPP. The scale is composed of 5 subscales (perceived benefits, perceived barriers, social norms, social influence, and intention to participate). The TPBS contains 20 items with response choices ranging on a 7-point Likert scale from strongly agree (+3) to strongly disagree (-3). Positive scores would be interpreted as an increased likelihood to participate in an ERIPP for all subscales except the perceived benefits where a negative score would be interpreted as an increased likelihood to participate in an ERIPP. The psychometric properties of the TPBS have previously been confirmed within a physically active adult population. The independent variable was previous exposure to ERIPPs and the dependent variables were the subscales of the TPBS. Total scores and associated median and interquartile ranges were calculated for each subscale. Mann-Whitney U tests were used to detect differences in attitudes. Non-parametric effect sizes (ES) were calculated using the following equation (Z/\sqrt{n}). ES was interpreted as small (<0.10), moderate (<0.30), or large (<0.50). Alpha was set at $P<0.05$ for all analysis.

Results: Participants who had PE to ERIPP perceived statistically significantly more benefits (PE=14.00 (3.75), NPE=8.00(9.75), $P<0.001$, ES=-0.49), more social norms (PE=10.00 (6.50), NPE=6.50 (7.75), $P=0.04$, ES=-0.28), more social influences (PE=8.50 (3.75), NPE=3.00 (8.50), $P=0.01$, ES=-0.34) and intention to participate (PE=11.50 (6.50), NPE=6.00 (11.50), $P=0.03$, ES= -0.30) than those who had NPE with a small effect size. There were no other statistically significant differences ($P>0.05$).

Conclusions: Participants with PE to ERIPPs perceive more benefits, social influences, social norms, and intention to participate than participants who had NPE. Due to the differences in attitudes, implementation strategies for ERIPPs may need to focus on different factors for individuals with PE and NPE. There is a need to further explore effective implementation strategies.

Total Word Count: 443

[209482GA](#)

Influence of Elbow Stretch on Flexor Carpi Ulnaris Motor Neuron Pool Excitability in Healthy Males

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Context: Individuals who participate in overhead throwing activities are uniquely susceptible to injury due to disproportionately high valgus torque at the medial elbow, relative to what the static ligamentous structures can resist. Cadaveric studies suggest the flexor carpi ulnaris (FCU) significantly enhances joint stability. However, previous research suggests that capsular distention, or tissue stretch, reduces motor neuron availability to muscles surrounding a joint, thus inhibiting that muscle. If this occurs about the elbow in response to high joint loading during overhead throwing, it could implicate injury risk. Therefore, our objective was to investigate the influence of elbow stretch on FCU motor neuron pool excitability in healthy males.

Methods: We used a descriptive laboratory study to investigate 12 physically active, healthy adult males with a history of overhead sport participation (age: 23.6 ± 2.3 years, height: 181.8 ± 8.6 cm, mass: 71.6 ± 3.4 kg, Tegner: 5.3 ± 0.6). Independent variables included stretch condition (neutral, medium, high). Participants were seated upright in an isokinetic dynamometer with their dominant arm supported at the elbow and wrist. Full shoulder ROM was recorded, and appropriate joint angles were determined for each stretch condition: neutral (50% ROM), medium (75% ROM into external rotation), and high (90% ROM into external rotation). Dependent variables included maximum Hoffmann reflex (H-reflex), muscle response (M-response), and normalized H-reflex (H:M ratio). Electrical stimuli were delivered to the ulnar nerve proximal to the ulnar tunnel, and surface electromyography (EMG) recorded each dependent variable over the FCU using the H-reflex technique as described. To facilitate each response, participants maintained a standardized wrist flexion contraction (5% maximal effort) during testing. All testing occurred using random order of stretch conditions. The H-reflex, M-response, and H:M ratio were compared between stretch conditions using separate analyses of variance. Cohen's d effect sizes were used to quantify magnitude of observed differences.

Results: All stretch conditions significantly differed from one another (all $p < .05$): neutral ($90.4 \pm 31.4^\circ$), medium ($121.3 \pm 31.5^\circ$), and high ($152.2 \pm 33.2^\circ$). H-reflex was lower during high stretch compared to neutral condition (1.40 ± 1.14 vs. 2.56 ± 1.85 volts, $p = .049$, $d = 0.6$ [-0.4, 1.6]). However, M-response ($p = .52$) and H:M ratio ($p = .70$) did not differ between stretch conditions (Figure 1).

Conclusions: Although reflexive excitability (H-reflex) of the FCU appeared to lessen with increased stretch, it did not reduce the proportion of available motor neurons (H:M ratio) to the FCU in healthy males with a history of participation in overhead activities. It may be possible that our approach did not sufficiently stretch the elbow to produce a change in neural signaling from the joint. Alternatively, these data may suggest that healthy individuals are able to maintain adequate neural drive to the FCU during elbow joint stress, which may act as a protective mechanism from injury.

Total Word Count: 446

200033PA

Influence of Physical Characteristics on Thermoregulation and Predicted Heat Safety in Runners

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Context: Previous research examining predicted heat safety in runners participating in an outdoor, warm weather race showed that a modified heat tolerance test (HTTM) was not correlated with physiological measures (i.e., rectal temperature [TREC], thermal sensation, heart rate [HR]) during race day; however, the study did not examine the association of one's body surface area with these measures. Thus, our study set out to examine the relationship of thermal and cardiovascular responses to body surface area in recreational runners during a HTTM in an attempt to detect race day thermoregulatory safety.

Methods: Cross-sectional design. Laboratory and field setting. Fifty-one participants (n=28 males; n=23 females) over two years participated in the study (age 43±12y, body mass 68.72±13.66kg, body fat 19.52±6.35%, BSA 1.80±0.23m², VO₂max 45.33±8.49ml·kg⁻¹·min⁻¹). TREC, thermal sensation, and HR responses were obtained every five minutes during a HTTM (11.26km at 60% VO₂max, 2% incline; ambient temperature [TAMB] 26.6°C, relative humidity [RH] 50%, WBGT 23.42±0.77°C) ~two-weeks prior to an outdoor, warm weather race. The same physiological measures were then collected on race day both pre- and post-race (11.26km; TAMB 23.19±2.62°C, RH 83.75±7.32%, WBGT 25.23±1.71°C). Descriptive statistics and Pearson's product correlations were used to identify any significant correlations between variables. Significance was set a priori at p<0.05.

Results: BSA was significantly correlated with post-HTTM HR (R²=0.123, p=0.013), but was not associated with any other main physiological variable (i.e., post-race TREC, post-race HR, thermal sensation). However, TREC post-HTTM and post-race (R²=0.121, p=0.012), HR post-HTTM and post-race (R²=0.305, p<0.001), and thermal perception post-HTTM and post-race (R²=0.158, p=0.004) were all significantly correlated.

Conclusions: Thermal and cardiovascular responses during a laboratory HTTM were not associated with those same measures collected during an outdoor, warm weather race. Interestingly, all measures were significantly correlated from the HTTM to race day. While a great deal of thermal physiology would suggest that BSA influences thermal load and heat tolerance, these data do not support that association during a HTTM. Further research to specifically examine the role BSA plays in both laboratory and field settings is warranted.

Total Word Count: 331

[206433FA](#)

Influence of Rating of Perceived Exertion on Collegiate Cross-Country Athletes' Running Biomechanics

DeJong AF, Hertel J: University of Virginia, Charlottesville, VA.

Context: Wearable sensors can be used to measure biomechanical outcomes in runners' natural training environments for an estimate of external load. This information is important to consider in conjunction with the athletes' perception of bouts of exercise, or the internal load, to interpret biomechanical responses to training intensity. This information would lend valuable insight for clinicians and other stakeholders to recognize the physical burden associated with exercise intensity. Therefore, the purpose of this study was to compare biomechanical running outcomes across light, moderate, and hard intensity runs in a cohort of female collegiate cross-country runners. We hypothesized that with increased perceived exertion, athletes would present with increased loading, cadence, and stride length outcomes.

Methods: Twelve female Division 1 Cross-Country athletes (20 ± 2 years, 166.8 ± 5.1 cm, 57.9 ± 7.8 kg) participated in this prospective cohort study. Lace-mounted footpod sensors (RunScribe™, Half Moon Bay, CA) that have been previously validated were worn twice per week over six weeks of outdoor training during the competitive season. Participants completed Borg's 10-Point Rating of Perceived Exertion (RPE) scale following each run to determine the self-reported intensity. RPE outcomes were divided into tertiles for light (1-3), moderate (4-6), and hard (7-10) intensity runs. Step-by-step data for each run were extracted from all activities over the time period. Mean stride pace, stride length, cadence, shock, foot strike, and maximum pronation velocity were calculated for each individual run. One-way ANOVA's were used to compare all biomechanical outcomes across running intensity categories. Tukey's post-hoc analyses were conducted for significant findings. Alpha was set a priori to .05 for all analyses.

Results: Seventy total runs (25 light, 35 moderate, 10 hard) were included for analysis. There were significant main effects for stride pace ($F_{2,34}=20.94$, $p<.001$), stride length ($F_{2,32}=14.50$, $P<.001$), and shock ($F_{2,44}=5.29$, $P=.009$). Post-hoc analyses reflected that hard intensity runs had significantly higher stride paces (mean difference [MD]= 0.26 m/s, $P=.004$) and stride lengths (MD=0.21 m, $P<.001$, Figure) compared to light intensity runs; however, there were no notable differences between the hard to medium nor medium to light intensities. Hard intensity runs had significant higher shock than the medium intensity runs (MD=0.94 g, $p=.03$). There were no other notable findings across intensities for any outcome.

Conclusions: Higher intensity runs resulted in anticipated increases in stride pace and stride length. Logically, intensity relates to speed demands which is reflective of the increased spatiotemporal outcomes. However, loading was only increased from moderate to hard intensities. As increased loading has been found to relate to running-related injury, this may help to inform clinical decision-making for activity modifications in regards to injury risk or recovery. Our results highlight the importance of quantifying individual training responses and biomechanics to inform patient-centered interventions.

Total Word Count: 440

[209742FD](#)

Influence of Sagittal Trunk Position on Lower Extremity Muscle Activation in Runners

Frymier A, Murray A, Bouillon L, Norte GE, Glaviano NR: The University of Toledo, Toledo, OH

Context: The incidence of lower extremity injuries in runners stretches as high as 79.3%. Weakness or insufficient coordination of the quadriceps and gluteal muscles can lead to overuse injury and promote proximal adaptations in movement, such as increased trunk flexion. The trunk accounts for roughly 50% of a person's mass and changes in orientation can alter the mechanical demands that are placed on the lower extremity. Sagittal plane posture is associated with patellofemoral joint stress and greater trunk flexion may increase the action of the hip extensors. However, there is a lack of evidence quantifying lower extremity muscle activation when altering sagittal trunk position. The objective was to determine the effects of trunk flexion position on lower extremity electromyography (EMG) measures in a healthy running population.

Methods: This descriptive study was performed in a university laboratory. Eighteen (10 female, 8 male) healthy, recreational runners (age: 23.8 ± 3.1 , height: 173.9 ± 6.4 cm, mass: 68.7 ± 10.0 kg, miles per week: 18.2 ± 7.2 , Tegner activity scale: 6.5 ± 0.9) participated. The independent variable was trunk position (preferred, self-selected flexion, and self-selected extension). The dependent variables were EMG activation of the quadriceps, gluteus maximus, hamstrings, and erector spinae (ES) Maximum voluntary isometric contractions (MVIC) were performed first for EMG normalization. Participants completed five successful running trials for each of the trunk positions. Trials were considered successful if the participant landed with their dominant leg completely in the force plate within $3.4 \text{ m/s} \pm 5\%$. The preferred position was completed first, and the flexed and extended positions were randomized. Mean muscle activity throughout the complete stance phase of the running trials was assessed relative to peak EMG activity of the MVIC trials. Muscle activation was analyzed using separate ANOVAs with Tukey post-hoc testing. The mean sagittal trunk, hip, and knee kinematics were plotted across the stance phase with their associated 90% confidence intervals. Significance for kinematic variables were set as confidence intervals that did not overlap.

Results: Muscle activation of the quadriceps and hamstrings did not differ across the trunk positions, $p > 0.05$. Gluteus maximus activity was significantly greater ($p = .006$) in the flexed position ($45.06 \pm 13.36\%$) compared to the extended position ($30.72 \pm 12.47\%$). ES activation was significantly greater ($p = .003$) in the extended position ($34.78 \pm 14.86\%$) than the preferred position ($20.50 \pm 10.66\%$). Self-selected trunk positions during running resulted in changes in sagittal plane trunk kinematics during both the flexed and extended trials. (Figure 1). There were no significant differences in sagittal hip or knee kinematics across the three positions.

Conclusions: Sagittal plane trunk positioning influenced on gluteus maximus and ES muscle activity during free running. Clinicians may consider incorporating a more forward lean as one strategy to increase gluteal muscle activity. Future research should evaluate if altering trunk flexion influences lower extremity muscle activation in pathological subgroups.

Total Word Count: 444

209284MD

Instructor Versus Feedback Manikin Assessment of CPR Skills

Evans EI, Bradney DA, Gould H, Walker J: The University of Lynchburg.

Context: Healthcare professionals perform high quality cardiopulmonary resuscitation (CPR) to increase the odds of patient survival during cardiac arrest. Accurate assessment and feedback are required for acquisition and enhancement of CPR. If CPR instructors lack the ability to accurately assess CPR skills, objective assessment would be required for accurate feedback. This research compares instructors' assessment of CPR skills to objective assessment of these skills. CPR teaching experience (number of years and classes taught per year) was also examined as possible predictors of assessment accuracy.

Methods: In a quantitative cross-sectional experimental design, 33 CPR instructors, were recruited to assess six 2-minute pre-recorded videos of 2-person CPR. The 6 videos contained 5 adult CPR skills each, for a total of 30 skills. The instructors had the option to watch each video twice. The skills assessed (dependent variables) in this study were components of high quality CPR according to the American Heart Association (AHA), which include chest compression rate (compressions/min), chest compression depth (mm), full chest recoil (adequate or inadequate), hand placement (correct or incorrect), and ventilation volume (mL). The instructors' subjective assessment measures were compared to Laerdal Resusci-Anne® Q CPR feedback manikin measures. Instructors assessed chest compressions per minute (rate) with a specific number while the other skills were assessed as a percentage of high quality skill performance between 0% and 100%.

A one sample t-test was used to compare the participants' subjective data to the manikin data. A multiple linear regression was used to determine if either independent variable (years of CPR teaching experience or average number of CPR classes taught per year) were predictive factors in accuracy of assessment (dependent variable).

Results: 25 out of the 30 (83%) skills assessed were different ($P < .05$). The table shows the t-test results as well as specific manikin (objective) data for each skill per video. Videos 3 and 6 contained only high quality skills (no errors), yet the assessment results between participants and manikin were different ($P < .05$). Instructors' ability to accurately assess CPR skills could not be predicted by CPR instructor teaching experience in years and classes taught ($P < .05$).

Conclusions: Our results suggest that CPR instructors not only have a difficult time detecting errors with CPR skills but also are challenged with identifying high quality CPR skills. Since January of 2019, the American Heart Association (AHA) has required objective measurements of adult chest compression depth and chest compression rate with a feedback device. Our findings not only support this requirement, but also indicate the need for objective feedback with other life-saving CPR skills.

Total Word Count: 416

208753CD

Intentions for Stakeholders to Intervene Following a Suspected Concussion in Collegiate-Sport Athletes

Anderson MN, Weber Rawlins ML, Miller LS, Courson R, Reifsteck F, Schmidt JD

Context: Approximately 50% of all sport-related concussions at the collegiate level go unreported and reasons for failing to disclose a potential concussion are still unclear. However, stakeholders such as parents, athletic administrators, coaches, and sports medicine professionals do play a role in concussion recognition and reporting. Each of these groups have a different role in an athletes' life, assesses the value of reporting a concussion differently, and could intervene to instruct or encourage athletes to seek care for a suspected concussion. In order to improve concussion reporting, we must identify factors that contribute to stakeholders' intentions to intervene when they observe a possible concussion. The purpose of this study is to compare groups of stakeholders intentions to intervene following a suspected concussion in collegiate-aged athletes

Methods: Stakeholders (parents (n=16), athletic administrators (n=4), coaches (n=52), and sports medicine professionals (n=28) from three universities in the state of Georgia were invited to complete a concussion education module via Qualtrics (Qualtrics Lab, Inc., Provo, UT) in the Fall of 2018 (female=46%). Stakeholders completed a 26-item questionnaire developed using the bystander intervention model that included a 7-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). The survey consisted of five sections: failure to intervene due to skills deficit, audience inhibition, failure to notice, failure to identify a situation as high risk, and responsibility. Due to the data being non-normally distributed, a series of Kruskal-Wallis H-tests were conducted to determine if there were significant differences in sub-scores between stakeholder groups with subsequent Mann-Whitney U ($\alpha=0.05$) tests to determine which specific groups were significantly different.

Results: We found significant group differences between all stakeholder groups and sub-scores (failure to intervene due to skills deficit: $p<0.01$; audience inhibition: $p<0.01$; failure to notice: $p<0.01$; failure to identify a situation as high risk: $p<0.05$; responsibility: $p<0.01$). The most significant differences in bystander intervention outcomes were between sports medicine professionals and coaches for all five sub-scores ($p<0.01$). Sports medicine professionals had overall significantly greater bystander intervention intentions than all other stakeholder groups for all five sub-scores ($p<0.05$). Additionally, there were significant differences between coaches and parents for audience inhibition ($p<0.05$).

Conclusions: Sports medicine professionals reported higher bystander intervention intentions for each of the five categories compared to other stakeholders. Future educational interventions should be created to specifically target parents and coaches in order to increase their bystander intentions to intervene on a suspected concussion which, in turn, may increase the number of athletes who seek care following a concussion.

Total Word Count: 408

208631CD

Interleukin-6 Concentrations are Not Affected by Concussion History, Lifetime Incidence, or Recency in Special Operations Forces Combat Soldiers

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Context: Interleukin-6 (IL-6) is a neurotrophic cytokine expressed in neurons and glia. It is involved in the neuroinflammatory response following concussion; however, there are mixed findings around its effects and relationship to concussion given IL-6's pro- and anti-inflammatory properties. The purpose of this study was to investigate the effect of concussion history, lifetime incidence, and recency on IL-6 concentrations in Special Operations Forces (SOF) combat soldiers.

Methods: We enrolled 140 male SOF combat soldiers (age=33.5±3.6 yrs) in this cross-sectional study. Participants were asked to self-report concussion history (no, yes), lifetime incidence (0, 1, 2, 3+), and recency (<1 month, <1 year, ≥1 year). Fasted blood samples were obtained from an antecubital vein at a standardized time point. Serum was separated and frozen until analysis. Sample vials for each soldier were checked, thawed out, vortexed 10 seconds, and centrifuged at 3000 RPM for 15 min. Supernatant was extracted and used for the assays to determine IL-6 serum concentration. Samples were run in duplicate and the mean values used for analysis. Median and interquartile ranges (IQRs) are reported because IL-6 serum concentrations are not normally distributed. A Wilcoxon rank-sum analysis compared IL-6 concentrations between those with and without concussion history. Separate Kruskal-Wallis tests compared IL-6 concentrations across concussion lifetime incidence and recency groups.

Results: Sixty-five SOF combat soldiers reported no concussion history, while 75 reported a concussion history [median (IQR) lifetime incidence = 3 (2.75)]. We did not observe differences in IL-6 concentrations ($z=0.97$, $p=0.33$) between those with (median=1.10 pg/mL, IQR=1.38) and without (median=1.28 pg/mL, IQR=0.92) concussion history. There was no effect of concussion lifetime incidence ($\chi^2(3)=1.41$, $p=0.70$) or recency ($\chi^2(2)=0.08$, $p=0.96$) on serum IL-6 concentrations. Serum IL-6 concentration values and group level sample sizes for all analyses appear in Table 1.

Conclusions: Interleukin-6 does not appear to be a sensitive long-term physiological blood biomarker in SOF combat soldiers given the lack of differential findings in our study. Further studying this population acutely following injury may provide insights into post-concussion neurophysiology impairments that exist in a population that sustains repetitive subclinical injury exposures. Translating this work to future civilian athlete studies may provide valuable insights for athletic trainers working with collision sport athletes.

Total Word Count: 357

207195LD

Inter-Rater Reliability of a Novel Movement Assessment Performed on Overhead Throwing Athletes

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Context: Movement assessments that evaluate dynamic symmetry and postural control allow for the identification of specific deficits that can guide corrective exercise programs. Movement assessments such as the Functional Movement Screen and Y-balance test have been found to have good inter-rater reliability. A new movement assessment which features ground based movements has been developed and tests the postural control of the front functional oblique myofascial kinetic chain (front shoulder to opposite hip adductor) and back functional oblique myofascial kinetic chain (posterior shoulder to opposite glut). The purpose of this study was to assess the inter-rater reliability of this new movement assessment.

Methods: The raters for this reliability study included: 1 expert rater (6 years of experience using the assessment), 2 novice raters (4 hours of training with the assessment). Raters used the assessment to evaluate 38 college overhead throwing athletes in an indoor training facility during their fall season (23 Division I baseball players [age= 20.0±1.38 years]; 15 Division I softball players [age= 19.93± 1.28 years]). Participants were placed in a prone quadruped position with their knees 1 inch off the ground (beast position) and were asked to stabilize the position with a fixed right hand and fixed left foot (RHLF) while the other limbs are lifted for 5 seconds, and then with a fixed left hand and fixed right foot (LHRF). Next, participants were placed in a supine quadruped position with their buttocks 1 inch off the ground (crab position) and are asked to stabilize contralateral limbs (RHLF and LHRF) while the other limbs were lifted for 5 seconds. Each position was scored (1=poor, 2=fair, or 3=good) based on the compensations made during the test. All raters stood 1.5 meters at a 45 degree angle from the participants performing the assessment and individually scored the performances. The dependent variables were the scores of the assessments: beast RHLF, beast LHRF, crab RHLF, and crab LHRF. Intraclass Correlation Coefficient (ICC) was used to determine inter-rater reliability among scores for the movement assessments. Significance levels were set to $p \leq 0.05$. We operationally defined the level of reliability as good reliability greater than or equal to 0.75, moderate reliability between 0.50 and 0.74, and poor reliability up to 0.49.

Results: There was good inter-rater reliability of beast LHRF (ICC=0.781, $p=0.001$). There was moderate inter-rater reliability of beast RHLF (ICC=0.607, $p=0.017$), crab RHLF (ICC=0.741, $p=0.001$), crab LHRF (ICC=0.580, $p=0.025$).

Conclusions: We found moderate to good inter-rater reliability of the of the beast and crab movement assessment. It may be useful by clinicians for identifying stability in the functional oblique myofascial kinetic chains. Perhaps inter-rater reliability would improve if the the novice testers received more training.

Total Word Count: 436

2005240D

Intramuscular Heating Rates of a Chattanooga Intellect Legend XT® Therapeutic Ultrasound with a 3 MHz Frequency and 1.0 W/cm² Intensity at Three Depths up to 2.5 cm.

Smith M, Gange K, Hackney K, Blodgett-Salafia E: North Dakota State University, (Fargo, ND)

Context: Current textbook parameters for thermal ultrasound are based on previous research using the Omnisound unit. Variations in heating rates have been observed among different manufacturers. However, no published studies have been performed regarding the heating rates of the Chattanooga Intellect® ultrasound unit. Therefore, the objective of the study was to determine the rate of tissue temperature increase of the medial triceps surae using the Chattanooga Intellect® Legend XT ultrasound unit.

Methods: A 3 x 4 repeated measures factorial design was used for this study. The independent variables were tissue depth (1, 1.75, 2.5 cm) and time (baseline, 5, 10, end). The study was conducted in a research laboratory. Twenty-five healthy volunteers (F=14, M=11; age 22.04 ± 2.67 years; adipose thickness = 0.53 ± 0.15 cm) participated in the study. Three thermocouples were inserted into the medial triceps surae at 1.0, 1.75 and 2.5 cm depths. Then, a 3 MHz, 1.0 W/cm² ultrasound treatment was performed for 15 minutes using the Chattanooga Intellect® Legend XT unit. The treatment was performed until all depths reached a 4°C increase, the subject reported discomfort, or the 15 minute treatment time expired.

Results: The 1.0 cm depth increased 4.10 °C in 6 minutes (0.68°C/min rate), the 1.75 cm depth increased 4.17°C in 8 minutes (0.52°C/min rate), and the 2.5 cm depth increased 3.07°C in 15 minutes (0.20°C/min rate). A significant main effect of depth ($F(1.56, 35.82 = 79.64, P = 0.003)$) and time ($F(1.75, 40.23 = 487.05, P = 0.026)$) occurred. In addition, a significant interaction existed between times and depths ($F(2.46, 56.61 = 19.52, P < 0.001)$).

Conclusions: Heating rates varied at each depth and differed from the rates stated in textbooks. The 1.0 cm depth is the only depth that heated at rates similar to textbook information. It is not feasible to reach specific temperature goals at tissue depths below 1.0 cm using textbook parameters with the Chattanooga Intellect® unit.

Total Word Count: 316

[2084230D](#)

Intramuscular Temperature of Rectus Femoris During and After Cold-Water Immersion: A Gender Comparison

Kim Y*, Rech N*, Talin L*, Bressel E*, Dolny D*: *Utah State University, Logan, UT.

Context: Cryotherapy, specifically cold-water immersion (CWI), is a widely used post-exercise therapeutic modality to minimize fatigue, expedite recovery, and treat exercise induced muscle damage by slowing blood flow, nerve conduction velocity, and suppressing cellular metabolism. Several gender-based differences, such as body composition and adipose distribution, have been suggested as potential factors influencing the rate of tissue cooling. However, gender comparisons of intramuscular temperature change during and after CWI has received minimal attention in the literature. The purpose of the current study was to compare intramuscular cooling rates during and after CWI following moderate-intensity exercise between males and females. A secondary purpose was to investigate the correlation between intramuscular cooling rate, adipose thickness, body fat percentage, and body mass index (BMI) in each gender group.

Methods: Sixteen healthy adults, including eight males (age: 24.5 ± 2.6 yrs, mass: 96.3 ± 16.3 kg, anterior thigh adipose thickness: 0.9 ± 0.3 cm, body fat: $17.7 \pm 5.6\%$) and eight females (age: 24.0 ± 0.8 yrs, mass: 65.5 ± 8.0 kg, anterior thigh adipose thickness: 1.3 ± 0.3 cm, body fat: $26.4 \pm 6.9\%$), participated in this cross-sectional study conducted in a sports medicine facility with a dedicated polar-plunge pool. Following 30-min of moderate-intensity stationary bicycle exercise, participants received a CWI treatment (10°C ; iliac crest depth) until either intramuscular thigh (rectus femoris) temperature (2 cm sub-adipose) decreased 7°C below pre-exercise level or until 30 min was reached. Temperature was recorded every 30 sec for all phases of the protocol using implantable fine-wire thermocouples and until the intramuscular tissue began to rewarm. An ANOVA was performed to examine differences in cooling rate over time and between genders. Cohen's d was used to assess the meaningfulness of any differences and Pearson correlations were used to assess the relationship among the following variables: Intramuscular cooling rate, adipose thickness, body fat percentage, and BMI for each gender. The alpha was set to .05.

Results: There was a significant difference in the intramuscular temperature change after CWI between males and females ($-1.1 \pm 0.6^\circ\text{C}$; $-2.3 \pm 1.1^\circ\text{C}$; $p=.02$; $d=1.14$); whereas no significant differences in cooling rate during CWI ($0.3 \pm 0.2^\circ\text{C}/\text{min}$; $0.2 \pm 0.1^\circ\text{C}/\text{min}$; $p=.07$; $d=0.90$) and post-CWI cooling time (12.7 ± 8.0 min; 33.4 ± 27.8 min; $p=.06$; $d=0.92$) were observed. The cooling rate during CWI had a significant negative correlation with body fat percentage (male: $r=-.83$, $p=.01$, female: $r=-.73$, $p=.02$), adipose thickness (male: $r=-.84$, $p=.01$, female: $r=-.69$, $p=.03$), and BMI (male: $r=-.75$, $p=.02$, female: $r=-.69$, $p=.03$).

Conclusions: After moderate-intensity exercise, CWI cooled intramuscular tissue of the rectus femoris at a comparable rate regardless of gender. Additionally, females presented greater intramuscular cooling after the termination of CWI than males, which may be attributable to the greater adipose thickness of females. The data presented here suggests CWI treatment protocols should consider gender, adipose thickness, body fat percentage, and BMI when prescribing CWI for the purpose of changing intramuscular thigh temperature.

Total Word Count: 441

[207381LD](#)

Intra-Session and Inter-Session Reliability of the Trunk and Hip Strength Measurements Using the Portable Tension Dynamometer

Garza EA, Dugan KN, Oyama S: Department of Kinesiology, Health, and Nutrition, University of Texas San Antonio, San Antonio, TX

Context: Trunk/pelvis is an important link between the upper and lower extremities. Therefore, assessing strength of the trunk and hip muscles that control the segments is clinically meaningful. However, difficulty in securing the resistance to the trunk segment without a specialized harness is a challenge when assessing trunk strength. While an isokinetic dynamometer with a special attachment can be used to measure trunk strength, the equipment is expensive and not portable. Therefore, the purpose of the study was to test the reliability of the simple trunk and hip strength measures that utilize a bar, straps, and a portable tension dynamometer.

Methods: Twenty college-age individuals (10 males / 10 females, age=20.9±3.7years, height=1.68±0.10m, mass=67.8±10.9kg) participated in the study. The participants attended two sessions in the research lab, one week apart. The participants' trunk flexion, rotation, and hip abduction strength (Figure) were measured at each session. For trunk strength tests, the participants laid supine on a treatment table with hip flexed 45°. A bar with straps attached to the dynamometer was placed over their chest at an axillary level, and was held in place by the participants. Trunk flexion strength was measured as the peak force recorded by the dynamometer as the participants attempted to lift their torso, as if performing a crunch, with a maximal effort. Trunk rotation strength was measured as the participants attempted to lift their shoulder towards the contralateral hip, as if performing an oblique crunch. Hip abduction strength was measured with participants lying on their side with the leg on top (testing limb) extended, and the bottom knee flexed 90°. The strap was attached to the ankle, and was adjusted to become taut when the testing limb was horizontal. The hip abduction strength was measured as the participants abducted their hip against the strap. The measurements were taken three times or until 2 consistent (±1lb.) values were recorded. The forces were normalized to the participant's body weight (BW). The first 2 measures from both sessions were used to calculate the intra-session reliability, and the averages from the 2 sessions were used to calculate the inter-session reliability. The reliability was evaluated through calculation of the intra-class correlation coefficients (ICC_{2,k}) and the standard error of measurements (SEM) (=Standard deviation*sqrt(1-ICC)).

Results: The intra-session ICC_{2,k} (SEM) for trunk flexion, rotation, and hip abduction were .837(5.2%BW), .978(1.3%BW), and .955(1.0%BW), respectively. The inter-session reliability for trunk flexion, rotation, and hip abduction were .871(4.3%BW), .801(3.8%BW), and .894(1.5%BW), respectively.

Conclusions: Overall, the measures of trunk and hip abduction strengths are highly repeatable within a session. The reliability of the measures between sessions were also good with relatively small SEM. The tests described in this study can be used to assess changes in trunk/hip strength over time.

Total Word Count: 446

208642BD

Investigating the Relationship Between Self-Efficacy and Cardiopulmonary Resuscitation Quality in Certified Athletic Trainers

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Context: For certified Athletic Trainers (ATC's) to provide high-quality CPR, factors that impact CPR performance must be identified to improve patient outcomes attributed to sudden cardiac arrest. Though self-efficacy is one factor that has been shown to impact the performance of CPR in doctors and nurses, there have been no studies involving ATCs. The primary purpose of this study was to investigate the relationship between self-efficacy and CPR quality in ATCs.

Methods: This was a mixed-methods design including both survey and objective data at a mid-sized research university. A convenience sample of 33 ATCs (M = 31.06 ± 11.07 years; females = 19, males = 14) with experience ranging from 1 to 30 years volunteered. The independent variable were participant responses to a modified version of the Basic Resuscitation Skills Self-Efficacy Scale created by Hernandez-Padilla et al. This was a pre-post test design where participants completed the self-efficacy questionnaire before and after performing single-rescuer CPR in accordance with the 2015 American Heart Association CPR guidelines for 8 minutes and 59 seconds. CPR was performed on a Resusci Anne® Q CPR Manikin, and objective measures of CPR quality were measured via Laerdal SkillReporter software. Pearson product-moment correlations were computed between self-efficacy and 11 dependent variables consisting of CPR parameters.

Results: Results from the self-efficacy questionnaire suggest ATCs are confident in their ability to perform high-quality CPR (M = 5.091 ± .678). After performing CPR, ATC confidence increased (M = 5.273 ± 0.761) though the observed increase in self-efficacy was not statistically significant. Although overall CPR self-efficacy was high, several CPR parameters such as percentage of adequate ventilations (M = 42.303 ± 30.570) were low. In general, chest compression depth was adequate (M = 52.030 ± 4.510 cm), and overall CPR quality was 80.061 ± 17.927%. A forward-stepwise regression model always selected self-efficacy score as the only independent predictor of overall CPR quality compared to other factors such as age, gender, BMI, and years of experience. Pearson product-moment correlations between overall self-efficacy and 11 CPR performance variables suggest there is no statistical significance at the 5% level. What is notable, however, is the prevalence of negative correlations, implying that greater levels of self-efficacy and emergency generally leads to worse performance measures. Specifics related to CPR parameters and self-efficacy can be found in Table 1.

Conclusions: Overall, ATCs are very confident in their ability to perform high-quality CPR. However, this high CPR self-efficacy is not always reflected in CPR performance. Further research involving larger sample sizes must be conducted to determine whether the relationship between CPR self-efficacy and CPR performance in ATCs is statistically significant to warrant discussions focused on updating CPR education to include confidence-building activities.

Total Word Count: 438

209173QD

Investigation of Athletic Trainers Self-Reported Uses of Electronic Medical Records Systems in the Collegiate Settings

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Context: Athletic training governing bodies suggest quality patient medical records lead to quality patient care. Currently, there are health care initiatives written and enacted to increase meaningful use of electronic health information as a tool to improve health outcomes, but information of patient documentation through electronic medical records (EMR) systems and meaningful use is lacking in the field of athletic training. Therefore, the purpose of this study is to investigate how athletic trainers (ATs) in the collegiate settings are using EMR systems in their current practice.

Methods: We developed a 43-item questionnaire that was validated and pilot studied based off of current best practice documentation strategies. The tool included 9 demographic questions, 22 items for participants to specify how often they document in their EMR system on a 6-point Likert scale (1=I do not document this information in my EMR; 2=I do not know how to document this information in EMR; Not available in my EMR; 3=Not available in my EMR; 4=Almost never; 5=Sometimes; 6=Almost every time) and 12 follow-up reasons EMR documentation occurred, which only appeared for those who indicated they documented the aspects in their EMR. Reasons for documentation included: to demonstrate value to stakeholders, provide information to other providers, provider information to patients, provide information to parents/guardians, track patient progress, plan future patient care, bill insurance, provide legal protection, legal obligation, and/or other. This web-based survey was distributed to 4733 collegiate ATs through the National Athletic Trainers' Association via email with 3 subsequent follow-up reminders (n=367/4733, response rate=7.9%; n=341/367, completion rate=92.9%). Descriptive statistics were used to identify measures of central tendency and variability.

Results: Participants (14+/-10 years of experience; 126+/-138 patients; 7+/-8 different athletic teams; 8+/-10 coworkers) primarily worked in NCAA DI (n=128/376, 34.8%) with their highest degree earned among participants being a professional master's (222/367, 60.4%). The most commonly used EMR systems were Sportsware© (145, 39.5%) and Athletic Trainer System® (93, 25.3%). A large majority of ATs indicated documenting initial evaluations (344/367, 83.7%), follow-up evaluations (256/367, 69.7%), discharge/return-to-participation (267/367, 72.7%), interventions (241/367, 65.7%), and communication with supervising physicians (171/367, 45.6%) "almost every time" in their EMR systems. ATs indicated tracking patient progress, legal obligation, and legal protection were the most common reasons for documenting initial evaluations, follow-up evaluations, discharge/return-to-participation, interventions, and communicating with supervising physicians (Figure).

Conclusions: Despite previous research, which indicated that ATs are not frequently completing medical documentation, our study findings indicate ATs in the collegiate settings document more frequently than previously thought and they typically use EMR systems to document patient care. Reasons for the high usage of EMR systems may be due to their level of education, ease of access for EMR documentation, or institutional standards/ policies.

Total Word Count: 441

[206634AD](#)

Iron Deficiency Anemia Induced Peripheral Neuropathy in an Adolescent Athlete: A Level 4 Rare Events CASE Study

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Background: A 15-year-old African-American female basketball player (height:188cm; mass:62.6 kg) presented to the athletic trainer complaining of bilateral quadricep “tightness, heaviness, and numbness.” The athlete is of low socioeconomic status and has no previous history of lower extremity injury. The athlete stated that the sensations worsened with increased physical activity and subsided with rest. Upon evaluation, the athlete presented with limited hip flexion and hip extension, but did not present with palpable tenderness, strength deficits, neurological deficits, or positive special tests. The athlete was instructed to complete a daily lower extremity stretching program, specific to the quadriceps, hamstrings, and hip flexors, for four weeks. Femoral nerve glides and instrument assisted soft tissue mobilization for the quadriceps were gradually incorporated. Upon no improvement of symptoms, the athlete was referred to a primary care physician for further evaluation and testing.

Differential Diagnosis: Differential diagnoses included lower extremity muscle tightness and exertional compartment syndrome of the quadriceps femoris. Due to personal and family history, the possibility of a cardiovascular deficiency or multiple sclerosis was also considered.

Intervention & Treatment: A complete blood count revealed reduced hemoglobin (10.3 g/dL) and ferritin levels (7 µg/dL). The flag reference ranges for hemoglobin and ferritin are 10.8-14.5 g/dL and 7-84 µg/dL, respectively. With such low hemoglobin levels, which met diagnostic criteria for anemia (< 12 g/dL in menstruating women), the athlete was diagnosed with Iron Deficiency Anemia (IDA). She was prescribed 235 mg of Ferrous Sulfate 2x daily for a minimum of 6 weeks. Additionally, the athlete was encouraged to increase her consumption of iron-rich foods, such as red meat, poultry, dark green leafy vegetables, and eggs, to improve her natural intake of iron. Within two months of beginning oral iron therapy and after making adjustments to her diet, the athlete felt relief of symptoms and had improved hemoglobin (12.5 g/dL) and ferritin levels (37 µg/dL).

Uniqueness: Iron deficiency is considered the most common nutritional deficiency in the world. However, IDA is only present in approximately 9% of adolescent females and is frequently asymptomatic. Risk factors that increase susceptibility of suffering from IDA may include race and socioeconomic status. Furthermore, peripheral neuropathy symptoms are not frequently associated with IDA, but are traditionally a result of traumatic physical injury with symptoms most commonly occurring more distally on the body (i.e. feet) rather than proximally (i.e. quadriceps and hamstring musculature).

Conclusions: The investigation of IDA as a cause of peripheral neuropathy symptoms in individuals that may be at high risk of IDA should be further explored. As an athletic trainer, it is important to be aware of personal and environmental risk factors that may predispose patients to IDA. Athletic trainers play a pivotal role in timely referral for general medical conditions and adequate knowledge of this condition could expedite the referral process for athletes who may be at increased risk of nutritional deficiency.

Total Word Count: 466

[208991GD](#)

Isolated Intramuscular Tear of the Triceps Medial Head in a Collegiate Football Athlete

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Background: A triceps tear is an uncommon injury usually involving a rupture of the triceps tendon. While triceps tendon ruptures are infrequent, intramuscular disruption of the triceps brachii is exceptionally rare. Previous research reports only 1 in 1,014 cases of muscle and tendon injuries involve solely the medial triceps head. In this scenario, the patient suffered an intramuscular partial tear of the medial head of the triceps brachii muscle non-tendinous.

Patient: This is a Level 3 Exploration CASE study of a 21-year-old male redshirt junior with 12 years of experience playing football at quarterback. Mechanism of injury was a direct blow to the superior right elbow joint on the posterior side. Pain was initially rated as a 6 on a 0-10 pain scale, which subsided shortly after injury; however patient reported decreased accuracy while throwing the football. Patient denied past history of triceps injuries. Upon inspection, a deformity in the medial head was present and swelling was noted; muscle was tender to palpation, no neurological irregularities were noted. Initial clinical diagnosis by the Certified Athletic Trainer was a triceps contusion. Patient was referred to a physician for further evaluation which revealed mild swelling and a notable defect in the medial triceps. Range of motion was within normal limits for active elbow flexion and extension bilaterally; manual muscle testing revealed 4/5 elbow extension on the right elbow. Valgus/Varus stress testing was negative for pain and laxity. Vascular tests on brachial and radial pulses were graded as "2+" bilaterally. At two days post-injury, an MRI revealed a linear grade 2 posterior triceps muscle belly tear approximately 12cm from the distal triceps tendon insertion on the olecranon process and extending down to the myotendinous junction without tendon disruption. Prominent surrounding muscle edema and subcutaneous/perifascial edema was also noted, however no acute bony pathology or elbow joint effusion was found. Final diagnosis was deemed a "Medial head of the triceps intramuscular partial tear non-tendinous". There is no available data on similar triceps injuries in quarterbacks so the prognosis for returning back to sport-specific activities was uncertain.

Intervention & Treatment: This injury was treated conservatively and resolved at 20 weeks post-injury following 7 weeks of being in an elbow brace and 13 weeks of rehabilitation exercises.

Outcomes or Other Comparisons: Athlete verbally reports feeling 100% in right arm and indicates no difference in throwing technique or accuracy. However, a noticeable divot is still present at the site of injury.

Conclusions: This case is an irregular presentation due to the presence of an isolated tear to the medial head of the triceps brachii. Differential diagnoses from this case include triceps brachii contusion, right elbow pain, pain on right humerus and a traumatic rupture of right triceps tendon. Final diagnosis of this injury was made from an MRI. When diagnosing this type of injury, we encourage athletic trainers to look for the presence of a deformity within the muscle belly. Research supports this claim noting the characteristic features of intramuscular triceps tears as inability or weakness of elbow extension and a palpable gap in the muscle. Tendon injury can be excluded if the tendon is not tender to palpation. Surgery is not required and good prognosis is shown with conservative care. Based on this case, throwing athletes suffering from intramuscular triceps tears can return to sport following rehabilitation with no functional limitations.

Clinical Bottom Line: The presence of a deformity in the muscle coupled with weakness of elbow extension are key factors in diagnosing intramuscular triceps tears.

Total Word Count: 567

204925GD

Isolated Scapular Body Fracture in a High School Football Player

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Background: A 16 year-old high school football player reported that as he was tackled his posterior shoulder was driven directly into the ground with multiple players landing on top of him. On initial exam there was no obvious deformity or swelling but demonstrated full but painful shoulder ROM for flexion and abduction which diminished as his pain level became intensified. Severe point tenderness noted to the lateral scapular border. Special test for glenohumeral instability were negative as were tests for the acromioclavicular and sternoclavicular joints. There was no clavicle pain and no paresthesia noted. The athlete did note some upper thoracic and rib cage discomfort associated with the trauma. Both vital signs and breath sounds were within normal limits. The athlete was treated with ice and placed in a shoulder sling with instructions to follow-up with the team physician the following day.

Differential Diagnosis: Shoulder contusion, rib fracture, glenohumeral sprain, acromioclavicular joint sprain, occult clavicle fracture and scapular fracture.

Intervention & Treatment: The athlete was seen by the primary care sports medicine physician and x-rays revealed a fracture to the scapula extending from the lateral border through the scapular body to the medial border. A confirmatory CT scan corroborated the initial radiographs for scapular body fracture. The athlete was instructed to continue wearing the sling for the next 4 weeks and was given a prescription for tramadol and permitted to take ibuprofen. At two weeks post-trauma he was permitted and encouraged to begin elbow, hand and wrist ROM as his pain levels decreased. Follow-up treatments included hot packs to aid in reducing pain and soreness. Four weeks post-trauma revealed significant fracture site healing and the athlete was instructed to begin progressive upper extremity rehabilitation exercises. At eight weeks he returned to all weight room and football related activities without incident.

Uniqueness: Nine studies encompassing ten cases of scapular fracture sustained during sporting events have been identified in the literature with acute trauma responsible for 70% of the fractures. The scapula has large muscular coverage and thus fractures are uncommon and account for no more than .5% of all shoulder girdle injuries and no more than 1% of all fractures. Scapular fractures are commonly associated with high energy forces and blunt trauma impacts such as motor vehicle accidents and falls from various heights. Scapula fractures will often have accompanied injuries to the chest and head. Direct trauma to the scapula leads to fractures of the scapular body, spine or the acromion. Indirect trauma that pulls or levers the arm will result in fractures of the glenoid fossa or scapular neck. Complications of scapular fractures include altered shoulder girdle dysfunction, rotator cuff dysfunction or impingement and scapulothoracic dyskinesia.

Conclusions: Fractures of the scapula body are normally treated in a nonoperative manner with little functional loss. Conservative treatment results in 86% of scapular fractures have excellent to good outcomes and results. More than 90% of scapular fractures are non-displaced or moderately displaced and thus can be treated conservatively. The treatment goal of scapular body fractures is to rest and allow healing to occur and then begin rehabilitation therapy. It is imperative to achieve full active and passive motion as soon as tolerable to decrease adhesion development in the scapulorthoracic joint. This case illustrates the appropriate evaluation, conservative treatment and care leading to complete resolution of an isolated scapular body fracture. The athlete is currently asymptomatic and has returned to all athletic and daily living activities.

Total Word Count: 564

209674CD

Kinesiophobia is Unrelated to Acute Musculoskeletal Injury Incidence Post-Concussion

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Context: Previous evidence suggests that collegiate athletes with a history of concussion may have an increased risk of musculoskeletal injury (MSK), but psychological factors such as kinesiophobia have yet to be explored in relation to MSK. The objective of this study was to compare Tampa Scale of Kinesiophobia (TSK) scores of collegiate athletes diagnosed with a concussion and then who did or did not have an acute MSK within 180 days of return to play (RTP).

Methods: Thirty-two Division I collegiate athletes (24 males, 8 females) with an average age of 19.5 ± 1.26 years, height of 184.7 ± 8.52 cm, and mass of 99.9 ± 21.43 kg participated in the current study. Participants completed the TSK upon reporting symptom-free in regards to their diagnosed concussion. Participants were then divided into two groups dependent on a subsequent musculoskeletal injury following RTP from their diagnosed concussion. In subjects where more than one MSK occurred our analysis included the first injury chronologically. The first group (MSK, age: 19.1 ± 1.10 years, height: 185.4 ± 8.87 cm, mass: 101.8 ± 23.24 kg) suffered an acute MSK within 180 days of RTP. The average days between RTP from concussion and injury was 87.9 ± 52.58 days. Participants in the MSK group were matched to subjects (control) by sex, age (19.9 ± 1.35 years), sport, position, height (183.9 ± 8.49 cm) and mass (98.1 ± 20.30 kg). The control group was also matched to the MSK group based on days of practice following RTP. Independent t-tests were used to compare group demographic data and TSK outcome scores. Analyses were performed with $\alpha=0.05$.

Results: No differences were observed for any of the demographic variables ($p < 0.05$). No difference was observed between the MSK group (32.2 ± 5.90) and the control group (29.8 ± 3.36) in terms of the TSK outcome score. Of observed injuries, 76% occurred in the lower extremity with the majority being ligament sprains (41%) and muscle strains (24%); the remaining injuries included acute tendon inflammation, an elbow dislocation and a meniscus tear.

Conclusions: Our findings indicate that collegiate athletes that experience an acute MSK following RTP from concussion have no difference in kinesiophobia compared to athletes who do not suffer a MSK. While previous research found that high TSK scores may associate with poor vestibular/ocular function, TSK scores in our sample appear to be unrelated to musculoskeletal injury after RTP. Psychological factors must be considered when returning an athlete to sport following a diagnosed concussion, however, our results suggest that kinesiophobia is not linked to musculoskeletal injury rate following concussion.

Total Word Count: 398

[206761QA](#)

Knowledge and Perception of Cannabis Amongst Health Care Students

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Context: The purpose of this study was to identify knowledge and perceptions pertaining to cannabis (Hemp, CBD, marijuana) among students enrolled in different health care disciplines. As the amount of widely advertised information on cannabis continues to grow, it is likely healthcare providers will face questions from patients on its use and safety.

Methods: A web-based survey design was used; we emailed program directors in a college of nursing and health sciences requesting they forward a survey link to their students. Due to limited prior research on the topic, we developed and piloted the tool. Participants answered 8 questions, responses were completed anonymously and voluntarily. Disciplines included: athletic training (AT), occupational therapy (OT), physical therapy (PT), health services administration (HSA), communication sciences and disorders (CSD), undergraduate (UN) and graduate nursing (GN).

Results: A total of 112 students completed the survey. Whilst a majority of students (74.1%, n=83) agreed or strongly agreed it was important for their discipline to better understand cannabis and its impact on their profession, 86.6% (n=97) of respondents had not received any cannabis education. Most (84.8%, n= 95) students believe cannabis education should be included in their current curriculum. However, only 15 participants (13.4%) had received formal education on cannabis via elective or program required courses. Despite lack of formal education, 40.2% (n=45) of students agreed or strongly agreed that they would feel comfortable and confident educating their patients on cannabis products. There was a significant difference in the level of comfort and confidence in educating their patients on cannabis products between those who received formal education (M= 2.15, SD=1.07) and those who did not (M=3.00, SD=1.42); $t(108)=2.07$, $p=0.041$. Almost all respondents (94.6%, n= 106) believe cannabis products should be legal for either medicinal purposes only (35.7%, n=40) or both recreational and medicinal purposes (58.9%, n=66).

Conclusions: Cannabis products used to treat medical conditions have garnered much attention over recent years and information is often spread through mainstream outlets. Patients may be misinformed or confused and healthcare providers should be utilized as a reliable resource. The results of this survey identified a knowledge gap regarding the education on cannabis amongst students in different health care programs, demonstrating a need for curricular exposure to principles of the endocannabinoid system and cannabis as an intervention. This consideration is especially relevant as the majority of respondents support cannabis legalization and believe it will impact their profession. It is important for health care providers to understand pharmacology, pharmacokinetics, evolving regulations, and use of cannabis as an intervention for medical conditions. Future research is necessary to identify curricular content and clinical implications. Specifically, AT's should be educated on cannabis products, especially CBD, due to the increasing use in the physically active population.

Total Word Count: 446

[208475FA](#)

Lateral Ankle Complex Hysteresis in Individuals With Chronic Ankle Instability

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Context: Ligaments exhibit viscoelastic behaviors, but injury, such as ankle sprain, may alter those properties in the lateral ankle complex. Inadequate ligament healing and altered biomechanical behaviors may be factors in perpetuating Chronic Ankle Instability (CAI). Hysteresis, representing the change in the area under the loading and unloading phases of a load-displacement curve, may reflect changes in tissue properties after injury, providing insight to facilitate appropriate evaluation and healing. The purpose of this preliminary study was to determine if hysteresis was altered in individuals with CAI compared to uninjured controls. We hypothesized the CAI group would demonstrate reduced hysteresis.

Methods: This cross-sectional study was completed in a biomechanics laboratory. Volunteer recreationally active individuals were categorized into 2 groups and pair-matched. The CAI group (3 males, 5 females; age 22.6 ± 2.7 yr; height 171.1 ± 5.7 cm; mass 78.0 ± 10.9 kg) reported at least 1 moderate-severe ankle sprain at least 1 year ago, ≥ 2 episodes of “giving way” at the ankle, and Cumberland Ankle Instability Tool (CAIT) score ≤ 24 indicating poor function. The CON group (3 males, 5 females; age 22.4 ± 5.0 yr; height 166.9 ± 8.2 cm; mass 68.1 ± 16.5 kg) had no history of ankle injury and CAIT scores ≥ 28 indicating good function. Participants underwent 3 successful trials of an anterior drawer test, loading to 15dN, on the lowest scoring limb in CAI and matched limb in controls, via an instrumented arthrometer (LigMaster, version 1.26, Sport Tech, Inc., Charlottesville, VA, USA). Participant position and instructions were standardized, and a single rater’s reliability was established prior to testing as >0.80 . Loading (Energy Absorption, EA) and unloading (Energy Restitution, ER) load-displacement curves were extracted. The area under each curve (AUC) was approximated using the trapezoidal rule. Hysteresis was calculated as the difference between the AUC of EA-ER. A Dissipation Coefficient (DC) was calculated as $(EA-ER)/EA$. The average of the last 2 trials was calculated. Independent samples t-tests were used to determine group differences ($\alpha < 0.05$).

Results: The CAI group demonstrated a trend toward reduced hysteresis (67.4 ± 17.1 vs. 102.7 ± 44.5 dN•mm; $p=0.06$; $d=1.05$; $1-\beta=0.50$) and significantly lower DC (0.40 ± 0.05 vs 0.47 ± 0.08 ; $p=0.04$; $d=1.05$; $1-\beta=0.50$). There were no group differences in age, mass or height ($p > 0.05$).

Conclusions: Reduced hysteresis and DC may indicate diminished ability of the lateral ankle complex to respond to a load. Impaired structures may provide inadequate static support or altered sensory signals, making viscoelastic behaviors important in evaluating the healing process and clinical pathway after injury. Future research may focus on the role of viscosity and hysteresis in subtypes of CAI and its relation to self-reported function.

Total Word Count: 408

208395ED

Leg Pain in a High School Athlete

Jacobs, D; Straughn, C; Kaiser, K

Background: A 16-year-old high school football and track runner reported to the AT after 1-week of pain in his right hamstring. He stated he was sprinting and felt a “tearing sensation” in his hamstring. The AT noted swelling in the hamstring and the patient was treated with ice and a compression wrap. Due to pain with ambulation and sitting in certain positions, the patient was referred to the sports medicine clinic. During clinical exam, the patient denied any prior history of hamstring injury or back pain. His knee ROM was normal, with pain with flexion and full extension. The extremity was neurologically intact and distal pulses normal. Inspection of the posterior thigh revealed swelling at the mid-belly of the hamstring, without ecchymosis or deformity in the area. Strength was 5/5 for quadriceps and hamstrings. He was able to perform a prone straight leg raise, which was painful at mid-belly of the hamstring. He reported he had been taking NSAIDs and icing the area. X-rays were normal. The patient was instructed to use crutches when walking and to continue the ice and compression over the injured area. He was given a prescription of anti-inflammatory and physical therapy and told to return to clinic in 1 month. Due to another health issue, he did not report to the clinic until 2-months post-injury. The patient complained of a “football” sized mass in mid-bell hamstring. Examination revealed full pain-free ROM. A diagnostic ultrasound was performed to inspect the mass in the hamstring. The ultrasound showed coagulated blood and some fluid superficially along hamstring. The hamstring tendons appeared normal proximally off ischium as well as distally at the knee. An MRI was ordered to rule out hematoma vs tendon rupture.

Differential Diagnosis: 1) Hamstring contusion 2) Hamstring Strain 3) Piriformis syndrome 4) Complete tear of the hamstring tendon proximally.

Intervention & Treatment: The MRI revealed a complete tear of the long head of the bicep femoris tendon, proximal to its origin from the ischial tuberosity. The patient was referred to a hip specialist for further evaluation and treatment. At 3-months post-injury the hip specialist recommended non-operative treatment since for now it was a chronic hamstring injury and the patient was functional. Surgery was discussed, only if physical therapy and rest did not improve the function of the patient’s hamstring. At this time it was recommended to continue physical therapy including hip, core and lower extremity strengthening. At 5-months post-injury he began jogging. At 6-months the patient progressed running intensity. He was sprinting 6.5 months post-injury. At this time, he was released to full activities without restrictions.

Uniqueness: A complete rupture of the Biceps Femoris is a rare injury. The biceps femoris is the dominant flexor of the lower leg and a dynamic stabilizer of the knee making it the most common muscle injured in the hamstrings. The recovery of this injury is unpredictable, can be prolonged, and re-injury is common. Biceps femoris tendon injuries frequently result in a significantly longer recovery time than injuries that do not involve the tendon.

Conclusions: If biceps femoris injuries do not receive proper treatment, weakness, pain and sciatic neuralgia may occur. The biceps femoris has a high recurrence of re-injury. Surgical treatment may be recommended for complete biceps femoris rupture; however, this case demonstrates that non-operative treatment can provide a positive outcome.

Total Word Count: 545

[209563LD](#)

Limb Differences in Hamstring Muscle Function and Morphology 2-9 Years After Anterior Cruciate Ligament Reconstruction

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Context: Current rehabilitation strategies following anterior cruciate ligament reconstruction (ACLR) place heavy emphasis on restoring quadriceps strength, atrophy, and improving neuromuscular deficits, such as voluntary activation. Recovery of these outcomes are commonly evaluated using inter-limb differences to determine the magnitude of asymmetry between the injured and contralateral limbs. However, research evaluating alterations in the hamstring musculature is lacking, hindering the development of evidence-based treatment approaches. Our purpose was to compare inter-limb differences in hamstring strength, volume, and muscle activity between patients with ACLR and healthy controls.

Methods: We used a cross-sectional design in a research laboratory to investigate patients after primary, unilateral ACLR (5M/6F; 22.6±1.9yrs; 167.4±7.9cm; 66.3±12.3kg; 69.5±22.5 months from surgery; 9 patellar tendon /2 hamstring tendon) and matched healthy controls (5M/6F; 23.3±1.7yrs; 168.6±10.4cm; 66.3±12.7kg). The independent variable was group (ACLR, control). The hamstring muscles were individually traced to determine the volume of the semimembranosus (SM), semitendinosus (ST), biceps femoris long head (BFLH) and short head (BFSH) using MRI. Following the MRI, peak semitendinosus and biceps femoris muscle activity was assessed using surface electromyography (EMG) during the landing phase (first 250 ms) of a single leg hop for distance (SLH). The mean EMG amplitude of the three trials was then normalized by the peak EMG amplitude across all three SLH trials. Peak isokinetic hamstring torque was recorded from 3 concentric contractions at 60 and 240 deg/sec, and normalized to body mass (Nm/kg). Percent limb-differences (%LD) were calculated between limbs for each outcome measure ($(|ACLR\ limb - contralateral\ limb| / highest\ value) \times 100$), with higher values representing greater asymmetry between limbs. Independent t-tests were used to compare %LD values between groups ($\alpha=0.05$). Cohen's d effect sizes with associated 95% confidence intervals were calculated to quantify the magnitude of group differences.

Results: Means and standard deviations for %LD values, and effect sizes are reported in Table 1. The ACLR group demonstrated greater %LD values for ST EMG (ACLR: 32.4±21.1%, control: 16.3±12.1%, $p=0.040$; $d=0.94$, $CI=0.06-1.82$), BFSH volume (ACLR: 12.0±6.5%, control: 6.0±4.6%, $p=.021$; $d=1.07$, $CI=0.18-1.97$), and ST volume (ACLR: 15.1±14.9%, control: 3.6±2.7%, $p=0.029$; $d=1.07$, $CI=0.18-1.97$) compared to healthy controls. No differences were observed between groups for LH EMG, isokinetic torque, BFLH and SM muscle volume.

Conclusions: The ACLR group displayed greater asymmetries in ST EMG, BFSH and ST muscle volume when compared to healthy controls. Reductions in activation and muscle volume may produce an unstable environment for the knee joint during functional tasks. Less activity of the hamstrings could result in greater preferential contraction of the quadriceps and increased ACL strain due to excessive anterior tibial translation during single-leg landing. Rehabilitation should place emphasis on exercises that enhance hamstring activation and muscle volume to minimize the potential for early fatiguing and reinjury during physical activity.

Total Word Count: 446

207412HB

Long Term Effects of Pitching on Muscle Characteristics of the Scapular Stabilizers in Professional Baseball Players

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Context: The deceleration phase of pitching results in forces up to 1.5 times bodyweight on the shoulder. The posterior scapular stabilizers play a major role in the absorption of these forces. Interestingly, these muscles are designed to function with low load and velocity. However, in the deceleration phase of pitching these muscles are required to function with high load and velocity. Chronic eccentric loading is demonstrated to cause muscular adaptations in the lower extremity. Therefore, the purpose of the study was to determine the chronic adaptations of the scapular muscles and the relationship with glenohumeral adaptations in professional pitchers.

Methods: A cross-sectional design was used to assess 1 independent variable: arm (dominance and non-dominance) and 3 dependent variables: muscle thickness and isometric strength of the upper trapezius (UT), middle trapezius (MT), lower trapezius (LT), rhomboid major (R-maj), rhomboid minor (R-min), and humeral retroversion (HR). Twenty-eight male professional baseball pitchers (aged 22.07, 2.09 years; mass 94.56, 16.92 kg; height 190.22, 7.21 cm) were included. A Microfet hand-held dynamometer (HHD) (Hoggan Health Industries, Draper, Utah) was used to measure strength during a maximum voluntary isometric contraction of the UT, MT, LT, R-maj, and R-min. A M-Turbo Ultrasound System Scanner with a 15-MHz linear-array transducer (FujiFilm Sonosite Inc. Bothel, WA, USA) collected UT, MT, LT, R-maj, and R-min muscle images and thickness was measured with ImageJ software. A digital inclinometer (SPI Swiss Precision Instruments, Garden Grove, CA) and ultrasound unit were used to measure HR. Paired sample t-tests were used to compare dominant and non-dominant strength and muscle thickness measurements. Pearson correlation coefficients were used to assess the relationship between HR, isometric strength, and muscle thickness. Significance was set at $p \leq 0.05$

Results: A significant increase in lower trapezius muscle thickness was found in the dominant arm compared to the non-dominant arm (mean difference= 1 mm; $p=0.004$). The Pearson correlation coefficient demonstrated a negative relationship between HR and R-maj muscle thickness ($p=0.03$; $R= -0.36$, Table 1). A negative correlation was also found between HR and MT strength ($p=0.03$; $R= -0.37$).

Conclusions: This study provides foundational information on scapular muscle adaptations due to years of pitching. Lower trapezius thickness was greater in the throwing arm than non-throwing arm of pitchers suggesting a potential positive adaptation of this muscle in response to eccentric load. Interestingly, there was a negative relationship between HR and R-maj thickness and MT strength. HR has been linked to decreases in internal rotation range of motion, which reduces the amount of glenohumeral motion during deceleration. This negative relationship suggests that due to limited glenohumeral motion during deceleration, the scapula may be forced into anterior tilt placing the R-maj and MT in eccentric overload.

Total Word Count: 439

204655CD

Longitudinal Changes in Tandem Gait in Healthy Football Players During Single and Dual Task

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Context: Simple single and dual task gait have demonstrated consistency of measurement over time. In recent publications, tandem gait has been identified as a potentially robust measure of dynamic balance to be measured at both baseline and post-injury. However, the stability of the measure has not been examined longitudinally.

Methods: As a part of a larger longitudinal study, 10 football players were tested serially for 3 years during the off season in postural and dynamic balance measures (2 were lost in year 3). For the tandem gait, participants were instructed to stand with their feet together behind a starting line (the test is completed barefoot). They walked in a forward direction as quickly and as accurately as possible along 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they crossed the end of the 3m line, they turned 180 degrees and returned to the starting point using the same gait. Four trials per each participant were completed and average time to complete was calculated. Tandem gait trials were performed without a concurrent cognitive test (single task) and with a cognitive test (dual task). Cognitive tasks were randomized and included subtraction by 3's and 7's, spelling in reverse, and months of the year in reverse.

Multivariate analysis of variance was performed using SPSS with task (2 levels) as a within subject comparison and year (3 levels) as between with Tukey's post hoc comparisons for multiple levels.

Results: All participants participated in the full season of football all 3 years and none sustained a concussion during the study period. Means and standard error are included in the attached table. A significant interaction of task and year was found ($P < .001$). Single task did not vary across all 3 years ($P < .262$). The speed among participants in year 1 and year 2 was slower in tandem gait with the cognitive dual task compared to year 3 ($P < .003$).

Conclusions: Single task tandem gait appears to be a stable measure when measured longitudinally over 3 years. Dual task however showed differences over time with year 3 significantly faster in time to completion than either of the first two years. Interestingly, participants increased their speed during dual task each year (table).

While we recognize that the participant numbers were small, this is the first time that tandem gait has been examined longitudinally to our knowledge. Dual-task tandem gait may exhibit a learning effect over time may need to be administered each year to improve clinical usefulness. Additionally, determining a minimal detectable change for tandem gait may assist with clinical decision making.

Total Word Count: 430

206415GD

Long-Term Effects of Pitching on Muscle Architecture of Posterior Rotator Cuff in Professional Pitchers

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Context: Currently the adaptations that have been identified in baseball players are clinical measures of range of motion (ROM) and strength, as well as osseous and posterior capsule adaptations. Muscle architecture (pennation angle [PA] and muscle thickness [MT]) have been shown to be important predictors of muscle force. While the importance of PA and MT has been shown at other joints, there has been little research in the shoulder of baseball pitchers. The purpose of this study was: 1) to examine the chronic effect pitching has on the rotator cuff muscle architecture, MT, and PA, in healthy professional baseball pitchers, and 2) to examine the relationship between muscle architecture and clinical measures of strength and ROM.

Methods: A cross-sectional design was used to assess one independent variable; arm (dominant and non-dominant) and 4 dependent variables: muscle architecture of the infraspinatus and teres minor (PA, and MT) and clinical measurements (internal (IR) and external rotation (ER) strength and ROM). Twenty-eight healthy professional baseball pitchers (aged 22.07, \pm 2.09 years; mass 94.56, \pm 16.92 kg; height 190.22, \pm 7.21 cm) were included in the study. A Microfet hand-held dynamometer (Hoggan Health Industries, Draper, Utah) was used to measure strength during a maximum voluntary isometric contraction. A M-Turbo Ultrasound System Scanner with a 15-MHz linear-array transducer (FujiFilm Sonosite Inc. Bothel, WA, USA) collected infraspinatus and teres minor muscle images. PA and MT were measured with ImageJ software. A digital inclinometer (SPI Swiss Precision Instruments, Garden Grove, CA) and ultrasound unit was used to measure HR, which was used to isolate soft tissue glenohumeral internal rotation deficits (GIRD). Paired sample t-tests were used to compare bilateral strength and muscle architecture measurements. Step-wise linear regression was used to assess the relationship between muscle architecture and clinical measures. A significance level of $p \leq 0.05$ was used.

Results: There were no significant bilateral differences for ER or IR strength (-1.2lbs, $p=0.2$; 0.2lbs, $p=0.8$). Also, no bilateral differences were found for infraspinatus (0.5° , $p=0.4$; 0.5mm, $p=0.3$) or teres minor (-0.1° , $p=0.9$; 0.6mm, $p=0.3$) PA and MT. There was a positive relationship between infraspinatus MT and ER strength ($p=.003$, $R = .474$, Table 1) and soft-tissue corrected GIRD and the bilateral difference of teres minor PA ($p=.027$, $R = .442$).

Conclusions: Our study found no bilateral differences in strength, PA, or MT. We expected to see a stronger dominant arm, with larger PA, and greater MT. Interestingly, we found that ER strength was predicted by the thickness of the infraspinatus muscle. We also found that soft tissue GIRD was predicted by the bilateral adaptation of the teres minor PA. This suggests that when posterior shoulder tightness occurs, specifically the architecture of the teres minor muscle is involved.

Total Word Count: 445

[204992CA](#)

Long-Term Test-Retest Reliability of the BESS Test Using C3 Logix Platform in High School Athletes

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Context: The estimated risk of concussion in high school athletics is 230 concussions per 100,000 athlete exposures. Current best practices recommend performing an annual baseline examination of motor control using the Balance Error Scoring System (BESS) test; however, in practice, limited resources in secondary schools often extend this interval closer to 2 years. Previously, test-retest reliability of the BESS test has been evaluated at shorter intervals ranging from 2-3 minutes up to 1 year. We sought to evaluate test-retest reliability of the BESS test over a 2-year interval in high school athletes using the C3 Logix platform. We hypothesized that the test-retest reliability would be strong for ellipse volume, but poor for error count.

Methods: This retrospective study used data collected in athletic training facilities and classrooms during routine mass baseline concussion testing. Participants were 390 high school athletes (223 males, 167 females, ages 14.51 ± 2.34 years) from 8 high schools. Each athlete had 2 balance baseline assessments typically at the start of freshman and junior years (630 days \pm 152). All participants had no previous history of concussion prior to the first assessment and no intervening concussion prior to the second assessment. Data was collected using the C3 Logix application on an Apple iPad Air 2. Balance errors were manually counted and recorded by trained assessors and ellipse volume was collected and recorded by the application. With IRB approval, de-identified data was exported and analyzed. SPSS was used to calculate 2-way random consistency intraclass coefficients (ICC) for total number of balance errors at each baseline and ellipse volume and errors per each stance.

Results: There was fair reliability (ICC=0.40-0.59) for ellipse volume in single leg stance on firm surface, tandem stance on firm surface, and double leg stance foam surface (Table). There was poor reliability (ICC<0.40) for total error count, error count per stance, and ellipse volume in the remaining 3 stances.

Conclusions: This suggests that 2 years between baseline balance assessments may be too long and that ellipse volume is a more reliable measurement than error scores. This may be because it is an objective measurement versus subjective, as suggested by previous researchers. Future research should be performed prospectively to determine long-term test-retest reliability. Understanding test metrics is imperative to providing appropriate clinical guidance. These results question whether we can rely on older baseline assessments when determining concussion recovery.

Total Word Count: 388

208275DD

Lower Extremity Joint Loading During Gait Changes From Three Months to Time of Return-to-Sport Following Anterior Cruciate Ligament Reconstruction (ACL-R)

Garrison JC, Goto S, Hannon JP, Bothwell JM, Bush CA, Dietrich LN, Singleton SB.

Context: Restoration of gait in patients who have undergone ACL-R is often difficult. The relative contribution of loading at the hip, knee, and ankle joints during gait is unclear, especially during the latter stages of rehabilitation. Therefore, the purpose of this study was to compare energy absorption contribution (EAC) of the hip, knee, and ankle of the surgical limb during gait in patients following ACL-R at 12 weeks, 18 weeks, and time of return to sport (RTS).

Methods: A repeated measures study design was used in the clinical laboratory. Twenty participants (Age=15.85±1.84 yrs, Ht=174.25 ±9.88 cm, Mass=74.06 ±17.62 Kg) between 12-17 years of age with unilateral ACL reconstruction surgery volunteered. Each participant was measured post-operatively at 12 weeks, 18 weeks, and RTS. Eight three-dimensional cameras (120Hz) and two force plates (1200Hz) collected kinematics and ground reaction forces on the surgical limb while participants walked on a 10-meter runway with a self-selected velocity. Energy absorption (EA) was assessed during the first 50% of the stance phase of gait using an inverse dynamics approach. EAC of the hip, knee, and ankle was calculated relative to the total EA (sum of hip/knee/ankle) for analysis and variables were averaged across three trials. A 3 (joint – hip/knee/ankle) X 3 (time –12wk, 18wk, RTS) repeated measures ANOVA was performed. For significant interaction, post-hoc tests were run. In order to examine the EAC changes of each joint across time, paired t-tests were performed. Alpha level was set at $p < 0.05$.

Results: There was a significant time by joint interaction observed ($F=5.21$, $p=0.007$). Post hoc tests revealed that RTS knee EAC (19.68±9.44%) was significantly increased compared to 18wk knee EAC (13.67±10.23%, $p=0.013$) and 12wk knee EAC (11.73±8.08%, $p=0.001$). For the ankle joint, RTS ankle EAC (46.37±19.15%) was significantly decreased compared to 12wk ankle EAC (55.15±20.85%, $p=0.010$) and 18wk ankle EAC (56.04±20.23%, $p=0.011$). There were no other significant differences observed in any of the dependent variables ($p > 0.05$).

Conclusions: The ability to load the knee on the surgical limb during gait improves from 3 months post-operative ACL-R to time of RTS in adolescent athletes. At the same time, ankle loading on the surgical limb decreases, suggesting within limb alterations in joint load sharing as the athlete progresses through the rehabilitation process.

Total Word Count: 367

[209154FD](#)

Lower Extremity Loading Characteristics of Service Members With Transtibial Amputations During Drop-Landings from Varied Heights

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Context: Service Members with transtibial amputations (TTA) are at increased risk for negative secondary health effects, including acute and chronic musculoskeletal injuries (MSKI). It is essential to identify and mitigate post-TTA sequelae risk factors. Drop-landing movement assessments can identify individuals at greater MSKI risk and guide risk mitigation strategies. Greater drop heights may exacerbate MSKI risk factors, and aid clinicians in identifying them; however, the movement patterns of Service Members with TTA during drop-landings from a variety of heights have yet to be examined. We quantified lower extremity loading patterns of Service Members with and without TTA during drop-landings from three heights.

Methods: We conducted a laboratory based cross-sectional study of Service Members with unilateral TTA (n=4; male=100%; age=39.0±5.7yrs; BMI=29.0±4.3; time from amputation=98.1±33.8mos) and uninjured “controls” (n=8; male=100%; age=29.3±5.6yrs; BMI=26.3±2.7). Participants completed nine drop-landing trials, three trials each from 20cm, 40cm, and 60cm heights, onto two force platforms (AMTI). Participants did not receive instructions regarding landing techniques. Three-dimensional kinematic data were recorded (Qualisys) during the trials. The absolute difference in inter-limb touchdown time, peak three-dimensional knee moments, and the mean and peak instantaneous loading rates were calculated throughout the landing phase (initial contact to peak knee flexion). Kinetic data were normalized to body mass and averaged across trials. Means, standard deviations, and 95% confidence intervals (95% CI) compared the intact limb of Service Members with TTA and the right limb of control participants; non-overlapping 95% CIs were considered significantly different.

Results: Service Members with TTA (95% CI: 33.5, 44.5yrs) were older than controls (95% CI: 25.2, 33.4yrs); the groups did not otherwise differ. Service Members with TTA versus controls displayed: 1) greater inter-limb touch down time differences (40cm and 60cm), with the intact limb touching down prior to the TTA limb; 2) higher mean loading rates (20cm and 40cm); and 3) larger knee internal rotation moments (20cm) and smaller knee flexion moments (60cm). No other kinetic differences were observed between groups (Table 1).

Conclusions: Service Members with TTA display loading patterns that may increase MSKI risks in their intact limb. The intact limb of Service Members with TTA touched down prior to the TTA limb which likely contributes to the observed risk factors; this was true for all drop heights with the difference in inter-limb touchdown time increasing with increasing drop height. While drop-landings can identify secondary MSKI risks among Service Members with TTA, between-group kinetic differences were not consistently observed across all drop heights; thus, clinicians should assess drop-landings from a variety of heights to more thoroughly assess for possible injury risk factors. Reducing MSKI risk allows Service Members with TTA to more safely return-to-activity/duty and live a healthier and more active lifestyle.

Total Word Count: 440

200063ED

Lower Extremity Musculoskeletal Screening Tool Practices of Athletic Trainers in Collegiate and Secondary School Settings

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Context: Musculoskeletal (MSK) injury prevention programs have demonstrated the ability to reduce injury risk and severity. However, athletic trainers (ATs) in traditional settings face challenges of time and resources when implementing such programs. MSK screening tools can allow ATs to focus prevention efforts by providing patient risk information. Currently, there is a limited literature discussing the use and perceived effectiveness of screening tools among ATs. The purpose of this study is to examine the lower extremity MSK screening tool practices and perceptions of ATs in traditional settings.

Methods: A cross-sectional online survey (Qualtrics, Provo, UT) was distributed to ATs in traditional clinical settings. Prior to distribution, an expert panel and pilot testing was utilized to validate the survey tool designed to assess demographics and MSK screening tool practices and perceptions. MSK screening tools were grouped into 7 categories: Range of Motion (ROM), Strength, Balance, Drop and Jump Landing (D/J-Landing), Double- and Single-Leg Hopping (D/S-Hopping), Movement Quality (MQual), and Injury History (History). For each screening tool category, questions assessed MSK screening tool usage, the perceived effectiveness of MSK screening tools to provide relevant injury risk and return to play (RTP) information, and MSK screening tools effect on decisions to implement prevention programs. The survey was distributed to a total of 4,937 full- or part-time collegiate and secondary school ATs who were randomly selected by the NATA. An initial recruitment email and two reminder emails were sent to participants during a 4-week recruitment period. Data trends were analyzed using descriptive statistics and frequency counts.

Results: A total of 372 participants (female=215(48.4%), male=152(34.2%), age=35±10 years, experience=12±10 years, secondary school=194(52.2%), collegiate=178(47.8%)) completed the survey (response rate=7.5%, access rate=8.6%, completion rate=95.8%). Overall, participants within our study indicated the used of the following screening tools categories in clinical practice: ROM=339(91.1%), Strength=342(91.9%), Balance=238(64.0%), D/J-Landing=134(36.0%), D/S-Hopping=233(62.6%), MQual=212(57.0%), History=316(85.0%), and None=18(4.8%). Furthermore, 0-1 screening tool categories were used by 22 participants (5.9%), 2-3 by 40(10.8%), 4-5 by 168(45.2%), and 6-7 by 142(38.2%). Data regarding perceived effectiveness of screening tools to provide RTP and injury risk information and how much they affect decisions to implement prevention programs is provided in the table.

Conclusions: ATs in traditional settings indicate that they primarily use ROM, strength, and history screening tools to gather information concerning lower extremity injury risk and RTP. Additionally, ATs indicate that they use multiple screening tools in conjunction within their clinical practice. Lastly, the majority of ATs surveyed indicated that these tools provide moderately effective information to make injury risk and RTP decisions and indicate that screening tool results moderately effect their decision to implement prevention programs. Further research is needed to assess how ATs gather, assess, and determine which information is most relevant when using injury screening tools.

Total Word Count: 446

205615JD

Lyme Disease in a Women's Basketball Athlete

Dill KE, Huey MJ: Emory University

Background: The patient was a 20-year-old female from New Hampshire going to school and playing basketball in Georgia. She presented with complaints of fatigue, dizziness, fever, sore throat, myalgia, and aching in her knees on 10/22/2016. She denied a history of anemia but had used iron supplementation. She reported sleeping more than usual but fatigue persisted. She had been participating in varsity practices for one week along with strength and conditioning workouts for approximately 8 weeks.

Differential Diagnosis: Upper respiratory infection, influenza, iron deficiency anemia, streptococcal pharyngitis, mononucleosis, Lyme disease

Intervention & Treatment: The patient was referred to a registered sports dietician and general practice physician. Laboratory tests were unremarkable which included complete blood count, comprehensive metabolic panel, sedimentation rate, rapid strep A and rapid mono tests. The nutrition consult revealed a healthy vegetarian diet. The patient followed-up with the head team physician for further evaluation. Follow-up tests included enzyme-linked immunosorbent assay (ELISA) test which is used to detect Lyme disease, Epstein Barr virus panel, and thyroid stimulating hormone. These tests were also unremarkable, but the suspicion of Lyme disease was still present as the sensitivity of the testing is low. The patient was referred to infectious disease on 11/14/2016 for further testing which included a test to detect *Borrelia burgdorferi*, the bacteria that causes Lyme disease. The result of the test was negative, but with her continued symptoms, she wanted to see a physician specializing in Lyme disease. These physicians are generally located in the northeast region therefore, she went home to New Hampshire for the appointment. The specialist ordered a test to detect *borrelia burgdorferi* that was performed at a lab specializing in Lyme disease testing. This test was positive, which led to a diagnosis of chronic Lyme disease. The patient then began treatment for Lyme disease in December 2016, which included a course of oral antibiotics (azithromycin and cefuroxime) and regular follow-ups with the specialist. The physician advised her to take the medication for 6 weeks beyond the point of symptom resolution. Once the patient began antibiotic treatment, she was advised that she may progress to basketball activity. However, the patients' progress was delayed due to Lyme disease symptoms and antibiotic side-effects. The patient was able to begin an exercise program in March of 2017 and able to resume off-season basketball practice in April of 2017. Her Lyme disease treatment continued and in August of 2017 she was taking a course of antibiotics for 1 week every month to prevent symptoms. She was able to participate in the 2017-2018 basketball season with minor setbacks from the side effects of the medications. However, prior to her final season in 2018-2019 she had a relapse of symptoms and was unable to participate.

Uniqueness: According to the Center for Disease Control (CDC), approximately 300,000 people are diagnosed with Lyme disease on an annual basis in the United States. Further, 96% of Lyme disease cases occur throughout 14 states located throughout the Northeast and northern Midwest region. The patient's symptoms were consistent with Lyme disease despite no known tick bites.

Conclusions: The patient was able to participate in basketball activities once she began treatment with antibiotics. Although she couldn't complete her basketball career due to relapse in symptoms, she was able to return to a satisfactory level of exercise. It is important for athletic trainers to know about rare diseases to be able to assist their patients in finding the correct diagnosis. Athletic trainers should include Lyme disease in their differential diagnoses when a patient presents with the indicated symptoms and is from the Northeast or upper Midwest regions of the United States.

Total Word Count: 594

204902BD

Management of a Proximal Femoral Stress Reaction Utilizing Incremental Running and Cyclical Bone Strengthening in a DI Track and Field and Cross Country Athlete

Brunner JR, Fitzpatrick SG*, Henrichs JW†: *University of Illinois, †Carle Orthopedics and Sports Medicine.*

Background: A nineteen-year-old male Division I distance runner initially presented with a sharp pain in his left thigh following a summer training program where he averaged about eighty to eighty-five miles per week. This student athlete had no previous history of bony stress injury (BSI). Following his pre-participation exam this athlete was referred to the team physician for further evaluation.

Differential Diagnosis: Proximal femoral stress reaction, stress fracture, or thigh strain

Intervention & Treatment: This athlete was initially referred to the team physician on August 17th 2018. Further evaluation revealed non-tender palpation over any musculature surrounding the femur and a positive femoral fulcrum test. Consequently, further examination into the severity of the injury was done through X-ray imaging performed on August 17th 2018, which found the alignment of the hip and knee to be grossly normal while showing no evidence of fracture or periosteal reaction. A non-contrast MRI was performed on August 30th 2018, to further examine the site of injury. This imaging found slight cortical edema in the proximal metaphysis of the femur, with minimal early new bone deposition and periosteal reaction visible. These findings lead to the ultimate diagnosis of a proximal femoral stress reaction. Subsequent treatments included elliptical cross training as well as low impact exercise to be limited by pain. An Alter-G reduced gravity running progression was introduced on August 24th 2018, and was utilized during this period of low impact exercise. The student athlete was also permitted to continue strength training with a larger focus placed on axial loading through the femur. Little restriction was placed on intensity, with the only limitation being the absence of Olympic lifts. To encourage posterior chain loading and anterior cortical compression, uphill walking was included during this period of low impact exercise. On October 29th 2018, a ground running progression was introduced. The SA increased by fifteen percent each week, progressively, from the initial thirty miles established by the end of the Alter-G progression. This progression was unique in that it required the athlete to progress in a two week on, one week off running schedule at a 15% mileage increase per week

Uniqueness: This case is unique because the ground running progression had no stipulations on intensity of the training, but rather solely on the mileage prescribed. The athlete's mileage began at 30 miles and progressed at a 15% increase each week while never surpassing 65 miles. This progression was more aggressive than previously described 10% mileage increases but the time for return to participation with no regression in symptoms proved the 15% increase a viable option for long bone stress reaction.

Conclusions: The ground running progression of 15% increase in mileage over a two week "on" and one week "off" period was beneficial to providing proper bone loading without regressing back to re-aggravate the initial stress injury.

Total Word Count: 462

[204762ED](#)

Management of an Absent Infrarenal Inferior Vena Cava in a Collegiate Dancer: A Case Report

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Background: A 19-year-old female collegiate dancer entering her senior year reported to the athletic training staff complaining of dull pain, tightness and numbness in both of her calves. The patient could not recall a specific mechanism or onset, but reported delayed recovery from these symptoms following weight bearing conditioning for as long as she could recall. Initial evaluation was unremarkable. Patient demonstrated normal strength and active range of motion with all leg motions, and was not tender to palpation along the muscle bellies of the triceps surae. Palpation also revealed supple musculature, but the patient did note some tightness with passive dorsiflexion. During evaluation patient reiterated that her symptoms would only occur during and after physical activity.

Differential Diagnosis: Triceps surae tightness, exertional compartment syndrome, neurovascular entrapment, and intervertebral disc pathology.

Intervention & Treatment: Patient consented to cupping therapy treatment and therapeutic exercise program targeted at improving passive dorsiflexion. Patient reported positive outcomes and near full resolution following initial treatment plan, and continued with initial treatment plan for the remainder of the academic year. Over the summer break, the patient returned home and did not report any recurrence of symptoms to the athletic training staff. Upon returning to campus for the following academic year, the patient reported that her symptoms had increased dramatically. The patient reported that she had begun to experience a sharper pain along with transient losses in lower leg strength. After seeking out treatment from her primary care physician, she was referred for an MRI of her lower back and abdomen to evaluate for disc pathology. MRI revealed an abnormal conglomeration of blood vessels, leading a vascular specialist to order a CT scan. Once the CT scan was obtained, the specialist noted the absence of the infrarenal inferior vena cava. Due to the patient's positive outcomes utilizing cupping therapy, the vascular specialist recommended she re-initiate treatment when she returned to her athletic training staff. In addition to cupping therapy, the patient also began use of compression stockings to assist with venous return to activities of daily living and participation in dance practices and routines. At this time, the patient began a routine of cupping therapy with silicone cups applied to the anterior, posterior and lateral surfaces of her legs for 15 minutes each accompanied by lymphatic flushing utilizing moving cupping. Patient reported immediate and prolonged relief of symptoms during activities of daily living and dancing. Through use of her compression stockings and the previously described treatment plan, the patient was able to complete her dancing career without missing a practice or routine.

Uniqueness: The absence of an infrarenal inferior vena cava is extremely rare. The majority of patients are unable to participate in moderate or vigorous physical activity, and often carry out sedentary lifestyles to avoid exacerbation of associated symptoms. To the best of our knowledge, this is the first report of a patient continuing physical activity while being treated for symptoms associated with an absent infrarenal inferior vena cava.

Conclusions: The majority of musculoskeletal and general medical conditions that athletic trainers encounter in their day-to-day clinical practice are well described in literature or through anecdotal evidence. With the growing diversity in patients seen by athletic trainers, there is a strong likelihood that unusual conditions will present themselves. As such, it is the responsibility of the clinician to perform thorough and exhaustive evaluations to determine the underlying pathology behind reported symptoms. When dealing with an unusual condition, evaluation and re-evaluation of clinical and patient oriented outcomes is crucial to achieve optimal outcomes.

Total Word Count: 577

204705ED

Management of Collegiate Volleyball Player With Functional Scoliosis Caused by Leg Length Discrepancy: A Case Report

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Background: An 18-year-old female collegiate volleyball player reported to pre-participation physical examinations (PPEs) with a previous diagnosis of scoliosis. The patient reported that her previous physicians had also diagnosed her with degenerative disc disease at the L3/L4 and L4/L5 levels as evaluated by MRI. While the patient had been able to participate fully during her previous competitive seasons, she reported having to manage musculoskeletal pain, and muscle tightness and spasm. Previous treatments had included moist hot packs, motor TENS, and stretching, but failed to produce significant reduction of symptoms. Patient also reported that no concerted efforts were made to initiate a therapeutic exercise program previous by healthcare providers.

Differential Diagnosis: Pre-existing scoliosis with associated degenerative disc disease.

Intervention & Treatment: Following PPEs, the patient began daily therapeutic exercise aimed at improving core and pelvic stability. Throughout preseason practices, the patient reported musculoskeletal pain and tightness consistent with her previous season, but did not require any modifications from volleyball activities. At this time, the only modification made was discontinuing any weight lifting activities that involved an axial load of the spine. Six weeks after PPEs, the patient did not exhibit symptoms consistent with degenerative disc disease. Based off the lack of debilitating symptoms, the athletic training staff provided a neurosurgeon with the patient's x-rays and MRI for a second opinion. Upon review of the images, the surgeon determined that there was no evidence of degenerative disc disease, and that all signal was consistent with scoliotic changes. The surgeon also recommended assessing the patient's actual leg length as a possible factor for the seemingly large magnitude of scoliotic angle in the patient's lumbar spine. When leg length was measured, the patient was found to have a 2 cm leg length discrepancy, as measured from ASIS to the inferior aspect of the ipsilateral medial malleolus (Left leg = 89 cm, Right leg = 91 cm). Through consultation with team physicians and chiropractors, the decision was made to wait until the conclusion of the competitive season to make efforts to address the discrepancy. 10 weeks after PPEs, 5 mm inserts were added to the patient's shoes to begin the gradual process of accounting for the leg length discrepancy. During this time, the patient continued her therapeutic exercise program to continue to address core and pelvic stability. After two weeks with the previous inserts, a new pair that was 1 cm in height was issued. 14 weeks after initial contact, a pair of 1.5 cm insoles were provided to the patient. Throughout the remainder of the academic year, the patient noted a decrease in both pain and stiffness throughout her back. Prior to the start of the summer, the patient was issued a set of inserts for any new footwear she might use for strength and conditioning sessions.

Uniqueness: The magnitude of leg length discrepancy the patient exhibited with was rare compared to the majority of discrepancies. Furthermore, the majority of patients suffering from such a discrepancy often experience more severe symptoms than this patient. Often times, discrepancies that are so large do not respond well to conservative treatment and warrant surgical intervention.

Conclusions: When caring for patients with previous medical diagnoses, it is important to continue to evaluate and re-evaluate the success of treatment and rehabilitation programs. If these programs are not yielding promising results, it is the clinician's responsibility to exhaust all possible resources to determine the root cause.

Total Word Count: 558

209191GD

Management Of Lumbar Disc Herniation In A Division I Women's Basketball Player With Congenital Conjoined L5-S1 Nerve Roots-Level 4 Clinical Case Report

Simpson CM, Ploor RM, Jordan EM: Georgia Southern University, Statesboro, Georgia

Background: Patient is a 19-year-old female Division I Women's Basketball player. She complained of immediate sharp low back pain after sprinting during practice. The athletic trainer conducted an on-court evaluation and found muscle spasms. The patient said she could return to play. She experienced continued pain and reported radiating symptoms down her left leg through her calf. The patient was removed from further activity and treated symptomatically during the team's away trip. Patient had a prior history of back muscle tightness.

Differential Diagnosis: Low back spasms, disc herniation, and piriformis syndrome.

Intervention & Treatment: Upon return, the team physician prescribed prednisone taperpac to help with sleep and ordered an Magnetic Resonance Imaging (MRI). The MRI revealed an L5-S1 disc protrusion pressing on a congenital conjoined L5-S1 nerve root. The patient was referred to a spine orthopedic specialist who recommended an injection, rehabilitation, and discontinue basketball for the season. Surgery would be indicated after six weeks if conservative treatment failed; however, surgery was trying to be avoided due to the patient's young age and to preserve the disc. The patient received a transforaminal epidural steroid injection of cortisone before winter break and was given a home exercise program as well. After break the patient followed up with the specialist. At the time of follow up, she had back pain but no radicular symptoms. The specialist instructed the athletic trainer to progressively test functional basketball skills to see if symptoms returned. Follow up one week later, the patient reported increased central back pain and radicular symptoms to the gluteal region. The specialist instructed the athletic trainer to continue progressive basketball skills and follow up one month later. The patient continued to have radicular symptoms with sprinting and two-on-two workouts. Follow up one month later, the specialist recommended microdiscectomy. The patient underwent an L5-S1 hemilaminotomy medial partial facetectomy and left sided microdiscectomy. After surgery the patient was placed in a lumbar support brace and prohibited from bending, twisting, as well as lifting for six weeks. Post-operative rehabilitation consisted of isometrics for the first six weeks. Then the patient was allowed to progress to more advanced core and strength training. Patient is currently cleared to play.

Uniqueness: Congenital conjoined nerve roots are the most common nerve anomaly but are found in a small percentage of the population. Only 1.9 to 4% of lumbosacral nerve root anomalies are reported in imaging studies.¹ This anomaly is usually detected in surgery, which can cause the anomaly to hinder the surgical approach or could cause post-surgical complications. Overall prevalence of lumbosacral anomalies at autopsy is around 8.5% to 30%.¹

Conclusions: Congenital conjoined nerve roots are uncommon, and it is even more uncommon to diagnosis them with imaging such as an MRI. Not only did the patient have congenital conjoined L5-S1 nerve roots, the specialist was able to identify them before going into surgery. Early recognition was important because it allowed the surgical procedures to be altered beforehand which decreased the risk of complications during and post-surgery.

Total Word Count: 490

207303FD

Measurements of Postural Control Error Signal During the Y Balance Test™ in ACL Reconstructed Individuals

Decker MN, Ruhde L, Trowbridge C, Ricard MD

Context: The Y Balance Test™ (YBT) is a reliable and valid assessment of dynamic balance used with ACL reconstructed individuals (ACLR) at various time points after reconstruction. The YBT has primarily been assessed based on reach distance and composite scores, but there has been limited work on the underlying mechanisms in which maximum reach is achieved. To our knowledge, no data exists for variables related to postural control measures, specifically center of pressure (COP) and center of mass (COM), during the YBT assessment, especially in ACLR individuals. The purpose of this study was to determine if ACLR individuals several years post reconstruction demonstrate differences in reach distance and postural control in their involved limbs compared to their uninvolved limbs during the YBT.

Methods: A cross-sectional study design was used, and data was collected in a university biomechanics laboratory. Twelve recreationally active females (n=7) and males (n=5) (age=24.7±3.6yrs, mass=76.1±12.3kg, height=168.7±10.1cm) volunteered. All participants had a previous history of a unilateral ACLR with an average time of 7±3.1 years post reconstruction. Participants completed one testing session, in which they performed the YBT while being recorded using Vicon 3D motion analysis capture software and an AMTI force plate. Mean±SD of maximum reach distance (YMRD) were calculated in the anterior (ANT), posteromedial (PM), and posterolateral (PL) directions for involved and uninvolved limbs. Postural control error signals were analyzed using the difference between COP and COM during reach attempts. A medial/lateral (MLerror) and anterior/posterior (APerror) error signal was calculated for all reach directions on both limbs. Paired sample t-tests were used to determine differences for YMRD, MLerror, and APerror between involved and uninvolved limbs in all reach directions. Alpha was set apriori at 0.05.

Results: Significant differences were found for YMRD in the PL direction between the involved (86.8±12.9cm) and uninvolved (90.9±10.7cm) limbs (p=0.01). No significant differences were found for YMRD in the ANT and PM reach directions. No significant differences were found between limbs for MLerror and APerror. While not significant, there was a trend for differences in postural control error signals with ACLR individuals exhibiting greater MLerror on the involved limb during all reach directions and less APerror on the involved limb in all reach directions.

Conclusions: The reach differences between limbs in the PL direction demonstrate dynamic balance asymmetries and possible rotary stability deficits in ACLR individuals several years after reconstruction. Additionally, while not significant, the involved limb demonstrated greater medial/lateral postural control variability during all reaches, which may be indicative of deficits within single limb neuromuscular control while one limb is moved away from the body during dynamic balance tasks. Future work is needed to identify the cause of alterations in postural control error signals between limbs in ACLR populations.

Total Word Count: 445

209003ID

Measures of Quality of Life in Middle School Students Utilizing the PedsQL

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Context: Providing comprehensive health care through the use of health-related quality of life (HRQOL) assessments, is becoming the forefront of medicine and individualized patient care. However, incorporating HRQOL assessments in the pediatric population is often overlooked. Although normative values exist for healthy children they are not specific to physically active children engaged in sport. Additionally, age and gender have been found to affect HRQOL in late adolescence and adults. However, the influence of these factors remains unknown in physically active middle school age children. Utilizing a large sample of middle school student-athletes, we sought to establish normative reference values and examine how age and gender may be associated with self-reported baseline HRQOL in physically active middle school age children engaged in sport.

Methods: Athletic trainers administered the Pediatric Quality of Life 4.0 General Core Battery (PedsQL GCB) to 1,948 middle school age student-athletes participating in school-sanctioned sport [ages 10-14 years old; gender: girls=963 (49%), boys=985 (51%); grade level: 6th=456 (23%), 7th=581 (30%), 8th=911 (47%)] from nine middle schools within a large school division in Virginia during the 2017-2018 school years as part of pre-participation evaluations. Deidentified PedsQL GCB data were then retrospectively analyzed. Dependent variables included the overall PedsQL GCB score, Psychosocial health summary score, and independent subscales of: physical, emotional, social, school, and cognitive functioning. Higher scores endorsed indicate a higher HRQOL functioning. Kruskal-Wallis tests were used to evaluate differences in PedsQL performances across 3 grade levels (6th, 7th, and 8th), with Mann-Whitney U tests as planned comparisons. Mann-Whitney U tests were also used to examine gender differences (girls vs boys). A nonparametric effect size [$r=z/(\sqrt{N})$] was calculated to characterize the magnitude of observed effects. Alpha was set a priori at $p<0.05$.

Results: Normative reference values for this sample are presented in Table 1. Significant differences were observed in physical ($\chi^2(2)=7.22, p=0.03$) and social ($\chi^2(2)=13.40, p<0.01$) scores by grade. Sixth graders endorsed significantly lower physical scores than 7th ($U=121873.5, p=0.03, r=0.07$) and 8th graders ($U=190397.5, p=0.03, r=0.07$). Eighth graders endorsed higher social scores than 6th ($U=184761.0, p<0.05, r=0.10$) and 7th graders ($U=247471.5, p<0.05, r=0.06$). Boys endorsed significantly higher scores among physical ($U=404483.5, p<0.05, r=0.13$), emotional ($U=397612.0, p<0.05, r=0.14$), psychosocial health summary ($U=431071.0, p<0.05, r=0.08$), and total PedsQL GCB ($U=416191.0, p<0.05, r=0.11$) than girls.

Conclusions: Our findings provide normative reference values that may help clinicians to better evaluate the HRQOL of physically active middle school age children in the absence of baseline assessments. Although effect sizes were small, 6th graders and girls endorsed poorer HRQOL scores than older and male counterparts, respectively. Other moderators of baseline HRQOL and the effect of sport-related injury on HRQOL scores among middle school age students should be investigated.

Total Word Count: 443

[208242FD](#)

Mental Fatigue Impacts Ankle Joint Biomechanics During Anticipated and Unanticipated Jump-Stop Maneuvers

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Context: Poor lower extremity biomechanics during jump landing tasks have been tied to a multitude of lower extremity injuries, including ankle sprain and ACL injury. As research has identified intrinsic risk factors for injury (e.g. strength, limb alignment), exploration into more modifiable extrinsic risk factors is warranted. Mental fatigue may negatively affect jump landing biomechanics, and place individuals at increased risk for musculoskeletal injury. We therefore aimed to investigate the effects of mental fatigue and task anticipation on lower extremity biomechanics amongst uninjured individuals.

Methods: A pre-test post-test design was implemented to determine the effects of mental fatigue on landing biomechanics. Thirteen individuals (23 ± 2 yrs, 168.6 ± 9.7 cm, 73.8 ± 14.4 kg, 5M/8F) reported to a biomechanics laboratory for a single test session. Subjects were instrumented with reflective markers on key lower extremity landmarks, and asked to stand on a 30-cm box placed 70-cm from two in-ground force plates. Motion data was collected through 8-camera motion tracking system at 100-Hz while individuals jumped forward off the box, landed on the force plates, and performed a vertical jump to 50% of maximum jump height. Participants received instructions whether to jump or cut away from a randomly-determined test leg upon landing either before initiating movement (anticipated) or after leaving the box (unanticipated). Participants performed 5 jumps per condition before and after a 60-minute mental fatigue intervention, consisting of three 10-minute blocks of the N-back test, and three 10-minute blocks of the AX-continuous performance test. Fatigue was assessed using the Profile of Mood States (POMS). Differences in joint excursion, peak, and minimum joint angles from 250ms prior to landing until load acceptance were assessed with two-way analyses of variance (condition, anticipated vs. unanticipated; time, pre- vs. post-fatigue, $\alpha=0.050$).

Results: The fatigue domain of the POMS increased from pre-fatigue (1.27 ± 0.34) to post-fatigue (1.97 ± 0.57 , $p<0.001$). A significant main effect of time was observed for sagittal plane ankle joint excursion ($F=5.360$, $p=0.041$). Pairwise comparisons revealed individuals have more excursion pre-fatigue ($58.6\pm 18.0^\circ$) than post-fatigue ($56.8\pm 19.2^\circ$). A significant condition-by-time effect was observed for ankle internal rotation angle ($F=6.761$, $p=0.025$). Under the anticipated conditions, no differences were observed between pre- and post-fatigue conditions (pre-fatigue: $23.4\pm 19.0^\circ$, post-fatigue: $24.4\pm 16.0^\circ$, $p>0.596$); however, after fatigue, internal rotation angle increased from pre- to post-fatigue (pre-fatigue: $21.8\pm 17.1^\circ$, post-fatigue: $25.6\pm 17.3^\circ$, $p=0.016$). No main or interaction effects were observed at the knee and hip joints ($p>0.050$).

Conclusions: These findings suggest that following mental fatigue, individuals potentially land with stiffer and more internally rotated ankle joints. As stiffer joint landings are considered a risk factor for musculoskeletal injury, this may indicate a negative impact from the decreased level of arousal afforded by mental fatigue.

Total Word Count: 426

[208602LD](#)

Mental Fatigue Modifies Quadriceps Activation During an Unanticipated Jump Landing Task

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Context: Aberrations in neuromuscular control strategies have been tied to increased risk of injury, including ACL ruptures and ankle sprains. However, while physical factors have been observed to affect neuromuscular control, little research has identified the effects of cognitive factors, such as mental fatigue, on neuromuscular control strategies. Therefore, we aimed to investigate muscle activation strategies during anticipated and unanticipated jump landings before and after mental fatigue in un-injured individuals.

Methods: This study implemented a pre-test, post-test design. Thirteen individuals (23 ± 2 yrs, 168.6 ± 9.7 cm, 73.8 ± 14.4 kg, 5M/8F) reported to a biomechanics laboratory for a single test session. Subjects were instrumented with wireless electromyography (EMG) sensors over the vastus lateralis (VL), biceps femoris (BF), tibialis anterior (TA), and lateral gastrocnemius (LG) muscles of a randomly-determined test leg using standard procedures. Participants stepped off a 30cm box placed 70cm from two in-ground force plates. Instructions to jump or cut after landing were either provided before the jump (anticipated) or after initiation of the jump (unanticipated). The cut was performed 45 degrees in the opposite direction of the test leg (e.g. cut left if test leg is right), and the jump was to 50% max height. Participants performed 5 jumps per task and condition before (pre-fatigue) and after a 60-minute mental fatigue intervention (post-fatigue). EMG activity was collected at 1000 Hz, reduced to a complete linear envelope (bandpass filtered 20-400 Hz, rectified, low-pass filtered 10-Hz), normalized to peak activity, and means were extracted 250-ms prior to and 250-ms after force plate contact. Changes were assessed with factorial analyses of variance for condition (anticipated, unanticipated), time (pre-fatigue, post-fatigue), and phase (pre-landing, post-landing) ($\alpha=0.05$).

Results: For the cutting task, VL demonstrated a significant condition-by-time-by-phase interaction effect ($F=5.158$, $p=0.046$). Pre-fatigue, the VL showed a difference between anticipated ($11.6\pm 6.4\%$) & unanticipated conditions ($8.6\pm 3.9\%$, $p=0.016$), with no difference post-fatigue (anticipated: 9.2 ± 2.3 , post-fatigue: 8.7 ± 3.8 , $p=0.710$). A significant condition-by-phase interaction was observed in the TA ($F=10.764$, $p=0.008$) & LG ($F=6.299$, $p=0.031$). Pairwise comparisons revealed for both muscles and phases, activation was greater in the anticipated than the unanticipated condition (TA pre-landing $\Delta 5.3\pm 0.2\%$, post-landing $\Delta 1.3\pm 0.4\%$; LG pre-landing $\Delta 2.0\pm 0.8\%$; LG post-landing $\Delta 0.5\pm 0.2\%$). For the jumping task, a condition-by-phase interaction was observed for TA ($F=6.146$, $p=0.031$), where pairwise comparisons revealed greater activation in anticipated (pre-landing: $22.1\pm 3.7\%$, post-landing: $5.5\pm 0.9\%$) than unanticipated (pre-landing: $16.7\pm 2.4\%$, post-landing: $4.2\pm 0.6\%$; $p=0.031$). Effects of condition or time were not significant for jumps in the VL, BF, LG ($p>0.050$).

Conclusions: Our findings suggest that unanticipated jump landings, where motor plans were interrupted for individuals, led to decreased muscle activation in key lower extremity stabilizers. This difference seemed to be eliminated in the VL following fatigue; however, it remains unclear if this is a positive or negative adaptation.

Total Word Count: 443

200232ID

Mental Toughness, Anxiety and Depression Screening of Collegiate Athletes at Pre-Season, High-Stakes and Post-Season

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Context: Mental toughness (MT) has been considered necessary for individuals to be successful in the athletic setting. A connection has been theorized between MT and mental health, but not yet supported using quantitative data. The purpose of this study was to investigate if MT could be utilized as a predictor of the presence of depression and/or anxiety symptoms. This study also explored if MT, and depression/anxiety symptoms change over the course of a competitive season.

Methods: Data was collected electronically through Qualtrics Survey Software, and followed a cohort study design. 43 individuals (19.42 ± 1.26 years; 24 females, 19 males) participating in a fall team sport (football, women's volleyball, women's soccer, and men's soccer) from the same Division I University participated in the study. Participants were excluded if they had previously been diagnosed by a medical professional with depression or anxiety, and if they experienced time lost due to a concussion, as this may result in psychological changes. Data was captured during pre-season, high stakes, and end of season, and included: demographic information, Mental Toughness Index (MTI), Generalized Anxiety Disorder 7-Item (GAD-7), and Patient Health Questionnaire-9 (PHQ-9). The psychometric properties, reliability, and validity of the MTI across populations of competitive athletes have been supported through previous literature, with a reported internal consistency of $\alpha = 0.86$. Separate linear regressions determined if there was a relationship between pre-season MTI and GAD-7 or PHQ-9 scores. Changes in MTI, PHQ-9, and GAD-7 scores were determined using paired samples t-tests. The alpha level was set at $p < 0.05$, and effect sizes (d) were calculated.

Results: A significant, weak inverse relationship was identified between pre-season MTI scores and pre-season GAD-7 ($r = -0.315$; $p = 0.020$) and PHQ-9 ($r = -0.318$; $p = 0.019$) scores. MTI significantly predicted GAD-7 scores ($\beta = -.315$, $p = 0.04$) and PHQ-9 scores ($\beta = -0.318$, $p = 0.038$), but only explained 9.9% of the variance in GAD-7 scores ($R^2 = 0.099$, $F(1,41) = 4.514$, $p = 0.04$) and 10.1% of the variance in PHQ-9 scores ($R^2 = 0.101$, $F(1,41) = 4.619$, $p = 0.038$). High-stakes PHQ-9 scores were significantly greater than pre-season scores (Pre-season = 2.79 ± 4.209 , High-stakes = 4.64 ± 5.18 ; $p = 0.026$; $d = 0.392$).

Conclusions: Due to the weak inverse relationship between the PHQ-9, GAD-7 and MTI, and weak predictive abilities of the pre-season MTI, mental toughness alone should not be used as a predictor of the presence of anxiety or depression symptoms. Further, the results of the study support screening depression symptoms during periods of high-stakes competition due to the increase in PHQ-9 scores at high-stakes compared to pre-season.

Total Word Count: 433

205491FD

Midfoot Kinematics Using Dynamic Navicular Drop Tests: Assessing Alternative Approaches

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Context: The static sit-to-stand navicular drop test (NDT) and dynamic navicular drop (dND) test, assessed while walking on a treadmill, are frequently used to assess medial arch motion to identify potential injury risk. However, understanding navicular drop throughout other functional movements is not well understood in comparison to frequently used static NDT and dND tests. While walking gait dND analysis is most frequently used, not all clinical sites have access to necessary equipment and technology to conduct an adequate dND nor evaluate the results. Therefore, our objective was to assess navicular position throughout various functional movements (deep squat, drop vertical jump, run, and walk) using minimal technology in order to improve clinician-oriented measures.

Methods: Cross-sectional study completed in a Biomechanics laboratory using moderately physically active individuals ($n=30$; 15 male and 15 female; height= 171.7 ± 8.8 cm; mass= 67.4 ± 19.4 kg; age= 21 ± 2.9 years). Navicular tuberosity position was determined relative to a line connecting the medial aspect of the Achilles insertion to the base of the 1st metatarsal head, see Figure 1. This was assessed in video camera recordings (60fps) of static and dynamic tests by one rater using Kinovea open source sport analysis software. Sit-to-stand static measurements identified navicular position with the test foot in a relaxed, neutral position and in weight bearing. The static tests were used to determine test limb either by greatest static navicular displacement or non-dominant limb with no displacement difference between limbs (20 left, 10 right). Functional assessment of navicular position included 3 trials of walking and running gait, deep squats, and drop vertical jumps. A one-way repeated measures ANOVA was used to determine mean differences in navicular position based on static and functional tests ($\alpha=.05$). Associations of walking dND with static and functional assessments of navicular position were determined with Pearson's correlations ($\alpha=.05$).

Results: The navicular position was significantly affected by the type of static or functional assessment used, $F_{2,76,80.18}=109.70$, $p<.001$, $\eta^2=.79$. The navicular position was significantly higher in static tests than in dND (sit $p<.001$; stand $p=.008$) while the navicular position in dND was significantly higher than the other functional tests ($p<.001$ for run, squat, drop vertical jump). All navicular positions found with static and functional assessments were positively correlated with navicular position identified with dND ($r=0.69-0.75$, $r^2=.48-.56$, $p<.001$).

Conclusions: Static navicular position assessment commonly used in clinical practice may not be sufficient to accurately assess navicular movement throughout functional tasks. Navicular positions were the lowest during the run, deep squat, and drop vertical jump compared to NDT and dND. The functional assessments used minimal technology and can be used by clinicians to better assess navicular drop for physically active patients. Clinicians are encouraged to incorporate additional navicular position functional assessments into their navicular drop screenings.

Total Word Count: 440

208861DD

Minimally Depressed Fracture Involving the Anterolateral Margin of the Lateral Tibial Plateau with Marrow Edema in a High School Football Player

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Background: This level 3 case study focused on the diagnosis, treatment, and recovery of a high school football player with a left tibial plateau fracture. Generally, those with a tibial plateau fracture are unable to walk after the injury. These fractures are common in middle aged adults with osteoporosis and may result from a hard fall or vehicle collisions. Fractures of the tibial plateau may also be caused by varus or valgus forces combined with axial loading or weight bearing on the knee.

Patient: Patient was a 17-year-old male football player. Previous history included right growth plate fracture, 2 years prior to tibial plateau fracture. Patient reported to the athletic trainer complaining of moderate pain on lateral side of left knee from a teammate landing on his knee (i.e., direct valgus force). Patient was able to walk and lightly jog without an increase in pain. However, sprinting lead to pain 5/10 “inside” his knee. Swelling became visible around the joint capsule. Palpation was tender on lateral and posterior aspects of the knee and motion was restricted with knee flexion. Lachman test was done showing slight laxity and causing the patient 7/10 pain. Anterior drawer was unable to be done because of pain. Differential diagnoses included left ACL, MCL and/or meniscus tear.

Intervention & Treatment: Patient was referred for an MRI following the injury report and clinical assessment. MRI showed nondisplaced fracture of lateral condyle of left tibia, initial encounter for closed fracture. Since this was a nondisplaced fracture, the patient ultimately did not need surgery. In a typical tibial plateau post injury protocol, you can expect recovery within 3-4 months, with limited weight bearing and braced for added stability. Therapeutic exercises are needed to maintain leg strength after the injury and into the recovery phase. For this patient, phase I of rehabilitation, 0-3 weeks post injury, was geared towards protecting the area, decreasing pain, inflammation, and partial weight bear with an unlocked brace and crutches. Phase II of rehabilitation, 4 weeks post injury, the patient progressed to full weight bearing without the use of crutches and continued use of a brace. During Phase II, the patient continued with rehabilitation exercises and moved onto more complex skills including sport specific exercises. The goal was to promote healing and regain and improve muscular strength with therapeutic exercises. Phase III of the patient’s rehabilitation program, week 5 post injury, the patient was cleared for practice and competition. Throughout his treatment and rehabilitation, TENS and iontophoresis were used before therapeutic exercises and ice application was applied after therapeutic exercises. During Phase II and Phase III, heat was used before activity and occasionally, soft tissue mobilizations. Therapeutic exercises included stationary bike with little to no resistance in the beginning of the rehabilitation process, along with progressive range of motion exercises.

Outcomes or Other Comparisons: The patient was treated conservatively and has returned to sport full time with a brace. Tibial plateau fractures traditionally require surgery to re-establish alignment of the limb and articular congruency.

Conclusions: This level 3 case study concentrated on the diagnosis, treatment, and forthcoming return of a patient with a minimally depressed fracture involving the anterolateral margin of the lateral tibial plateau with marrow. This case shows an uncommon incident of a tibial plateau fracture in a 17-year-old male, in which the patient was able to walk/lightly jog immediately after injury. Every individual is different and may not present the same signs when it comes to tibial plateau fractures.

Clinical Bottom Line: Despite common signs and symptoms present with traumatic tibial plateau fractures, weight-bearing and ambulation might not be indicative of injury.

Total Word Count: 587

[208223FD](#)

Movement Control Differs with Age in Children

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Context: The incidence of lower extremity injuries, including ACL sprains, commonly peak during adolescence. Previous research demonstrates that movement-based risk factors for injury increase across development in an athletic population, however, these studies are often not generalizable to all youth populations. Understanding how normative movement-based risk factors change during childhood can guide future injury prevention strategies. The purpose of this study was to evaluate differences in movement control, using the Landing Error Scoring System (LESS) between age groups and sexes in a large sample of children.

Methods: A multi-site, cross-sectional study design was used. Participants were recruited to complete a single test session from area schools and youth sport organizations (age range: 6-18years; n=1498, male=651, female=847). Sex and age were reported on a questionnaire completed by parents/legal guardians. Participants were grouped into 3 age categories (elementary school: 6-10years; middle school: 11-13years; high school: 14-18years). Movement control was assessed during 3 trials of a standardized jump-landing task. Jump-landing movement control was assessed using the LESS, which is a valid and reliable clinical tool. Lower scores on the LESS indicate better movement control and reduced risk of ACL injury. LESS scores were graded using one of two methods: by trained human experts or with automated movement assessment software (PhysiMax Technologies Ltd, Tel Aviv, Israel). The average total LESS score across 3 trials was calculated. A two-way analysis of covariance was used to compare LESS scores between age groups and sexes while controlling for method of LESS grading (human, PhysiMax). Pairwise comparisons were evaluated with 95% confidence intervals ($p < 0.05$).

Results: There was a significant difference in LESS scores between age groups ($p < 0.001$) and sexes ($p = 0.017$). Regardless of sex, each age group was significantly different from each other (Mean [95% Confidence Interval]: elementary= 6.6 [6.4, 6.8], middle= 5.7 [5.5, 5.8], high= 4.6 [4.4, 4.8]). Regardless of age, females demonstrated higher LESS scores than males (males=5.5 [5.4, 5.7]; females=5.8 [5.7, 5.9]). No significant interaction between age and sex was present ($p > 0.05$).

Conclusions: Movement control, as measured by the LESS, demonstrated fewer movement errors in older age groups of children when compared with their younger counterparts. Children that do not improve movement control during adolescence may be at future risk of injury. This lack of improvement in movement control may be due to developmental deficiencies. Females demonstrated greater movement errors than males, which is consistent with previous literature and may increase their risk of injury. These results provide the largest comprehensive normative database of LESS values in youth and adolescents. Future research should look to evaluate movement control in children longitudinally to identify specific factors that may influence movement control as children develop.

Total Word Count: 433

207683FD

Multi-Joint Control Strategies Do Not Differ Between Limbs During Single-Leg Triple Hop Landing in ACL Reconstructed Females

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Context: Following anterior cruciate ligament reconstruction (ACLR), approximately 25% of individuals will suffer a second ACL injury. The risk of recurrent injury is partially attributed to asymmetries in strength and function; often quantified by limb symmetry index (LSI) of distance traveled during a single-leg triple hop (SLTH). Unfortunately, clinically acceptable LSI values (>90%) can be achieved in spite of compensatory strategies and/or bilateral deficits in strength and function that mask poor quality of movement. While quantifying total support moment (TSM) impulse to evaluate multi-joint movement strategies could identify potential compensatory mechanisms utilized during SLTH landing, it remains unclear whether individuals who have undergone ACLR and achieve >90% LSI demonstrate similar landing strategies between limbs during the SLTH. Therefore, the purpose of this study was to compare multi-joint landing strategies during SLTH landing in ACLR participants who surpassed >90% LSI.

Methods: Thirteen physically active females (Age: 18.92 ± 1.44 years, Height: 1.63 ± 0.08 m, Mass: 63.04 ± 7.04 kg) who have undergone ACLR and surpassed 90% LSI in a SLTH ($98.45\% \pm 4.34\%$) were included. Kinematics and kinetics were collected bilaterally during the first hop of three SLTH trials using an optical motion capture system interfaced with a single force plate. Net internal extension/plantarflexion joint impulses of the ankle, knee, and hip were quantified by integrating the area under the moment-time curve during the deceleration phase (i.e., initial contact through peak knee flexion). TSM was calculated by summing the impulses across joints. Joint contribution to TSM (i.e., percentage of TSM from the ankle, knee and hip) were calculated along with time-to-peak knee flexion. Net internal joint impulse, TSM impulse, joint contributions to TSM, and time-to-peak knee flexion were averaged across SLTH trials and compared between limbs using a paired-samples t-test or Wilcoxon signed rank test ($\alpha \leq 0.05$).

Results: No significant between limb differences in ankle, knee, or hip moment impulse, TSM, or joint contribution to TSM during SLTH landing were identified. Additionally, there was no significant difference in time-to-peak knee flexion bilaterally (Table 1).

Conclusions: ACLR females who surpass >90% LSI exhibit similar net joint moment impulse magnitudes and individual joint contributions to TSM impulse bilaterally during SLTH landing. Moreover, time-to-peak knee flexion and the overall magnitude of TSM impulse did not differ bilaterally, which suggests that the magnitudes of net joint moment impulse and individual joint contributions to TSM impulse were not skewed by between-limb differences in landing phase duration or TSM impulse magnitude, respectively. While it appears that no multi-joint compensatory mechanisms were utilized by the ACLR limb during SLTH landings, future research should evaluate whether the lack of compensatory between-limb mechanics is consistent during the propulsive phase of SLTHs and if the landing strategy used by these ACLR individuals is similar to a healthy reference group.

Total Word Count: 446

[204845DD](#)

Multiligament Knee Injury with Capsular Avulsion in a Collegiate Football Player

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Background: During a Division II intercollegiate football game, an 18 year old male football athlete was pushed from behind while decelerating, causing a hyperextension and varus force injury to his right knee. Upon sideline evaluation by authors, the patient was neurovascularly intact, and presented with pain and effusion in his R knee. Patient had point tenderness over his medial joint line, lateral joint line, and in his posterior knee. Special Tests on patient's right knee revealed +Valgus Stress, +Varus Stress, +Posterior Drawer, +Posterior Lachman's. Patient has no past medical history of injury to the involved or contralateral knee.

Patient: 18 year old male Division II College Football Player

Intervention & Treatment: The patient was seen the following day by the team orthopedic surgeon. An MRI was performed 96 hours post injury and revealed the following: a grade 3 tear of the PCL, a grade 3 tear of the LCL at the tibial attachment, along with a grade 2 tear of the MCL, avulsion and tear of the posterior medial meniscus, avulsion of the biceps femoris tendon, as well as complete avulsion of the posterior capsule at the tibial attachment. Patient was put in a hinged brace locked at 0 degrees of extension for 4 weeks and was NWB on crutches. In an attempt to have the PCL scar down and allow the capsule to heal, surgery was performed 6 weeks post injury. In surgery, patient underwent a repair of the root of the medial meniscus, biceps tendon reattachment, repair of the LCL with internal fixation, and MCL repair.

Outcomes or Other Comparisons: Following surgery, with vigorous and dedicated rehabilitation by both the patient and the institution's sports medicine team, the patient was cleared for the following intercollegiate football season nine (9) months after his initial injury. Uniqueness: A multiligament knee injury is a knee injury classified where at least two of the 4 major ligaments in the knee are ruptured.¹ Multiligament knee injuries account for approximately 11-20% of all knee injuries, with an incidence rate of 0.002% to 0.2% per year.^{2,5} A knee dislocation is the most common cause of multiligament knee injuries.⁵ The most common ligaments involved in multiligament knee injuries are the ACL and PCL.³ While the PCL will not tear completely and will not need surgical repair, the ACL often tears completely and requires surgical intervention.⁴ This multiligament knee injury included all major ligaments of the knee excluding the rupture of the ACL. Additionally, surgery is often performed soon after injury, but due to the disruption of the posterior capsule surgery was delayed to avoid complications with arthroscopic surgery.

Conclusions: While multiligament injuries are an uncommon occurrence, they can have devastating effects on the athlete and on the return to play of the injured athlete. Although most research of multiligament tears involves the ACL, little if any evidence exists regarding multiligament tears that do not involve the ACL. The clinician must always remember to ensure neurovascular integrity of the injured limb and to advocate for the patient to ensure expedited care.

Clinical Bottom Line: The clinician must always remember to ensure neurovascular integrity of the injured limb and to advocate for the patient to ensure expedited care.

Total Word Count: 517

209474CD

Multivariate Rate of ImpACT Failure in Post-Concussion Recovery in NCAA Athletes and Military Academy Cadets

Marra, CA, Marra, DE, Houck, Z, Clugston, J

Context: Computerized neurocognitive tests are frequently used to evaluate cognitive functioning following sports-related concussion (SRC) and monitor recovery. Reliable change indices (RCI), which characterize statistical evidence for meaningful score change relative to baseline test scores, are typically used to determine post-injury cognitive impairment. The frequency of reliable change depends on the strictness of the RCI cutoff and the number of neuropsychological tests administered (i.e., multivariate base rates). The following study examined the multivariate base rates (MBRs) of reliably changed scores on Immediate Post-concussion Assessment and Cognitive Testing (ImpACT) in NCAA athletes and military cadets participating in the Concussion Assessment, Research, and Education (CARE) Consortium as they follow the return to sport (RTS) protocol.

Methods: Data were retrospectively collected from a large sample of concussed athletes and military cadets (N = 1199, Mage = 19.76). Participants underwent testing at baseline and three post-injury time points: within 24 hours, asymptomatic (MTime = 10.65 days), and unrestricted RTS (MTime = 19.35 days). Qualitative analyses compared the MBR of reliably changed scores across RCI as outlined by Broglio and colleagues (2018). The 90% RCI was used for direct comparison of multivariate base rate of failure based on RCI offered by the ImpACT Administration Manual.

Results: Across multiple RCIs, the majority of athletes had at least one reliably changed score within 24 hours, and the proportion of reliably changed scores decreased at the asymptomatic and unrestricted RTS time points. At 24 hours, fewer athletes had at least one reliably changed score with the 90% RCI provided by ImpACT (33%) compared to 90% RCI provided by Broglio (54%). Prevalence of reliably changed scores with 90% RCI were similar at asymptomatic (23-26%) and unrestricted RTS (20-24%).

Conclusions: The following study documents the MBRs of reliably changed ImpACT scores in NCAA athletes and military cadets during the RTS protocol. At least one reliably changed score is common throughout the RTS protocol (1 in 5 participants). It can be argued that if clinicians require patients to retest until there are no impaired scores they may be unnecessarily withholding participants from resuming normal activity. Thus, clinicians should take into account additional concussion assessments when determining clearance for RTS. Future research will examine the convergence of these findings with other tests as part of the multi-modal assessment of SRC.

Total Word Count: 374

204805MD

Muscle Strength of Scapular Stabilizers in College Baseball Players With and Without a History of UCL Injury

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Context: Ulnar collateral ligament (UCL) injuries are common in overhead athletes and have increased in prevalence among baseball pitchers of all ages. The purpose of this study is to examine the difference between the strength of five scapular stabilizing muscles in college baseball pitchers with UCL injury and those without UCL injury. The hypothesis stating that those participants with UCL injury would demonstrate decreased strength in all five scapular stabilizing muscles.

Methods: Thirty-nine healthy college baseball players, (average age: 20.2 yr, weight: 184 cm, height: 89.4 kg), from a NCAA Division I University and a NCAA Division II College volunteered to participate. Each participant completed a self-guided warm-up and then the strength of five scapular stabilizing muscles were assessed using a hand-held dynamometer. Station one tested latissimus dorsi and serratus anterior while the middle trapezius, lower trapezius, and rhomboids were assessed at station two. To determine the difference between groups independent t-tests were performed with a significance level of $p \leq 0.05$.

Results: The results showed no significant difference in muscle strength for all five muscle strength tests between the two groups. Although not statistically significant, the injured group averaged greater strength than the non-injured group for all five muscles tested.

Conclusions: The findings were not consistent with the hypothesis that college baseball pitchers who experienced UCL injury would demonstrate decreased scapular stabilizing muscle strength. The increase in UCL injuries among baseball players creates a need for identification of risk factors and prevention of these injuries. The results of this study indicated there was no difference in scapular stabilizing muscle strength between college pitchers with and without a history of UCL injury. This may be due to proper rehabilitation following the UCL injury.

Total Word Count: 279

[209371ED](#)

Mysterious Presentation of Mid-Shaft Femoral Fracture

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Background: We present an unexplainable presentation of a mid-shaft femoral fracture in a 19-year-old male, long distance runner. This non-contact injury occurred when the patient was approximately 300 meters into a 5000-meter indoor race while running straight ahead. The patient reported no prior pain or weakness in his leg. The patient was transported via ambulance to a local hospital where a 5 cm displaced mid-shaft, oblique femoral fracture was confirmed with radiographs. The patient underwent surgical intervention to place an intermedullary nail in his femur. He was released from the hospital after 5 days and was cleared by his physician for toe touch weight bearing on crutches, and the use of wheelchair for long distances.

Differential Diagnosis: Underlying pathologies for non-contact femoral fractures include osteosarcoma, stress reaction, and endocrinologic issue.

Intervention & Treatment: In-hospital CT scans were negative for osteosarcomas. Blood work evaluating electrolyte levels, including calcium, were within normal limits. When the patient returned to his college campus, he reported to his athletic trainer for continued care. Additional bloodwork was ordered at this time, including calcium and thyroid-stimulating hormone levels, which all came back within normal limits. The patient had previous bone density scan results for comparison from a prior fibular stress reaction the year before; these results were re-visited and again deemed normal. (z-scores: spine -0.1, left femoral neck -1.5.) The patient was referred to an endocrinologist to review all diagnostic results and hopefully gain understanding as to why the fracture occurred. This physician suggested additional tests including a repeat of earlier bloodwork and a urinalysis to determine if calcium was present; this would indicate that his body was improperly processing calcium. Again, all results came back within normal limits. An additional bone density scan was performed with results that were also within normal limits. Over 6 months, the patient has worked to successfully rehabilitate his leg, focusing on regaining strength to the gluteal, quadriceps, and hamstrings musculature. The patient has returned to running, while continuing to work on strength, activation, and coordination.

Uniqueness: There is currently no known reason for this significant fracture in an otherwise healthy, young individual with no prior history of leg pain. Typically, the cause of a femoral fracture is clear through mechanism, recent history of preceding symptoms consistent with stress reaction, or identification of underlying medical condition through advanced diagnostic testing. Potential underlying conditions to consider include osteosarcoma causing the bone to weaken, or endocrinological issues such as a hormone imbalance. None of these risk factors have been identified in this patient.

Conclusions: This case study is an unusual presentation of a displaced mid-shaft femoral fracture with no known mechanism of injury in a healthy, young individual. Diagnostic testing, including advanced imaging and blood work, can serve an important role in determining underlying pathology following significant musculoskeletal injuries. However, this case also serves to remind athletic trainers how unpredictable the human body can be and the need to support patients even in the face of unexplained injuries.

Total Word Count: 487

[208284LD](#)

Neither Sensory Nor Motor Threshold Transcutaneous Electrical Nerve Stimulation Alters Proprioception After Exercise-Induced Muscle Damage

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Context: Transcutaneous electrical nerve stimulation is a commonly used intervention in athletic training to modulate pain after injury. This intervention is most commonly performed at the sensory threshold (sTENS), modulating pain through gate control mechanisms; however, motor-level TENS (mTENS) may also have clinical utility in pain management through the release of endogenous opioids. There is a paucity of evidence on the role of mTENS on pain modulation after injury, thus we aimed to explore the effect of mTENS and sTENS on proprioception after exercise-induced muscle damage (EIMD).

Methods: This study implemented a randomized controlled trial design. Twenty-four uninjured and untrained participants reported to a biomechanics laboratory twice. Participants were randomly assigned to mTENS (n=8, 71.1±13.6kg, 173.4±6.9cm, 21.3±1.9yrs), sTENS (n=8, 63.3±9.7kg, 166.4±7.2cm, 20.8±0.9yrs), or sham (n=8, 66.1±14.5kg, 171.4±8.0cm, 21.1±1.2yrs) groups. Participants were assessed for passive knee joint position sense (JPS) on an isokinetic dynamometer. The dynamometer demonstrated an angle (between 60-80°) to the participant, then performed 10 trials in which participants were passively moved from 20° to 90° flexion (2-5°/sec) and asked to depress a handheld switch when they perceived they were at the target angle. Ten trials were performed at 5 different angles. Constant error (JPS angle - target angle) and absolute error (|JPS angle - target angle|) were extracted. After initial assessment, participants performed 6 sets of 12 eccentric contractions (20-90° flexion, 90% MVIC) to cause EIMD. Participants then received 30-minutes of either mTENS (4-Hz, 200µs pulse duration, above motor threshold intensity), sTENS(80-Hz, 100µs pulse duration at sensory threshold), or Sham (no stimulation) before being assessed for JPS again. Participants returned 48-hours later and were assessed for JPS, re-treated with TENS, and re-assessed for JPS. Differences in dependent variables were assessed with group-by-time analyses of variance ($\alpha=0.050$).

Results: No group-by-time effects were observed for constant ($F=0.516$, $p=0.794$) or absolute error ($F=0.556$, $p=0.763$). However, significant main effects of time were present for constant error ($F=3.523$, $p=0.020$), but not relative error ($F=2.568$, $p=0.062$). Pairwise comparisons revealed constant error worsened from Day 1 Pre ($-2.83\pm 5.48^\circ$, $p=0.029$) and Post-treatment ($-2.66\pm 5.93^\circ$, $p=0.032$) to Day 2 post-treatment ($-6.13\pm 7.83^\circ$).

Conclusions: Our results suggest that TENS treatment did not impact knee joint proprioceptive acuity following EIMD. EIMD has been proposed as a potential model to understand the neural effects of injury in a controlled model. As constant error worsened, this indicated subjects became more likely to under-shoot target angles at the final time point. This may indicate that 30-minutes of sitting 48-hours after EIMD negatively affects JPS.

Total Word Count: 406

[206505LA](#)

Neural Correlates of Knee Extension Exercise and Single Leg Hop Performance Following Attentionally Focused Neuromuscular Training

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Context: Attentional focus theory provides a framework to understand motor skill development. There are early reports of neural changes in response to changing focus of attention during simple exercise. However, little is known of neural correlates that correspond to motor performance changes that result from neuromuscular exercises delivered with external and internal foci. **Objective:** Determine changes in functional performance and brain activation during knee extension exercise across 8 weeks of attentionally focused neuromuscular training.

Methods: Prospective controlled trial. **Setting:** Neuroimaging and biomechanics laboratories. **Participants:** Twenty-nine healthy, recreationally active participants (12 males, 17 females age = 21.9 ± 3.2 yrs, height = 1.67 ± 7.8 m, mass = 68.5 ± 13.4 kg). **Interventions:** Participants were randomly assigned to external, internal, or no focus of attention neuromuscular training groups. The training groups performed lower extremity body-weight strength and stabilization exercises 3x/week for 8 weeks. Attentional focus was directed either externally or internally each session by a research team member. Sets/repetitions were equal across groups. Neuroimaging was performed at baseline and following 8 weeks of training. Participants completed unilateral left 45° knee extension/flexion movements at a rate of 1.2 Hz laying supine in a MRI scanner for 4 blocks of 30 seconds interspersed with 30 second rest blocks. Single leg hop testing was assessed pre and post. **Main Outcome Measures:** Delta scores in single leg hop distance were calculated and assessed with Cohen effect sizes. First level fMRI analyses identified neural activity associated with movement by contrasting move blocks with rest blocks. Baseline to post-training fMRI changes within each group were then contrasted using a mixed-effects general linear model with an a priori cluster threshold of $Z > 2.3$ and $p < .05$.

Results: There were no differences between groups in baseline Tegner scores (External= 5.2 ± 1.9 ; Internal= 5.0 ± 1.2 ; Control= 5.3 ± 1.3 ; $p = 0.92$): Medium-to-large effect sizes of increases in single-leg hop performance (ES = 0.74 and 1.25) were noted of external (20.0 ± 11.6 cm) compared to internal (10.3 ± 13.2 cm) and control (5.0 ± 11.4 cm) groups across 8 training weeks. The external group had an increase in activation from pre-to-post in the left putamen (cluster size = 297 voxels, $Z_{min-max} = 2.3-3.2$, $P \leq .016$; MNI coordinates $Z_{max} X = -18$, $Z_{max} Y = 16$, $Z_{max} Z = -4$). There were no differences in pre-to-post brain activation in control and internal focus groups.

Conclusions: In accordance with previous work, the largest gains in motor performance were found in the external focus training group. Given the importance of the putamen in spatial cognitive processes in motor control, the increased putamen activity in the external group following the intervention may be a neural correlate to help explain the mechanisms underlying attention focus theory. Future investigations should continue to investigate neural mechanisms underlying the acquisition of motor skills.

Total Word Count: 427

[207133LD](#)

Neural Excitability of Fibularis Longus During Single-Leg Balance in Patients with Acute Lateral Ankle Sprain

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Context: Alteration in the central nervous system to respond to postural disturbance is thought to be a major contributor to impaired postural balance in patients with chronic ankle instability. However, it remains questionable whether the alteration in CNS exists at the early phase of ankle sprain while maintaining a single-leg balance. The purpose of the study was to examine the effect of acute lateral ankle sprain (ALAS) on neural excitability of fibularis longus during single-leg balance.

Methods: Case-control study was conducted in sports medicine laboratory setting. Fourteen patients with ALAS that had occurred within 14 days (4 men, age=20.2±2.7yrs, height=172.1±8.9cm, weight=70.2±8.8kg, days of injury= 8.4±3.6 days) and 14 healthy individuals without any history of ankle sprain (5 men, age=20.7±2.3yrs, height=172.6±8.7cm, weight=67.2±15.5kg) participated. All participants completed two separate neural excitability tests in one day. Participants were asked to maintain single-leg balance with the injured side in the ALAS group or dominant side in the healthy control group throughout the neural excitability tests. Neural excitability tests consist of (1) the Hoffmann reflex (H-reflex) for measuring spinal excitability and (2) Transcranial Magnetic Stimulation (TMS) for measuring corticospinal excitability. For H-reflex, peripheral electrical stimulation was utilized to stimulate the sciatic nerve just before bifurcation into tibial and common fibular nerve in the popliteal fossa to elicit both H-reflex and motor responses of the fibularis longus muscle. We recorded five trials of maximum H-reflexes (H-max) and motor responses (M-max). For motor evoked potential (MEP), TMS was used to excite a cortical area innervating the fibularis longus muscle. We collected ten trials of MEP at a TMS intensity of 100%,120%, and 140% of active motor threshold. For the main outcome measures, averages of five trials of H-max and ten trials of MEP responses were normalized to the M-max average to compare neural excitability between groups. Separate independent t-tests were conducted with an alpha level set at .05.

Results: There were no statistical significant difference for any of neural excitability measures in ALAS compared to healthy controls: Hmax:Mmax ratio (p=0.118, ALAS=0.31±0.2, healthy control=0.23±0.1, d=0.61), MEP100%AMT :Mmax ratio (p=0.901, ALAS= 0.16±0.1, healthy control= 0.16±0.1), MEP120%AMT:Mmax ratio (p=0.392, ALAS=0.23±0.1, healthy control=0.19±0.1), and MEP140%AMT:Mmax ratio (p=0.361, ALAS=0.27±0.2, healthy control=0.22±0.1).

Conclusions: The current study showed that alteration of spinal and corticospinal excitability of fibularis longus was not present in the patients with ALAS. However, despite the statistical insignificance, the moderate effect size in spinal excitability may suggest the potential compensatory mechanism with facilitated H-reflex of the evertor muscle to maintain single-leg balance.

Total Word Count: 407

[206752FA](#)

Neuromuscular Characteristics Are Altered in Female Soccer Athletes Following 9-Weeks of Elevated Training Load

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Context: Excessive training load (TL) is associated with increased injury rates in athletes. Alterations in neuromuscular profile are theorized to mediate the relationship between excessive TL and injury. However, research has not investigated if an athlete's neuromuscular profile is altered following a period of high TL exposure. The primary purpose of this study was to investigate if lower extremity range of motion (ROM), movement quality, and power output in female soccer players were negatively affected following a period of high TL from pre-season to mid-season. A secondary purpose was to explore if cumulative TL was associated with negative changes in lower extremity ROM, movement quality, and power output.

Methods: Female Division 1 soccer athletes ($n=29$, age = 19.8 +/- 1.4 yrs, ht 66.2 +/- 2.2 in, wt = 142.9 +/- 15.1 lbs) participated in this study. A repeated-measures design was employed where all athletes performed testing at pre-season (2-days before first practice) and mid-season (following 9-weeks of training and competitions). All testing included measurement of ROM (ankle dorsiflexion, hip internal and external rotation), movement quality (number of movement errors observed during a single-leg squat, double-leg squat, and jump-landing task), and power output (maximal effort counter-movement jump). During the 9 weeks between pre-season and mid-season testing, daily recordings of session ratings of perceived exertion (sRPE) (0-10 scale) and training/competition duration (minutes) were taken to quantify TL. Cumulative TL was measured by summing the daily TL values from pre-season to mid-season. Paired t-tests compared pre- and mid-season values for all dependent variables ($\alpha < 0.05$). Pearson correlations determined associations between the change (mid-season – pre-season) in each dependent variable with cumulative TL.

Results: ROM values for right ($p=0.002$) and left ($p=0.001$) hip external rotation, as well as right ($p=0.006$) and left ($p=0.003$) total hip rotation were decreased (Table 1). Contrastly, ankle dorsiflexion was significantly increased on both right ($p=0.002$) and left ($p=0.003$) sides (Table 1). All significant ROM changes were accompanied by moderate effect sizes (range=0.55 to 0.71) (Table 1). There were no significant changes in movement quality or power output ($p > 0.05$) (Table 1). Changes in right hip external rotation ROM ($r=0.45$, $p=0.015$) was the only variable associated with cumulative TL from pre- to mid-season.

Conclusions: Hip external and total rotation ROM were revealed to undergo negative changes (decreased ROM) from pre- to mid-season in elite female college soccer athletes. Thus, hip rotation ROM should be monitored and managed in female college soccer athletes. Reduced hip rotation ROM was not associated with cumulative TL based on sRPE measures. Further research is needed to understand whether reductions in hip external and total rotation ROM are influenced by alternative TL metrics and mediate future risk of injury.

Total Word Count: 438

200131AD

Nicotine Overdose in a High School Football Athlete

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Background: The patient was a 15-year-old male football player with no apparent history of seizures, diabetes, or neurological conditions. The patient arrived at the site of a game on August 23, 2019 unconscious. Teammates and coaches reported the patient was seen conscious and alert approximately 15 minutes prior to evaluation by certified athletic trainer (ATC). Teammates reported patient had used vapor nicotine delivery device before losing consciousness. No cyanosis, pallor, or other discoloration. The patient did not respond to sternal rub. The patient did not feel hot upon palpation. No visible airway blockage, but chewing tobacco was removed from the patient's mouth. Radial pulse (70 beats per minute), oxygen saturation (98%), blood pressure (102/74), respirations (60 per minutes). ATC was unable to note pupillary reaction to light (PERRLA) on scene. Emergency medical services (EMS) later confirmed PERRLLA. Personal nicotine delivery device and multiple nicotine pods were found in the patient's pocket. EMS was activated, the patient was transported via ambulance to a local hospital, then airlifted to a larger local hospital. The patient experienced seizures during the airlift. After hospital evaluation, the patient was put in a medically induced coma for 10 hours. Further neurological testing was performed after the patient gained full consciousness.

Differential Diagnosis: Nicotine poisoning, seizure, and concussion.

Intervention & Treatment: Testing confirmed patient had experienced nicotine overdose. Concussion return to play protocol was initiated after the patient was cleared by a neurologist. Patient performed cardio, sport-specific drills, non-contact practice participation, and full contact practice participation before full return to play on September 12, 2019.

Uniqueness: The patient was under the legal age to purchase tobacco products but had obtained a vapor nicotine delivery device and chewing tobacco. The patient's pulse was within normal limits. Early signs of nicotine poisoning typically present increased heart rate, increased blood pressure, and increased respiratory rate.^{1,2} The patient only had an increase in respiration.

Conclusions: Approximately 4.7 million middle and high school students use at least one form of tobacco product.³ The use of tobacco/nicotine products in athletics is apparent. The dangers of nicotine products must be addressed in youth populations.

Total Word Count: 342

205344ED

Non-Contact Femoral-Tibial Dislocation With Peroneal Nerve Palsy in a High School Football Linebacker

Briles MW; Tew BJ; Mason RA; Xerogeanes JW: Emory Sports Medicine

Background: The patient is a 17-year-old, male, high school American football linebacker with no previous injury history to his right knee who suffered a non-contact femoral-tibial dislocation during football practice.

Differential Diagnosis: The school's athletic trainer provided initial on-site care as the patient was in excruciating pain and his knee visibly dislocated at the femoral-tibial joint. The injury was sustained when he stepped in a hole on the football practice field causing him to trip and fall, creating a simultaneous transverse and varus force at the knee without external contact. The emergency action plan was activated, and the athletic trainer performed a lower leg neurovascular assessment and found that both myotomes and circulation were compromised. When applying a straight-leg immobilizer, the knee spontaneously reduced, and vitals were subsequently rechecked and had not improved. EMS arrived and removed the immobilizer and applied a vacuum splint to the patient's leg. The patient was taken to a level one children's trauma center where MRI and vascular evaluation took place.

Treatment: An MRI of the injury revealed tearing to the ACL, PCL, LCL, and MCL. Additional follow up occurred with the team's orthopedist early the following week for evaluation, bracing, and referral to physical therapy centered on regaining range of motion and quadriceps activation. A lack of resolution to the patient's foot drop was noted at three months and an EMG was carried out to assess peroneal nerve function. EMG revealed right peroneal sensorimotor neuropathy with a severe axonal loss with distal muscles showing signs of denervation and no voluntary activity. In the weeks following the EMG, an orthopedic surgeon was brought in and carried out reconstruction of the ACL with a quad tendon autograft, reconstructed the LCL using a tibialis anterior allograft, and reconstructed the posterolateral corner of the right knee. The patient continued a course of physical therapy consistent with ACL reconstruction. Two weeks after his surgery, he met with an additional orthopedic surgeon to discuss a peroneal tendon transfer to address the foot drop associated with the peroneal nerve palsy and is presently scheduled for surgery. At the time of abstract submission, the patient was doing very well with regards to his knee. Though fighting an extension lag, his rehabilitation was progressing normally, and he was able to accomplish activities of daily living utilizing an ankle and foot orthosis. However, the extent of his nerve damage was severe and the prognosis for regaining full function of the peroneal nerve, even with surgery, was poor.

Uniqueness: Knee dislocations are a rare injury that can have serious complications including irreparable nerve damage and amputation of the affected limb. They have an estimated prevalence of <0.02% and of these injuries, 14-40% have an associated peroneal nerve palsy. This is due to the peroneal nerve's anatomical location tight against the fibular head and its poor tolerance to accommodate stretch and shear forces. Non-surgical interventions for peroneal nerve injuries are associated with long-term use of an ankle and foot orthosis and alteration of gait into a vaulting or circumduction pattern, thus affecting lower extremity function and satisfactory activities of daily living. If the popliteal artery is compromised and the injury is not treated within 8 hours, the chance of amputation of the limb is 86% compared to 11% with prompt treatment. Failure to recognize and correctly manage a knee dislocation can cause catastrophic damage through these neurovascular complications.

Conclusions: Recognition and appropriate acute treatment of this rare, but serious injury are paramount for preventing loss of limb, resuming normal activities of daily living, and having any chance of returning to competitive athletics.

Word Count: 596

[208741DD](#)

Non-Contact Total Knee Dislocation of the Posterolateral Corner in a College Football Player

Rudd K, Martinez RE, Odai ML: Florida International University, Miami, Florida

Background: This is a level 4 case-study of a 21-year-old, male, NCAA D1 Football Wide Receiver. Patient-reported he “hyperextended” his knee while stepping to catch a football. Patient denied contact with another player as he fell to the ground. Patient was unable to stand and reported no initial pain, but edema over the insertion of the bicep femoris was evident. The initial examination was performed by an athletic trainer with 35 years of experience. Upon examination, special tests revealed a positive varus stress test and negative valgus stress test, Lachman, anterior drawer, and posterior drawer.

Differential Diagnosis: Lateral collateral ligament and anterior cruciate ligament sprains. An MRI was ordered to help determine the extent of the injury.

Intervention & Treatment: Patient was reexamined by the team physician who reported the same results as the athletic trainer. The MRI revealed complete tears of the ACL, distal fibers of LCL, and a bicep femoris tendon retraction off the fibular head of approximately 2 cm. Additionally, a partial tear in the mid-proximal fibers of the PCL, a mildly sprained MCL, and a minor peripheral tear in posterior horn of the medial meniscus were also present. The MRI also confirmed an anteromedial bone contusion on the medial femoral condyle and posterolateral soft-tissue edema, joint effusion, and tear of proximal fibers of the popliteus. Patient began treatment the day after surgery. Patient began treatment with laser therapy, patellar and scar mobilization; as well as ankle, quadricep, and hip strengthening. Five weeks post-op, treatment also included core, balance, hip, quadricep, hamstring, and calf strengthening. Henrich stated that more advanced strength training should begin 25-36 weeks after surgery, while a post-surgical brace should be taken off 7-10 weeks after surgery [1]. This patient began advanced strength training about 13 weeks post-op and his brace was removed 7 weeks following his surgery.

Uniqueness: Typically, in a total knee dislocation, patients would test positive in more than one of the exams previously mentioned, if they are even administered. Knee dislocations can be defined as a tear of both cruciate ligaments in conjunction with one collateral ligament. However, knee dislocations can still be diagnosed with an intact cruciate ligament. If a patient experiences extreme valgus or varus instability in full extension or exaggerated hyperextension, it can signify a possible knee dislocation.¹ The most common direction for knee dislocations include anterior (30%), posterior (22%), lateral (15%), medial (4%) and rotary (4.5%).² This patient experienced a posterolateral, rotary, dislocation due to high impact forces delivered to the knee. Typically, high-velocity dislocations are paired with extremely violent forces, while low-velocity knee dislocations are associated with soft-tissue damage.¹ While total knee dislocations are not uncommon, this case is. This patient experienced a total knee dislocation in his posterolateral corner with a non-contact mechanism of injury. Despite all signs were consistent with a LCL sprain, the severity of and the extent of damage was unknown until after diagnostic imaging.

Conclusions: This level 4 case study followed the evaluation, diagnosis, and treatment of a non-contact knee dislocation. This case showcases non-traditional clinical manifestation of a knee dislocation as all signs and symptoms were consistent with a LCL injury. As a result, clinicians should remain cautious and consider the possibility of traumatic injury even when evaluative findings are not life and limb-threatening.

Total Word Count: 539

[205482ED](#)

Non-Operative Management of a Proximal Anterior Cruciate Ligament Avulsion in an Adolescent Volleyball Player: A Case Study

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Background: The anterior cruciate ligament (ACL) is the most commonly injured ligament. ACL avulsion injuries are more common than mid-substance tears in the skeletally immature population, and frequently occur at the tibial attachment. The purpose of this Level 3 case study is to present and discuss the management of a 15-year-old (177.8cm, 71kg) volleyball player who sustained a proximal femoral avulsion of her ACL.

Patient: While participating in a club volleyball tournament, the patient landed on her left leg upon which she felt her knee twist and pop. The patient was able to continue participating for the rest of the day with mild pain. The next morning she awoke with increased pain, visible swelling, and was unable to participate in the matches. Two-days post-injury she was evaluated by a sports medicine physician. The patient rated her pain 7/10 and stated it was sharp and stabbing in nature. Examination revealed a small effusion, a 5° knee extension deficit and 130° of knee flexion. She was tender to palpate along the lateral joint line and the lateral femoral condyle. Manual muscle testing of both the quadriceps and the hamstrings was strong and no laxity was noted with ligamentous testing. Patellar manipulation and patellar grind were painful, all ligamentous tests were unremarkable. Routine x-rays of the knee revealed no fracture and normal joint spacing and alignment. The patient was referred for an MRI of her knee without contrast. The patient presented for re-evaluation and MRI follow-up 4-days post-injury upon which her Lachman's and anterior drawer tests were positive for laxity, and the MRI results revealed a proximal femoral disruption of the ACL. The patient was diagnosed with a proximal ACL avulsion and referred to her ATs to begin conservative treatment.

Intervention & Treatment: Four-days post-injury the patient began the first phase of rehabilitation (weeks 1-2) which focused on decreasing pain, eliminating swelling, increasing ROM, and gait retraining. Weeks 3-5 focused on improving lower extremity strength with exercises that progressed in difficulty. At the 1-month follow-up evaluation the patient reported she had experienced no instability. Her examination revealed no ligamentous laxity and a slight quadriceps strength deficit when compared bilaterally. At this time the patient was cleared to begin a running progression. Weeks 6-8 focused on increasing strength, normalizing her running gait and incorporating sport specific activities. At 2-months post-injury, the patient was cleared to begin volleyball activity. Prior to her full clearance, she performed functional testing with her ATs. She scored above the recommended 90% limb-symmetry index for the single leg hop, triple hop, and the six meter hop and was at an 89.2% for the crossover hop. During this time (weeks 9-12) the patient continued rehabilitation three times a week and gradually progressed back to volleyball activity under the supervision of the ATs.

Outcomes or Other Comparisons: At 12-weeks post-injury, the patient successfully participated without restrictions in a club volleyball tournament. The patient completed her club volleyball season without any further issues. The reported cases of proximal ACL avulsions in the skeletally immature population were primarily treated with surgical reconstruction. To our knowledge, there have been no cases of proximal ACL avulsions treated with conservative management reported in the literature. This case is unique because the patient was able to complete conservative rehabilitation and return to participate in club volleyball approximately 2-months post-injury.

Conclusions: Proximal avulsion fractures are rare in the pediatric athlete. A well designed treatment plan and interprofessional collaborations resulted in a positive outcome for this patient.

Clinical Bottom Line: Although rare, ATs should be aware of the non-operative management of proximal ACL avulsions in the adolescent population.

Total Word Count: 585

204684ED

Non-Operative Treatment of an Unstable Acetabulum Fracture in a Collegiate Football Player: A Case Report

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Background: A 19-year-old male collegiate football player presented to the athletic training room with acute posterior left hip pain following a plant and twist mechanism. The athlete reported no previous history of hip or lower leg injury, and was evaluated immediately after injury. The athlete was point tender along the posterior hip musculature, and reported pain with hip internal rotation. The athlete demonstrated a 4/5 resisted range of motion with hip internal and external rotation, and had negative Log Roll and Hip Scouring Tests. At the time, the working diagnosis was a hip external rotator strain. Following initial evaluation and icing, a plan was made for a re-evaluation the following morning.

Differential Diagnosis: Piriformis strain, Other hip external rotator strain, Posterior hip subluxation, Acetabulum injury.

Intervention & Treatment: Day 2, the athlete returned to the athletic training room complaining of a significant increase in pain along with an antalgic gait. At this time, the athlete's Log Roll test was positive, and the athlete was referred to the team physician. Day 3, the athlete was seen by the team orthopedic physician where x-rays revealed a posterior acetabulum fracture. The physician concluded that the athlete had suffered from a posterior subluxation of the coxofemoral joint, and an arthrogram MRI was ordered for further evaluation. Day 4, the arthrogram MRI revealed an osseous labral fragment projecting from the posterior acetabulum. The athlete was placed on crutches with 50% weight-bearing with standard hip precautions. Week 2, follow up x-rays revealed no significant signs of healing. The athlete was re-educated on crutch use, and began rehab to regain range of motion. Week 6, a follow-up MRI showed no evidence of osseous union. The attending radiologist recommended ordering an arthrogram MRI or CT Scan to allow for better evaluation. Week 8, a CT scan with no contrast revealed a 1mm displaced fracture fragment with no signs of healing. Following interpretation of the results, the team physician sat down with the athlete to discuss the risk of future injury, and cleared the athlete to progress his strengthening exercises while continuing to avoid deep hip flexion. The athlete then progressed to jogging on an underwater treadmill, and limited core and hip exercises in the weight room. Day 104, athlete returned to full football activities. Day 106, the athlete reported mild soreness, and was instructed to continue his rehabilitation to improve core and hip strength. Day 124, follow-up x-rays showed signs of healing, and plans were made for future follow-up to evaluate for avascular necrosis.

Uniqueness: The athlete suffered from a non-contact posterior hip subluxation that did not present with the traditional symptoms. The athlete also reported an atypical mechanism for this injury. Non-surgical treatment was chosen due to the age of the athlete, and the potential for success via conservative management. The athlete was allowed to return to play with a potentially unstable hip.

Conclusions: Current research supports surgical treatment of displaced acetabulum fractures. Additionally, there are no treatment guidelines for "clinically stable" acetabulum fractures. However, it is important for clinicians to take into account patient centered outcomes. Treatment plans must always incorporate the goals and specific demographics of your patient. Evaluation and re-evaluation are crucial for the success of any rehabilitation program.

Total Word Count: 527

209211ED

Non-Surgical Treatment for Medial Ankle Sprain with Avulsion Fracture

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Background: Level 3 CASE Study focused on the diagnosis, treatment and recovery of a female basketball player with a medial ankle sprain and avulsion fracture from the anterior colliculus. Ankle sprains are one of the most common injuries in basketball as 69.1% of women both professionally and collegiately have suffered a form of ankle sprain (either medial or lateral) and of those 60% have suffered multiple sprains. Less than 15% of ankle sprains involve the medial structures. Chronic ankle instability is characterized by recurring giving way, usually of the lateral ankle.

Patient: Patient is a 20 year old female collegiate basketball player in her 3rd year of eligibility. The patient has history of lower legs injuries bilaterally including right ankle dislocation 8 years prior. Patient experiences bilateral chronic ankle instability. Patient described a multi-directional mechanism of injury (inversion, plantarflexion, eversion) while playing basketball and complained of radicular pain in lateral and medial malleoli with swelling. On field test performed included anterior drawer, talar tilt and Kleigers which all produced unremarkable results as the patient has laxity in both ankles and bi-lateral comparison is not useful. Strength was normal but the patient did not return to the game. She was placed in a walking boot and treatment was started immediately to reduce pain and swelling. She was able to finish the last two weeks of the season and played with ankle heavily taped. Follow-up evaluation revealed a positive tuning fork test and she was referred to an orthopedic physician who ordered diagnostic imaging. X-rays were normal but MRI revealed an avulsion fracture from the anterior colliculus with minimal displacement as well as enthesopathy of medial malleolus, anterior tibiotalar osteophytes and anteromedial osteophytes.

Intervention & Treatment: She was given 3 options: play with pain, conservative treatment, or surgery for ligament repair and internal brace augmentation. Return to play following surgery was described as 4-6 months so she chose conservative treatment. She was given a cortisone shot and placed in a boot for 2 months. She was not to perform any rehabilitation during this time. After 2 months, she began rehabilitation focusing on ROM and strengthening. She wore an ankle brace all day for the next month

Outcomes or Other Comparisons: Patient was cleared to return to practice 3 months following diagnosis. She continues treatment to maintain strength and wears an ankle brace while playing.

Conclusions: This case highlights an avulsion fracture of the anterior colliculus. This case highlights a unique medial ankle injury that was treated conservatively to reduce recovery time. The diagnosis was based on diagnostic imaging as the clinical evaluation produced unremarkable findings except for pain. Although surgery was recommend due to general instability, conservative treatment posed less complications and reduced the time of return to play.

Clinical Bottom Line: Chronic ankle instability may mask signs and symptoms of a new injury and diagnostic imaging may be required to accurately diagnosis.

Total Word Count: 468

209545AD

Non-Time Loss and Time Loss Injuries in Secondary School Girls' Volleyball Athletes: A Report From the National Athletic Treatment, Injury and Outcomes Network

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Context: Volleyball is a popular high school sport and female athletes are susceptible to injuries that affect all body regions. While many girls' secondary school volleyball injuries may result in time loss (TL), more insight about non-time loss (NTL) injuries is needed to inform athletic trainers of injury trends so that effective prevention and management strategies can be implemented. The purpose of this study was to describe the epidemiology of NTL and TL injuries sustained by girls' secondary school volleyball athletes during participation.

Methods: This descriptive epidemiology design included data from 74 unique secondary schools with girls' volleyball, representing 136 team-seasons collected from the National Athletic Treatment, Injury, and Outcomes Network (NATION) injury surveillance program during the 2014/2015 through 2018/2019 academic years. Athletic trainers reported all injuries and exposures. Injury counts, rates (IR) per 1,000 athlete-exposures (AEs), and rate ratios (IRR) were reported with 95% confidence intervals (CI).

Results: NATION captured a total of 524 injuries over 196,576 AEs for girls' volleyball, producing an injury rate of 2.67/1,000AEs (95%CI:2.44,2.89). The overall injury rates were higher in competition (IR:3.46,95%CI:2.98,3.94) compared to practice (IR:2.33, 95%CI:2.08,2.59). The overall IRR between competition and practice was 1.48 (95%CI:1.24,1.77). The NTL (IR:1.31; 95%CI:1.15,1.47) and TL (IR:1.34; 95%CI:1.18,1.50) injury rates were similar. For competition, 78 (39.2%) injuries were NTL and 118 (60.2%) were TL, producing a NTL injury rate of 1.36/1,000AEs (95%CI:1.06,1.66) and TL injury rates of 2.05/1,000AEs (95%CI:1.68,2.42). The IRR for NTL to TL competition injuries was 0.66 (95%CI:0.50,0.88). For practice, 176 (55.0%) injuries were NTL and 144 (45.0%) were TL, producing a NTL injury rate of 1.28/1,000AE (95%CI:1.09,1.47) and TL injury rate of 1.05/1,000AE (95%CI: 0.88,1.22). The IRR for NTL to TL practice injuries was 1.22 (95%CI:0.98,1.52). Overall, the most common body locations for injuries were to the ankle (n=140, 26.9%; NTL:n=56, 21.7%;TL:n=84, 31.9%), knee (n=59, 11.3%; NTL:n=33, 12.8%, TL:n=26, 9.9%), hand/wrist (n=59, 11.3%; NTL:n=32, 12.4%, TL:n=27, 10.3%) and head/face (n=59,11.3%; NTL:n=14, 5.4%; TL:n=45, 17.1%). The majority of all injuries in competition and practice were sprains (n=176, 33.8%; competition: n=66, 33.7%; practice: n=110, 34.4%), strains (competition: n=28, 14.3%; practice:n=44, 13.8%), and concussions (competition: n=28; 14.3%; practice: n=18, 5.6%).

Conclusions: The NTL injury rates were higher in practices, whereas TL injury rates were higher in competitions. NTL and TL injuries require different management plans and knowing when they occur can ensure best delivery of care. Effective prevention programs should be implemented to address the high proportion of NTL injuries, particularly lower extremity sprains and strains, suffered in girls' volleyball athletes in practice. Athletic trainers should also be prepared to manage TL injuries, such as concussions, that more commonly occur during competition when play may be more intense.

Total Word Count: 437

[206794FD](#)

Novel Brain Mechanisms Regulating Anterior Cruciate Ligament Injury Risk Biomechanics Utilizing a Motion Analysis System Integrated with Functional Magnetic Resonance Imaging During Lower Extremity Movement.

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Context: Altered neural control is considered a contributor to anterior cruciate ligament (ACL) injury. Emergent research preliminarily identified brain activity biomarkers for ACL injury; however, technological limitations precluded prior investigations from simultaneous assessment of brain activation and ACL injury risk biomechanics. We have overcome these limitations using a custom motion analysis system that quantifies lower extremity kinematics during brain functional magnetic resonance imaging (fMRI). The purpose of this study was to employ integrated technologies to determine the specific neural substrates associated with ACL injury risk biomechanics.

Methods: Fifteen young healthy female soccer players (14.7±1 yrs; 169.7±7.3 cm; 147.1±50.61 kg) were positioned supine in a 3-Tesla MRI scanner and completed a series of right leg, combined ankle, knee and hip extension and flexion movements against resistance (i.e., a 'leg press') during brain fMRI. Participants completed this closed kinetic chain exercise to a reference beat of 1.2 Hz, with systematic rest and move blocks. Mean peak knee abduction angle during movement phases was measured simultaneously using a custom, MRI-safe single camera motion analysis system (Figure 1). Standard fMRI processing was completed for both lower level subject contrasts (movement – rest) and higher-level analyses (mean group brain activation) using a z threshold of 3.1, $p < .001$, and Gaussian random field cluster corrections. Participants' demeaned knee abduction angles during all movements were correlated with resultant mean group brain activation, and appropriate statistical corrections were made to account for multiple, voxel-wise comparisons.

Results: Increased mean peak knee abduction angle during closed kinetic chain movements was significantly associated with brain hyperactivity within clusters primarily located in the left middle frontal gyrus ($z_{max} = 5.14$, $p < .001$), left posterior cingulate cortex ($z_{max} = 4.52$, $p < .001$), left cerebellum lobule V ($z_{max} = 4.35$, $p < .001$), and left angular gyrus ($z_{max} = 4.30$, $p < .001$) (Figure 1).

Conclusions: The present results indicate distinct brain mechanisms directly associated with frontal plane knee abduction and may regulate movements related to ACL injury risk. These regions are important for both attention (middle frontal gyrus, posterior cingulate cortex) and sensorimotor control (cerebellum) and are also integrally involved in the resting-state connectivity of the default mode network (DMN; angular gyrus, posterior cingulate cortex). These data share similarities to previous electroencephalography findings demonstrating that aberrant knee positions may be due to dysfunctional DMN complexity that is constraining network transitions from rest to movement, as well as fMRI findings indicating altered sensorimotor connectivity as a prospective biomarker for ACL injury. Future research with other fMRI lower extremity exercises (e.g., open kinetic chain movements) and additional biomechanical measurements (e.g., hip kinematics) are warranted to further deconstruct the specific brain mechanisms regulating biomechanics associated with ACL injury risk.

Total Word Count: 441

208363QD

Odds of Having Standing Orders by Employment Provider Type and Status in Secondary School Athletic Trainers

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Context: Subject to each states' athletic training practice act, secondary school athletic trainers (ATs) often work under the direction of an overseeing or supervising physician or other licensed healthcare provider. Best practices routinely require standing orders to be approved and signed off annually, however this best practice is often assumed or absent putting the AT at risk for liability. The purpose of this study was to determine the odds of having standing orders by the type of employment provider, the level of AT employment and school type.

Methods: Secondary school ATs who completed the Athletic Training Locations and Services (ATLAS) survey from August 15th, 2018 to September 29th, 2019; (n=3580) were included in the analysis. Respondents who did not complete the question of interest were excluded due to response bias. The level of AT employment included full time, defined as the secondary school AT providing services to the school ≥ 30 hours/week, ≥ 5 days/week and ≥ 10 months/year, while part time, was defined as anything less than full time. School type included public and private schools. Employment provider types included school district employee/teacher (SD) and medical/university facility (MUF). Respondents must have answered if a physician or other licensed healthcare provider signs off on their standing orders. Pearson's Chi-Square, odds ratio (ORs) with 95% confidence interval (CI), and likelihood ratios (LR) were calculated in order to determine the relationship between secondary school ATs and standing orders within the level of AT employment, school type and employment provider.

Results: The odds of standing orders by employment provider, the level of AT employment, and school type are displayed in Table 1. Full time ATs had significantly (51%) greater odds of having standing orders than part time ATs in public and private schools combined (OR=1.514; [CI:1.19-1.92]; $\chi^2=11.70$; $P<0.001$). In public schools, full time ATs had 70% greater odds of having standing orders than part time ATs while no difference was present in private schools. Full time SD ATs in private schools and part time SD ATs in public schools had significantly (40% and 60%, respectively) reduced odds of having standing orders compared to full time and part time MUF ATs by each school type (OR=0.60; [CI:0.37-0.97]; $\chi^2=4.39$; $P<0.021$, OR=0.45; [CI:0.32-0.64]; $\chi^2=20.67$, $P<0.001$).

Conclusions: Across public and private secondary schools, full time ATs had greater odds of having standing orders compared to part time ATs. Employment provider and school type also impacted the odds of having standing orders. These findings will help to inform secondary school ATs and AT state association leaders regarding the current status of compliance in the US and in their state. Furthermore, they will guide strategic actions to better align with their respective state practice acts.

Total Word Count: 431

208501JD

Orbital Blowout and Maxillary Sinus Fractures With Nerve Entrapment in a Semi-Professional Soccer Goalkeeper – Level 4 Clinical Case Report

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Background: A 22 year old male semi-professional soccer goalkeeper collided head-to-head with an opponent attempting to make a block during a game. The patient immediately fell to the ground. After clearing c-spine, the medical staff removed him to the sideline. The patient complained of generalized facial pain and stated “my teeth feel loose.” The patient presented with bilateral epistaxis and a laceration above the right eye which were controlled. The patient was assessed for a concussion and facial trauma after being removed to the locker room. SCAT5 revealed a low symptom score and palpation indicated point tenderness; however, edema and ecchymosis made assessment difficult. Lack of sensation over the right side of the face was noted, and thought to be due to excessive swelling. PERRLA and eye motility were within normal limits.

Differential Diagnosis: Concussion, subdural hematoma, epidural hematoma, cerebral contusion, ruptured globe, vomer fracture, zygomatic arch fracture, naso-orbital ethmoidal fracture, LeFort fractures, tooth fracture, TMJ dislocation, mandible fracture.

Intervention & Treatment: Immediate emergency room care was refused by patient due to impending appointment with the team physician 4 hours later. A computed tomography (CT) scan was ordered along with a prescription of amoxicillin. The CT scan revealed 7 facial fractures with increased gas levels within the maxillary sinuses and displaced orbital fat. Next the patient saw a plastic surgeon for sutures and consultation, for which he recommended surgical intervention. The patient was cleared by an optometrist who ruled out any damage to the globe. The patient consulted with an oral and maxillofacial surgeon who recommended conservative treatment. However, the patient requested a third party opinion from an oral and facial surgeon for a treatment plan, who then recommended a surgical intervention. The patient scheduled surgery nine days post-injury with the initial plastic surgeon. The zygomaticomaxillary fracture was addressed using the Carroll-Girard Technique by securing free-floating maxillary fragments to the zygoma with a rod and screws. The maxillary sinus was irrigated of a hematoma and bone fragments compressing the infraorbital nerve were released. A 12-hole titanium plate was fashioned to the orbital rim by use of 4 mm titanium screws and supported by a 6-hole plate fashioned to the inferior zygomaticomaxillary buttress. A mesh-titanium plate was placed over the anterior maxillary sinus defect and secured by 4 mm screws. Herniated soft tissue was reduced into the orbital bulb. A Biomet microfracture implant was placed within the orbital floor defect and secured with 4 mm screws. Post-operative rehabilitation progressed in one week increments, moving through the following: no exercise, treadmill walking, non-contact lower extremity practice drills, ground-contact drills and player-contact drills. Patient returned to play Division One soccer without restrictions at six weeks post-operation. Patient was not ordered to wear any facial protective equipment upon return to activities.

Uniqueness: The uniqueness of this case involves the chain of injury that developed through a process of reactions to trauma. Once the maxillary sinus fractured, the infraorbital nerve was compromised, the sinus chambers filled with gas, and orbital fat was forced into the defect within the orbital floor. The infraorbital nerve compromise was not noticed until surgery began. If conservative treatment had been selected, damage to the infraorbital would not have been recognized until later in the rehabilitation process.

Conclusions: In-depth diagnostic and clinical testing should be combined following head and facial trauma due to the lack of certainty following clinical assessment. All facial traumas should be referred to physicians for CT or MRI examination in order to diagnose fractures that may be missed through palpations. Gaining opinions from several members of the allied health community should be sought out to ensure sound diagnoses.

Total Word Count: 593

[206995ED](#)

ORIF With a Bone Graft for an Anterior Mid-Tibia Stress Fracture in a Collegiate Basketball Player: Level 4 Clinical Case Study

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Background: A 21 year old collegiate female athlete has a past medical history of right ankle Brostrom ligament reconstruction and arthroscopy with debridement and drilling of osteochondral talar dome in September and August 2018 respectively. Athlete was returned to play (RTP) in March (7 months post-surgery). Consequently her left shin began hurting in November. Due to the inconsistent nature of the pain and lack of activity, it did not garner much attention from the patient and subsequently the healthcare team. In June, an initial evaluation by the certified athletic trainer (ATC) found a negative percussion and compression tests. AROM and RROM were normal. Most notable was tenderness on the midtibial shaft with a 'lump'. The athlete reported sharp pain during running, therefore a referral was necessitated.

Differential Diagnosis: Osteoid Osteoma (OO), tibial stress fracture, tibial fracture, medial tibia stress syndrome, cancerous tumor.

Intervention & Treatment: A diagnostic ultrasound ordered by the team physician revealed bone callous. The X-ray was positive for a possible stress fracture therefore crutches and an orthopedic referral were ordered. An MRI revealed focal signaling on anterior tibial cortex with approximately a 10 mm stress reaction with marrow edema confirming a stress fracture. The anterior tibia cortex is considered high risk due to its possible progression to complete fracture, delayed union or nonunion. Consequently, a tall aircast brace was issued for ADL's with strict NWB. Conservative and surgical management were reviewed with the patient. Because conservative treatment can last 4-6 months and still not heal, the athlete selected surgery, therefore an open reduction internal fixation was performed. Four screws and a plate were embedded in the tibia and a bone graft from the proximal tibia was added throughout the fractured area. Partial weight bearing was allowed at this point with swimming at 20 days post-operative. One month after surgery the crutches were discontinued and activities such as biking and shooting stationary were allowed. However, all activity included the use of the tall aircast brace. At two months the patient began a progressive plan to return to running. Repeat x-rays monthly revealed a healed fracture. The athlete was allowed to train for 1 hour every other day to include, weight lifting, jumping and running. Her non-impact days consisted of underwater treadmill workouts, non-plyometric weight lifting, lower leg soft tissue manipulation, scar tissue mobilization and hip mobility. At three months orthotics were ordered and patient's pain level seemed manageable based on OCD in right ankle and hardware in left tibia. Athlete RTP at four months without complications, similarly to other plated case studies.¹ The athlete pads the tibia for protection and uses cryotherapy for pain management.

Uniqueness: While contralateral dominance of a healthy limb is expected during recovery of a complicated ankle surgery entailing 8 weeks of NWB, it is not common to see it progress to a stress fracture. The 7 months of inconsistent pain indicators also attributes some uniqueness to this case. The patient's height (1.84 m), mass (102.96 kg), and activity levels during recovery may have attributed to her uncommon mid-tibia stress fracture.

Conclusions: When treating athletes in the post-operative course, it is imperative to consider the risks associated with various treatments and therapies. Though uncommon, benign appearing actions (such as 100% weight bearing on the "non-injured" leg) can have injurious consequences as demonstrated by this case. The patient's ability to ignore a stress injury during her post-surgical recovery is unique and highlights the importance of attempting to gauge a patient's pain tolerance.

Total Word Count: 569

206301DD

Osteochondral Defects of the Knee: Arthroscopic Treatment With Bone Marrow Aspirate Concentrate and Biocartilage

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Context: Osteochondral defects (OCD) remain a challenge to treat due to their limited healing capacity. Despite the numerous options to treat symptomatic patients, long-term outcomes have shown varied results and optimal treatment for defects remains questionable. The purpose of this study was to assess outcomes of patients treated with Bone Marrow Aspirate Concentrate (BMAC) and biocartilage during knee arthroscopy on patients with OCD in the knee. Bone marrow-derived mesenchymal stem cells (MSC) have a theoretical advantage over MSCs from other origins in that they have a greater differentiation capacity and are believed to regenerate tissues when lesions are present. While newer therapies have emerged with efforts to improve outcomes in patients with focal OCD, most studies evaluating BMAC and biocartilage are preclinical or imaging-based. No studies specifically evaluate clinical outcomes in OCD patients treated arthroscopically with BMAC and biocartilage.

Methods: A case series was performed at an outpatient orthopedic clinic. Inclusion criteria were those treated arthroscopically with BMAC and biocartilage [n=14; mean age 34 years (range: 16 – 58 years), 6 females and 8 males; mean follow-up 19 months (range: 12 – 31 months)]. A retrospective chart review was performed for patients diagnosed with OCD of the knee. All participant's surgical procedure included: surgically inserting BMAC into the knee, implementation of biocartilage and a final intra-articular BMAC injection. The dependent variables measured both pre and post surgery included: range of motion in flexion and extension (degrees), hamstring and quadriceps manual muscle testing (MMT: 0-5 grade), Visual Analog Scale (VAS: 0-10 score) Score, Knee Outcome Survey of Activities of Daily Living (KOS-ADL: 0-100%) and KOS Sports Scores (0-100%). We used paired samples t-test to evaluate differences of all dependent variables between pre and post procedure.

Results: Flexion significantly increased from (pre =124°, post=132°; p=0.002). Patients (n=13) regained full extension, one patient had a two degree extension contracture due to a traumatic event. Preoperative hamstring strength ranged from 4-/5 to 5/5 and postoperative strength ranged from 4/5 to 5/5. Preoperative quadriceps strength ranged from 3+/5 to 5/5 and increased postoperatively to a range of 4/5 to 5/5. Mean VAS Scores of all patients significantly decreased postoperatively (pre=4.5, post=1.4; p=0.001). There was a significant increase in KOS-ADL Scores from pre-operative to post-operative scores (pre=53.8, post=92.9; p=0.007). Mean KOS-Sports Scores also increased, although not significantly (pre=28.2, post=79.5; p=0.560). There were three noted complications included a stitch abscess, Baker's cyst, and pain (n=3, 21.4%).

Conclusions: This study demonstrated arthroscopic BMAC and biocartilage implantation appears to be safe and effective in improving patient outcomes. Prospective investigations on larger sample sizes using a control group are necessary.

Total Word Count: 426

[209872DD](#)

Osteochondral Lesion in A Football Player: Late Diagnosis

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Background: An osteochondral lesion (OCL) includes a range of acute or chronic localized abnormalities of the articular cartilage and subchondral bone(4). MRI is a useful diagnostic tool to aid in the evaluation of OCLs, with a sensitivity of 94% and a specificity of 99%, while physical examination can produce many differentials (4). There is a wide range of literature on return to sport qualifications and recommendations for cruciate ligament injuries but return to sport for osteochondral lesion fixations has not been well researched in the literature(5,7). This Level 3 CASE report discusses the importance of timely diagnosis and return to sport rehabilitation for OCL injuries.

Patient: Patient is a 6'3", 285lb, 18-year-old male football center transitioning from high school to collegiate athletics. He sustained a right knee injury falling into a valgus position while tackling; another player landed on the lateral aspect of the knee increasing valgus position. He reported immediate acute lateral sided knee pain. He was originally diagnosed with a bone bruise, confirmed after plain radiographs. Physical examination provoked lateral joint line pain, all ligamentous testing were negative. He continued to play the remainder of the season with no change in pain. At end of season he took 3 weeks off, remaining full weight bearing (WB). He did no rehabilitation during his time off. He continued to have pain along the lateral knee without improvement and sought out another opinion. MRI demonstrated intact ligaments, no meniscal pathology, and large osteochondral lesion in the posterior weight-bearing zone of the lateral femoral condyle. The patient consented to surgical treatment.

Intervention & Treatment: Diagnostic arthroscopy confirmed an unstable cartilage lesion. Three BioComposite compression screws were used for fixation of the lesion. Post-operatively he was non-WB for 6 weeks and locked in full extension for 2 weeks. He was allowed full ROM. At 9 weeks he was allowed closed-kinetic-chain quad/glute strengthening, stationary biking, pool therapy/alter G. For unknown reasons, his rehab did not follow this strengthening timeline. He denied any pain in the post-operative period and his MRI showed healing at the fixation, although his progression was limited by strength deficits. At 3.5 months post-operative he was not cleared for impact activities and was denied participation in drills and large impact activities at 6 months. His initial strength assessment at 6 months demonstrated a quad index of 24%. At 8 months post operative his quad index minimally improved to 40%. He was assessed for hamstring index, Y-Balance anterior reach, power, reaction time, and lower extremity dynamics, all of which demonstrate deficits (significantly <90%). Due to testing results he has not been allowed back to full return to play, with concern of a poor quad index, increasing his risk for reinjury and/or new injury(5,7).

Outcomes or Other Comparisons: Patient underwent surgical intervention 4 months after his initial injury without focused physical therapy and a period without an exercise program pre and post-surgical intervention. With inconclusive evidence regarding physical examination findings, surgical techniques, and return to sport timelines, an individualized patient-centered treatment approach considering lesion and sport specific requirements is necessary to improve knee function for competitive return to play in athletes with an OCL.

Conclusions: MRI is the gold standard for OCL diagnosis (10), but prompt diagnosis of OCLs and a patient specific rehabilitation protocol are important in the patient's return to full sport participation.

Clinical Bottom Line: This case highlights the importance of evaluation and consideration of differential diagnoses and the necessity for more research on return to sport after chondral fixation, including specific and objective testing parameters.

Total Word Count: 573

[208675FD](#)

Over-Shoe Stabilization System Does Not Change Plantar Pressure Distribution in Patients with CAI

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Context: Patients with CAI walk with increased lateral plantar pressure, which may predispose them to future lateral ankle sprains and the development of post-traumatic ankle osteoarthritis. Gait retraining to shift plantar pressure medially seems important to improve ankle function and mitigate long-term consequences of CAI. This study assessed if an over-shoe stability system can redistribute plantar pressure in patients with CAI during walking.

Methods: Eleven adults with unilateral CAI (age:20.8±1.7years; body mass index:26.7±4.6kg/m²) participated in this cross-sectional study conducted in a research laboratory. Participants met the definition of CAI according to the International Ankle Consortium criteria. A Pedar-X[®] insole plantar pressure system recorded contact time (CT) and peak pressure (PP) during treadmill walking. We utilized the Steright™ stability system, which fits over the shoe and consists of two half-spheres, 1 under the rearfoot and 1 under the forefoot, to destabilize the foot in both regions. A 30s baseline trial was collected while the participants walked on the treadmill in their own shoes. Then, a 30s baseline trial was recorded while participants walked with the stability system. Participants walked for 20-minutes with the stability system. Finally, a 30s post-walking trial was recorded without the stability system. The middle 10 steps of each trial were extracted and CT and PP under the total foot and 9 sub-regions (medial and lateral heel; medial and lateral midfoot; medial, central, and lateral forefoot; hallux, and lesser toes) of the foot were determined. Data were averaged across steps for each participant and limb x time repeated measures ANOVAs determined differences in CT and PP under each region of the foot (P<0.05). Post hoc t-tests were used in the event of significant interactions.

Results: There was a significant limb x time interaction for CT under the lateral heel (P=0.017). Post hoc comparisons revealed that CT was greater at baseline (744.18±156.83ms) than both baseline with the stability system (654.82±163.02ms, P=0.032) and post-walking (638.35±192.37ms, P=0.024) in the uninvolved limb. There was a time main effect for CT under the medial midfoot (P=0.036), such that CT was greater post-walking (794.23±123.41ms) than at baseline (767.70±99.55ms, P=0.030) in the involved limb. There were no other significant differences between limbs or over time for CT or PP.

Conclusions: Walking in an over-shoe stability system decreased CT without concurrent changes in PP. An absence of changes in PP suggests these devices do not redistribute plantar pressure. Future investigations should continue to examine strategies to medially shift plantar pressure to break the cycle of recurrent injury in patients with CAI.

Total Word Count: 411

208202JD

Pain Management Options for Post-Traumatic Ankle Osteoarthritis: A Case Study

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Background: This level two explorative case study details the management and subjective reports of a patient with post-traumatic ankle osteoarthritis treated using a leukocyte-poor platelet-rich plasma injection. Osteoarthritis of the ankle is debilitating and can prevent patients from participating in physical activity, therefore, it should receive more attention in regards to treatment options. Knee osteoarthritis is commonly examined due to its large prevalence; however, the case can be made, although less common, ankle osteoarthritis is of equal importance.

Patient: A healthy recreationally active male aged 43 years was diagnosed with a right tibial plafond fracture and ankle dislocation with associated fibular fractures upon initial evaluation in an emergency department after a snowboarding fall and impact to his right lower extremity. Sequela diagnoses in the following eighteen months included development of early post-traumatic arthropathy and compensatory Achilles tendinitis without tearing as evidenced by continued pain with activity in the tibiotalar joint despite appropriate conservative management.

Intervention & Treatment: Initial surgical management included urgent reduction and external fixation with subsequent open reduction and internal fixation. Two corticosteroid injections were utilized for pain management at six- and eleven-months post-surgery. Hardware removal was recommended and preformed for possible outcome improvement at eighteen months. A leukocyte-poor platelet-rich plasma injection was introduced one year and eight months after his initial surgery.

Outcomes or Other Comparisons: Follow up was conducted post-surgically and subsequently by electronic survey following the final platelet-rich plasma injection. Initial subjective platelet-rich plasma injection outcomes revealed an increase in symptoms of swelling, stiffness, and pain with activity. Ten days following the injection the patient experienced an improvement or resolution of all symptoms, including pain-free walking and light activity.

Conclusions: Posttraumatic osteoarthritis can cause chronic pain, which has been widely studied, but is still a difficult pathology to manage. Subjective data collected in this level two case study suggests leukocyte-poor platelet-rich plasma is a safe and – though case dependent – effective treatment for early onset posttraumatic osteoarthritis of the ankle.

Clinical Bottom Line: Several treatment options for pain management should be offered to patients to best fit their treatment and lifestyle goals, platelet-rich plasma injections are a safe addition to these suggestions.

Total Word Count: 345

208803QD

Parental Perceptions of the Importance and Effectiveness of Patient-Centered Care Delivery

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Context: Engaging in physical activity provides significant improvements in the overall health of young patients, but injury risk and subsequent patient care for adolescent athletes must also be considered. Musculoskeletal injuries are the leading cause for visits to primary care physicians. American healthcare commonly orients patient care around a disease, injury, or illness. Integrative patient-centered care (PCC) models encompass all aspects of the patient including physical well-being, literacy and informed decision making, and continuation of care as it relates to long-term health related quality of life. The purpose of this study was to explore parental experiences with the principles of PCC related to healthcare of their dependent, following an interaction with a provider.

Methods: We utilized an exploratory, cross-sectional observational research design to investigate parental perceptions of the principles of PCC. We created a web-based survey derived from the Picker Institute's eight principles of patient centered care (Table 1). The instrument was content validated by a panel of 5 athletic trainers with experience in principles of PCC. The 43-item tool included questions about healthcare decision making, the importance of PCC, and effectiveness of delivery of PCC in the delivery of care to the child from parental perspective. The tool utilized a 5-point Likert scale as measure importance and effectiveness. Questions regarding importance and effectiveness were rated as: not at all important/effective (1), slightly important/effective (2), moderately important/effective (3), very important/effective (4), extremely important/effective (5). We distributed the survey to 136 adults with children ages 3-17 who had engaged in the healthcare system in the previous 12 months. Through the web-based survey distribution platform (Qualtrics® Provo, UT) valid survey responses (n=102) were collected. Descriptive statistics were analyzed.

Results: Approximately the same number of males and females completed the instrument (48% male 49/102, 51% female 52/102, 1% intersex 1/102). Primary care physicians were reported as the most commonly utilized professional (34.3% 35/102). Primary reasons parents sought care for their child included treatment (32.9% 77/234), injury/illness assessment (29.1% 68/234), and evaluation (23.1% 54/234). The majority of participants scored PCC concepts as very important (mode = 4) or greater. Likewise, the majority of participants rated their providers as very effective (mode = 4) or greater in delivery of PCC.

Conclusions: The present study demonstrated that participants believed the components of PCC were 'very important' and that providers delivered high levels of PCC. These results emphasize the importance of PCC from the perspective of the patients and suggests that healthcare providers in general provide high levels of PCC during patient interactions. As athletic trainers further integrate in the broader healthcare system, it is critical that athletic trainers further integrate PCC concepts.

Total Word Count: 431

207201CD

Parents' Emotions and Perception of the Long-Term Implications of Concussion in Youth Sport

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Context: Concussions are prevalent in sport, and perceptions of this injury may influence participation decisions. Previous literature found that parents believe concussions are a critical issue, but more research is needed to further understand perceptions of this injury. The purpose of this study was to evaluate parental emotions and perception of the long-term implications of concussion and determine if there was an association between parent gender and those beliefs.

Methods: This was a cross-sectional study of parents (n = 467; males = 185, females = 282; age = 43.83 ± 0.4 years) of youth contact sport athletes (i.e., football, soccer, ice hockey, lacrosse). Participants completed demographic items and the Illness Perception Questionnaire that was altered to be concussion-specific. This assessment included Likert items (1-“strongly disagree”; 5-“strongly agree”) on emotions (e.g., fear, anxiety, etc) and beliefs about the long-term implications of concussion (e.g., major consequences on life, effects could last a long time, etc). The 15-minute survey was administered on-site after practices/events. Frequencies of concussion perception items were completed for the entire sample. The association between parental concussion perceptions and sex (male/female) were assessed using chi-square analyses, and Fisher’s exact tests when cell counts were <5. Significance was set at p≤.05.

Results: Overall, 72.5% (n=330/455) of parents were upset, 61.3% (n=279/455) were fearful, and 45.3% (n=205/453) were anxious at the thought of their child sustaining a concussion. Additionally, 75.1% (n=341/454) reported that concussions worry them. There were significant associations between sex and emotions with a greater proportion of females endorsing negative emotional concussion perceptions (p’s ≤.001; Table 1). For the long-term implications of concussion, 87.4% (n=396/453) of parents felt that they could have major consequences on their child’s life. Also, 46.2% (n=211/457) believed that the effects of concussion will last a long time; however, half of parents (53.3%, n=240/450) did not think that the effects would last their child’s whole life. When considering whether a concussion was likely to be permanent, there was variability in the participant responses with 33% (n=150/453) who disagreed, 26.7% (n=121/453) who agreed, and 28% (n=127/453) who were unsure. The only significant association between sex and long-term concussion implication perceptions was that a greater proportion of males did not believe that the effects of concussion would last their child’s whole life (p=.001; Table 1).

Conclusions: The majority of parents of youth athletes have negative emotions associated with concussion, and female parents may have more psychological distress compared to males in this regard. Furthermore, parents believe that concussions can have long-term implications on their child’s lives, but are unclear if the injury has permanent effects. There is a need to provide parents with evidence-based information regarding concussion outcomes and the benefits of youth sport participation.

Total Word Count: 443

206271GD

Parsonage-Turner Syndrome in a Female Collegiate Track Athlete

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Background: A 20-year-old female distance track runner presented in the athletic training facility with a primary complaint of prolonged right shoulder pain. She reported waking in the middle of the night due to a sudden onset of sharp pain approximately one month ago. The athlete reported a previous history of bilateral glenohumeral subluxations. After the incident she saw her primary care physician and was advised she reduce weights during lifting and continue activity as tolerated. Upon evaluation by the university athletic trainer, she found decreased shoulder internal rotation AROM at zero and 90 degrees, and painful popping with flexion and abduction with internal rotation AROM. Sulcus sign was positive but pain free on the left shoulder but was deferred for the right shoulder due to discomfort. The athlete was diagnosed with a right glenohumeral subluxation. Treatment included scapular stabilization and rotator cuff strengthening exercises and a reduction in weightlifting. After no improvements over the next two weeks the athlete was referred to the team physician. The team physician observed atrophy of the right supraspinatus and infraspinatus muscles, and scapular dyskinesis. The team physician suspected Parsonage-Turner Syndrome (PTS) and ordered an MRI and EMG. The MRI showed edema in the athlete's neck. The EMG showed an absence of neurological signal to the right infraspinatus and supraspinatus, revealing PTS.

Differential Diagnosis: Supraspinatus and infraspinatus strain. Thoracic outlet syndrome. Cervical radiculopathy. Brachial Plexus neuropathy.

Intervention & Treatment: The physician prescribed oral steroids to reduce lingering pain. The athlete began a return to running progression starting with running one mile per day. Eleven months after the initial incident, the athlete's rehabilitation stalled. She could only run four days a week for at most 2-3 miles at a time and reported persistent shoulder fatigue that progresses into aching pain. The team physician ordered another MRI and EMG. The EMG revealed continued lack of nerve conduction to the right supraspinatus and infraspinatus. Currently, the athlete is considering surgery to decompress the suprascapular nerve as conservative treatment is no longer meeting her desired goals. Due to the lack of improvement, prolonged rehabilitation, and prior medical history, the athlete was referred to a sports psychologist.

Uniqueness: Parsonage-Turner Syndrome has an insidious onset mechanism with an incident rate varying 1/1,000-100,000/year. The most common presentation of PTS begins with a sudden onset of severe and constant pain in the upper extremity that can wake people in the middle of the night. After a few days, weakness of the innervated muscles begins to develop. Once the nerve is completely denervated, extreme weakness and atrophy occur, approximately one month after initial onset. Physicians commonly prescribe NSAIDs or steroids to help reduce pain, but it does not treat the actual condition. Rehabilitation for PTS can last from six months to three years. It is important that clinicians consider the athlete's psychosocial outlook as it affects all aspects of the rehabilitation process.

Conclusions: PTS is a rare condition with limited cases reported in athletes. Athletic trainers should be aware of PTS as symptoms and presentation can mimic several shoulder injuries. When the athlete fails to improve with conservative treatment, it is important to reexamine as key signs of PTS are atrophy of the supraspinatus and infraspinatus approximately one month after the initial incident. Additionally, when treating PTS it is important to decrease pain as this is the primary symptom. Due to the potential of having pain for months and long-term rehabilitation, the athlete's participation and activities of daily living can be disrupted for an extended period. Therefore, it is strongly advised to monitor the patient's physical and emotional health.

Total Word Count: 587

207022EA

Patient, Injury and Treatment Characteristics of Hip Injuries Presenting to Athletic Training Clinics: A Report From the Athletic Training Practice-Based Research Network

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Context: Hip injuries are not uncommon during sport participation, with an incidence rate of 54/100,000 athletic exposures. While epidemiological studies provide insight into patient and injury characteristics of hip injuries, little is known about how these injuries are treated at the point of care. Our objective was to describe patient and treatment characteristics for hip injuries reporting to athletic training (AT) clinics.

Methods: This study was a retrospective analysis of electronic medical records, documented by athletic trainers within the Athletic Training Practice-Based Research Network. Data were reported from 200 AT clinics (secondary school=161, college=34, other=5) between 2009-2019. Cases were included if the patient was diagnosed with a hip injury identified by International Statistical Classification of Diseases and Related Health Problems diagnostic codes. Summary statistics (frequency, percentages, means±standard deviations, 95% confidence intervals [95%CI]) were calculated for patient (sex, age) and injury (diagnosis, sport, mechanism of injury, pain at intake as assessed by the Numeric Pain Rating Scale [NPRS]) demographics. Treatment characteristics included duration of care (initial evaluation to last documented episode of care [EOC]), EOC (number of documented patient encounters), and type of AT service (Current Procedural Terminology codes).

Results: A total of 1,345 patients (male=740, age=16.3±2.4 years) were included. Most injuries were diagnosed as a sprain/strain (79.0%, n=1063) followed by contusion (9.3%, n=125) and arthralgia (4.0%, n=54). Hip injuries most frequently occurred during track/cross country (24.3%, n=327), football (23.2%, n=312), and soccer (14.7%, n=198) and occurred by a non-contact (45.1%, n=607), insidious/unknown (31.6%, n=425), or contact (11.6%, n=156) mechanism of injury. At intake, patients reported a “sharp” (53.5%, n=719), “achy” (27.4%, n=369), or “throbbing” (7.5%, n=101) pain that was, on average, a 4.5±2.1 on the NPRS. A total of 7,627 AT services were recorded across all patient cases. The most frequently utilized treatment was hot or cold pack (29.4%, n=395), followed by therapeutic exercise (24.8%, n=333), therapeutic activities (15.0%, n=202), and manual therapy (11.4%, n=153). The average duration of care was 14.6±39.9 days (95% CI=12.5-16.6) across an average of 4.3±6.2 EOC (95% CI=3.9-4.6) per injury. The average number of treatments provided per EOC was 1.8±1.1 (95% CI=1.8-1.8).

Conclusions: To our knowledge, this is the first study to describe the treatment characteristics for patients with hip injuries including type, duration, and frequency of treatment. Treatment characteristics for hip injuries are similar to those reported for the knee and ankle. Our patient and injury characteristic findings concur with previous epidemiological studies. The results indicate athletic trainers play a valuable role in providing care for athletes suffering from moderate hip injuries. Future studies should determine the impact of treatment characteristics on short- and long-term health outcomes and identify effective treatment interventions.

Total Word Count: 434

[209892DD](#)

Pediatric ACL Reconstruction in a Skier

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Background: Anterior Cruciate Ligament (ACL) injuries in pediatric patients are becoming more prevalent. Incidence of ACL tears in pediatric patients between ages 6-18 have gone up annually ~2.3% over the last 20 years. The increase in prevalence may be due to an increase of participation in vigorous sport specific training. The four types of ACL tears in pediatric populations are cartilaginous avulsions, tibial eminence fractures, mid substance tears and partial tears. Tibial eminence fractures have been considered the pediatric equivalent of adult intrasubstance ACL tears and are commonly seen in adolescents age 8-14. They tend to be more common than mid substance ACL tears due to the lack of skeletal maturity. This level 3 CASE report describes an ACL tear in a 9 year-old high level alpine ski racer who underwent surgical ACL reconstruction.

Patient: The patient is a 9 year-old male, high level alpine ski racer competing in downhill. He suffered a right knee isolated mid substance, full thickness ACL tear during an alpine ski race. Upon evaluation, he denied any immediate effusion or any subjective instability. On physical examination the primary finding was a positive grade-3 Lachmans. The patient had a negative history of prior right knee pathology.

Intervention & Treatment: The patient consented to right knee ACL reconstruction using the physeal-sparing iliotibialband (IT) graft technique. The technique harvested the central portion of the IT band proximally and maintained the distal attachment on Gerdy's tubercle. The graft is then passed over the top posteriorly into the knee and under the intermeniscal ligament anteriorly onto the tibia. The graft was then fixed with a suture to the periosteum of the lateral femoral condyle and the tibia. Post-operatively the patient was non-weight-bearing for 6 weeks. At 6 weeks the patient was given a hinged brace and after 12 weeks the patient transitioned to only wearing the brace during activity. At the 6 week mark activities were limited to walking and freestyle swimming. At 6 months he began a running progression. At 9 months the patient began light activities such as golfing, swimming and road biking. The patient returned to skiing at 11 months post-operatively.

Outcomes or Other Comparisons: Tibial eminence fractures are more likely to occur than full thickness ACL tears between the ages of 8-14. The mechanism of high impact ski racing may increase the risk of a mid-substance tear. Pediatric ACL tears traditionally have been treated by limiting sports play, bracing and extensive rehabilitation, compliance although, is unlikely. A study of 18 non-operative patients 61% had further cartilage damage and arthritic changes, while 94% were unable to participate at pre-injury level. Due to these findings, operative indication for young adolescents have evolved. Post-operative rehabilitation occurs for 7-10 months with full return to sport at 10-13 months. In a study looking at 237 patients who underwent IT band physeal sparing 6.6% had re-ruptured ~33 months post-operatively. At approximately 2 years patients that didn't have graft rupture Pedi-IKDC scores were 93.3 ± 11.0 , mean Lysholm score were 93.4 ± 9.9 and a mean Tegner activity score of 7.8.

Conclusions: Full thickness mid-substance ACL tears are become more prevalent. Mid-substance ACL tears in young adolescent athletes are uncommon and the recovery of this injury has been shown in literature to be much longer than tibial eminence avulsions. It is important for athletic trainers to understand the predisposing risk factors of full thickness ACL tears in youth athletes. High risk sports such as alpine skiing, suggest an importance of preventative ACL programs.

Clinical Bottom Line: It's important to understand a young athlete's risk and to help take precautionary measures to help reduce the risk of a full thickness tear and preserve long-term joint health.

Total Word Count: 595

205294CD

Pediatric Cognitive and Balance Performance at 4-Weeks Post-Concussion Does Not Differ by 5P Risk Classification

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Context: To better help clinicians acutely identify children at risk of prolonged concussion recovery, the Predicting and Preventing Postconcussive Problems in Pediatrics (5P) study validated a clinical prediction rule that has moderate ability to predict persistent post-concussion symptom (PPCS) risk at 4-weeks post-injury and is more accurate than physician opinion alone. However, it remains unknown if the 5P clinical risk classification has prognostic utility for other objective clinical concussion outcomes at 4-weeks post-concussion. Therefore, the objective of the current study was to determine if performance on cognitive and balance outcomes at 4-weeks post-injury in children and adolescents with concussion differs based on the 5P clinical risk classification.

Methods: Sixty-two children and adolescents (age: 13.27 \pm 2.50 years; 29 (46.7%) females) diagnosed with a concussion were evaluated in this prospective, longitudinal study. Patient demographics (age, sex, previous concussion(s)/ duration of symptoms, personal history of migraines), Acute Concussion Evaluation (answers questions slowly), Balance Error Scoring System (tandem stance), and Post-Concussion Symptom Inventory (headache, sensitivity to noise, fatigue) were completed in the Pediatric Emergency Department within 72 hours of injury. These outcomes were used to classify patients as “high”, “moderate”, or “low” risk of PPCS using the 5P rule. Patients completed the Post-Concussion Symptom Inventory, ImpACT, Balance Error Scoring System, and tandem gait assessment in the laboratory at 4-week post-concussion. To ensure that the 5P rule was valid in our sample, the association between 5P risk classification and the presence of PPCS (3 new or worse symptoms at the 4-week assessment) was assessed using a Chi-Square Analysis. To determine if cognitive and balance performance differed between 5P risk classification, simple linear regressions were performed. Separate models were fit for all ImpACT (verbal memory, visual memory, processing speed, reaction time, and cognitive index), Balance Error Scoring System (total score), and tandem gait (fastest trial in seconds) scores.

Results: Means and standard deviations by 5P risk classification are presented for all outcomes in Table 1. As expected, individuals classified as high risk (11/15, 73%) using the 5P rule were significantly more likely to experience PPCS than individuals at low (1/13, 8%) or moderate (12/26, 46%) risk ($\chi^2=12.21$, $P=0.002$). Cognitive (verbal memory: $R^2=0.01$, $P=0.81$; visual memory: $R^2=0.12$, $P=0.08$; processing speed: $R^2=0.003$, $P=0.94$; reaction time: $R^2=0.02$, $P=0.69$; cognitive index: $R^2=0.08$, $P=0.11$) and balance (Balance Error Scoring System: $R^2=0.02$, $P=0.67$; tandem gait: $R^2=0.02$, $P=0.59$) performance at 4-weeks post-injury was not significantly influenced by 5P risk classification.

Conclusions: Presence of PPCS is significantly associated with 5P risk classification at 4-weeks post-concussion, but performance on cognitive and balance assessments are not. Therefore, the 5P rule provides clinicians with value prognostic information in the acute post-concussion period in relation to symptom, but not cognitive or balance, outcomes.

Total Word Count: 442

[208383QD](#)

Perceived Leadership Self-Efficacy in Athletic Trainers

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Context: Leadership self-efficacy (LSE) is the belief that one is able to be an effective leader. Individuals with high levels of LSE have the potential to set challenging leadership goals and direct efforts toward a groups goals. The purpose of this study is to examine the relationship among age, gender, work experience, and LSE in athletic trainers. We also examined the effect of years of experience on LSE.

Methods: We used a cross-sectional design by e-mailing participants a web-based survey from a randomly selected sample of NATA members (n=4733) currently working as athletic trainers. A total of 574 participants started the survey (12.1% response rate), while 461 participants completed the survey (80.3% completion rate). Thirty-eight percent of the participants were male (n=175), 60.7% were female (n=281), and 1.3% (n=6) preferred not to answer with a mean age of 36.9±11.3 years and 13.2±10.3 years of experience. We used the leadership self-efficacy scale (LSES) consisting of 21 items across 6 dimensions. The dimensions are: starting and leading change process in groups; choosing effective followers and delegating responsibilities; building and managing interpersonal relationships within the group; showing self-awareness and self-confidence; motivating people; gaining consensus of group members. Each item was scored on a Likert scale ranging from 1 (absolutely false) to 7 (absolutely true) with higher scores indicating higher LSE. We analyzed the relationship among experience, age, gender, and LSES total and dimension scores using Pearson correlation analyses. We examined the effects of years of experience on LSE by categorizing participants as young professionals (ATs with 12 or less years of experience) (YPs) or non-young professionals (ATs with 13 or more years of experience) (NYPs) using a non-parametric Mann-Whitney U test.

Results: Mean overall scores were 121.2±12.6, demonstrating moderately high overall LSE. Mean scores for dimensions 1 through 6 were 15.7±2.7, 23.4±3.0, 18.3±2.1, 30.2±3.0, 16.8±2.5, and 16.9±2.4, respectively. Statistically significant correlations were found, however none of the relationships were strong enough to have clinical significance. We identified significant differences between those designated as young professionals and those that are not (Mann-Whitney U=-2.885, p=0.004) and those ATs in their 20-30s and the other age groups of ATs ($\chi^2=12.738$, df=4, p=0.013) relative to “starting and leading change processes in groups,” whereby young professionals (15.4±2.6 out of 21) and those in the 20-30s (15.1±2.8) scored lower in this dimension. No other dimension or the overall score demonstrated significant differences.

Conclusions: These findings suggest young professionals and ATs in the 20-30s have high LSE relative to delegating, building relationships, demonstrating self-awareness and self-confidence, motivating people, or gaining consensus. But they do feel significantly less able to start and lead change within these groups, suggesting a perceived inability to truly engage as a transformational leader.

Total Word Count: 443

204983RD

Perceived Stress and Coping Skills in Professional Master's Level Athletic Training Students

Emily Madrak, MS, ATC, LAT

Jennifer Volberding, PhD, ATC, LAT

Context: As athletic training education continues to expand, it is important to consider the amount of stress students experience and what coping skills they use to mitigate it. Although there is considerable research on athletic training students and perceived stress (PS), there are few studies related to students enrolled in professional master's programs (MAT) regarding stress.

Methods: Cross-sectional design with current students in Commission on Accreditation of Athletic Training Education (CAATE) accredited MAT programs (males=42, females=99, age=23.42 ± 2.91 years). Program directors were asked to forward a link to students in their respective MAT programs. The survey included a brief demographics section (age, gender, year in school, learning model). Two surveys were included: The Perceived Stress Scale (PSS) (reliability $\alpha=0.78$) to measure perceived stress (PS), and the Coping Orientation to Problem Experience (COPE) inventory (reliability $\alpha=0.73$) to measure coping skills (CS). Means and standard deviations were calculated for the PSS and 15 subscales of the COPE. One-way ANOVA's were calculated for PSS utilizing demographic variables. Pearson correlation analysis was used to calculate most significant CS, and the impact of them.

Results: A mean PSS score (24.84 ± 7.267) revealed a moderate level of PS in MAT students. ANOVA demonstrated increased PS in females, in comparison to males ($F(1,139) = 4.93, p=0.03$). Pearson correlation analysis established multiple significant coping skills. Age revealed positive correlations with positive reinforcement ($r=0.168, p=0.05$), active coping ($r=0.25, p<0.01$), and acceptance ($r=0.25, p<0.01$); and negative for PS ($r= -0.18, p=0.03$). Gender revealed significant correlations for females in venting ($r= -0.19, p=0.02$), social support ($r= -0.22, p<0.01$), and emotional support ($r= -0.20, p=0.02$). Year 2 of schooling demonstrated a significant correlation with mental disengagement ($r=0.25, p<0.01$). Learning model presented significant correlations with venting ($r=0.18, p<0.01$) and mental disengagement ($r= -0.171, p<0.05$). Perceived stress demonstrated significant correlations with positive reinforcement ($r= -0.25, p<0.01$) mental disengagement ($r=0.188, p<0.05$), venting ($r=0.36, p=0.00$), active coping ($r= -0.27, p=0.001$) denial ($r=0.25, p<0.01$) behavioral disengagement ($r=0.39, p=0.00$), substance use ($r=0.25, p<0.01$) and planning ($r= -0.30, p=0.00$).

Conclusions: Our data suggests that female MAT students experience more PS than males. As age increases, the use of constructive coping skills increases. However, overall, MAT students use CS that are more detrimental to stress. These results can assist students and professors in recognizing and using healthier alternatives to cope with stress.

Total Word Count: 380

[209265CA](#)

Perceived Support for Return-to-Learn in Concussion Management by Secondary School Athletic Trainers and School Nurses

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Context: An interdisciplinary approach to concussion management, including return-to-learn, is warranted. However, current practices of health-care providers and perceived support for a transitional return-to-the classroom is unknown. The aims were to: 1) identify secondary schools' use of academic accommodations following concussion reported by athletic trainers (AT) and school nurses, 2) to evaluate ATs and school nurses' perceived stakeholder support for a transitional return-to-the classroom, and 3) determine perceived support for an AT versus school nurse led return-to-learn protocol in the secondary school setting.

Methods: A cross-sectional online survey was distributed as a larger project exploring the interprofessional relationship of health care providers' perceptions of concussion management regarding return-to-learn. Surveys were sent to 1,000 ATs via the NATA survey distribution center; school nurses were contacted via state organizations. All were asked: 1) to identify academic accommodations that teachers are allowed to provide and academic accommodations that are offered by their respective schools, and 2) if their school provides parents a written concussion management plan, and if it includes academic accommodations. Participants rated agreement on a 5-point Likert scale regarding if: 1) students, parents, teachers, and principals would follow/support a return-to-learn protocol, 2) ATs, school nurses, coaches would support an AT versus school nurse led return-to-learn protocol, and 3) whether workload would allow them to lead such protocol. Chi-square analyses, and Fisher's exact tests when cell counts <5, were used to determine associations between AT and school nurse responses ($p \leq .05$).

Results: Two-hundred twelve (ATs: 56.6%, $n=120/212$; school nurses: 43.4%, $n=92/212$) participants completed the survey. ATs most commonly identified added time on quizzes and/or exams (65.6%, $n=61/93$) and assignments (65.6%, $n=61/93$) as academic accommodations allowed by teachers; school nurses similarly selected added time on quizzes and/or exams (75.8%, $n=47/62$) and assignments (75.8%, $n=47/62$). ATs identified rest periods in the nurse's office (60.2%, $n=56/93$) and additional time on quizzes and/or exams (58.1%, $n=54/93$) as academic accommodations offered by the school; school nurses selected rest breaks during class (77.4%, $n=48/62$) and sitting closer to the front of class (61.3%, $n=38/62$) most often. A greater proportion of ATs (67.9%, $n=57/84$) reported their school provides parents with written concussion management plans compared to 44.4% of school nurses ($n=24/54$; $p=.005$). However, groups similarly responded that their written plans address academic accommodations ($p=.65$). ATs and school nurses similarly agreed students ($p=.14$), parents ($p=.40$), teachers ($p=.51$), and principals ($p=.83$) would follow/support a return-to-learn protocol. Agreement for support of an AT led versus school nurse lead transitional return-to-the classroom protocol is presented in Table 1.

Conclusions: ATs and school nurses similarly recognized academic accommodations following a concussion and agreed stakeholders would support/follow transitional return-to-the classroom. However, there is inconsistent agreement between ATs and school nurses perceived support for leading return-to-learn protocols. Interprofessional concussion management, especially for return-to-learn, needs to be developed.

Total Word Count: 447

200151MD

Perceptions and Beliefs on Preventative Training Programs Amongst Female Collegiate Gymnasts

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Context: Preventative training programs (PTPs) are effective in improving movement technique and reducing risk of lower extremity injury but they are still not widely used in many athletic populations. Several factors may contribute to the lack of implementation such as lack of time to run the TP, lack of motivation, or lack of buy-in from the coach or athletes. According to Martinez et al., female adolescent athletes are more likely to perform a preventative training program if data indicated that they would have a lower risk of injury and specifically sustain less leg injuries. There is currently a literature gap focusing on the collegiate setting and reasons a PTP may or may not be implemented. Limited research has focused on gymnastics and PTPs compared to studying sports such as soccer or basketball. Gymnasts focus on intense use of core strength and functional extremity manipulation, which places them at a high risk of injury. The objective of this study was to examine the attitudes and perceptions of female collegiate gymnasts in regard to the implementation of preventative training programs.

Methods: The Injury Prevention Program Attitude Survey was distributed to local female collegiate gymnasts to assess their attitudes and perceptions on preventative training programs. Forty-one gymnasts (Age=19.6±1.1, Years of Gymnastics =13.3±1.6) completed the paper-and-pencil survey that utilized Likert-style (1-Strongly Disagree to 5-Strongly Agree) and open-ended questions to examine the gymnasts willingness to perform a PTP if the data proved the player would experience improved performance, fewer injuries and risk factors; what factors influence their willingness to perform an PTP; who they would feel comfortable leading their team in an PTP; and what they believe an PTP is able to improve. Responses to Likert questions were dichotomized into Yes or No, "5-Strongly Agree" was considered "Yes" and responses of 1-4 were considered "No". Chi square tests were used to identify differences between gymnasts stated willingness and beliefs on PTPs. Alpha level was set a-priori at $P < 0.05$.

Results: The participants responded they would be more likely to participate in a PTP if data indicated that they would have fewer injury risk factors ($P < .001$), specifically ACL injury ($P < .001$) and leg injuries ($P < .001$). Female collegiate gymnasts were not motivated to participate in a PTP if they would have improved sport performance ($P = .43$), improved health ($P = .16$) or improved quality of life ($P = .64$).

Conclusions: Female collegiate gymnasts are more willing to participate in a preventative training program if they had information to indicate that their participation would result in decreased risk of sustaining injuries to the leg and particularly the ACL. Decreased risk of injury should be the focus when proposing PTPs to gymnasts instead of improved overall health or sport performance.

Total Word Count: 440

206125IA

Physical Activity and Quality of Life in Women With Current Injury: A Report From the Active Women's Health Initiative

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Context: Health-related quality of life (HRQL) can be impacted by injury and physical activity (PA). Understanding the effect of PA on HRQL in adult women with current injury can inform future intervention and health promotion strategies. The purpose of this study was to examine the relationship between PA and current musculoskeletal injury on HRQL in women across the lifespan. We hypothesized physically active women who reported a current injury would have higher HRQL than inactive women.

Methods: A total of 408 adult women between the ages 18-75 (age:39.9±13.2years, 163.9±8.3cm, 76.6±20.2kg) participated in this cross-sectional survey study. The Veterans Rand-12 (VR12) survey was used to determine general HRQL. The VR12 is a valid and reliable 12-item questionnaire with two component summary scores, the VR12-Physical Component Summary (VR12-PCS) and the VR12-Mental Component Summary (VR12-MCS). The VR12 is scored on a norm based algorithm of 50 (±10), where higher scores indicate greater HRQL. To determine PA status, participants were asked to self-select their current physical activity level. Based on the response, participants were placed in the YES-PA (N=297) or NO-PA (N=111) group. Based on the participants responses to "Do you currently have a bone, muscle, or joint injury that bothers you?" they were placed in either the YES-INJURY (n=157) or NO-INJURY (n=251) groups. The dependent variables were scores on VR12-PCS and VR12-MCS, and the independent variables were PA group (NO-PA, YES-PA) and current injury (NO-INJURY, YES-INJURY). Descriptive statistics (mean±standard deviation) were calculated. Separate factorial ANCOVAs (PA group x current injury) examined the interaction between PA and current injury, controlling for age, on HRQL (VR12-PCS, VR12-MCS). Post-hoc pairwise comparisons controlling for age were performed when indicated. Statistical significance was set a priori $p < 0.05$.

Results: For PCS scores, there was a significant interaction between PA group and current injury ($F=4.164, p=0.042$). Significant post-hoc analyses revealed YES-INJURY/YES-PA participants had higher PCS scores compared to the YES-INJURY/NO-PA participants ($F=4.787, p=0.03$, Table 1). The YES-INJURY/YES-PA participants had significantly lower PCS scores than the NO-INJURY/YES-PA participants ($F=22.72, p < 0.001$, Table 1). A significant main effect for current injury ($F=48.7, p > 0.001$) was also identified, the YES-INJURY group exhibited lower PCS (45.6 ± 9.7) scores compared to the NO-INJURY group (52.0 ± 7.9). There was no significant main effect for PA ($F=3.796, p=0.052$) on PCS scores. For MCS scores, there was no significant interaction ($F=0.036, p=0.850$) or main effects for current injury ($F=2.315, p=0.129$) or PA ($F=0.877, F=0.350$).

Conclusions: In the group with current injury, the women participating in PA had increased HRQL in the physical domain compared to those not participating in PA. This suggests PA may be a protective factor for HRQL for individuals with current bone, joint or muscle injury. Clinicians should consider safe PA participation strategies when developing treatment plans for musculoskeletal injuries to maintain HRQL.

Total Word Count: 441

200314MD

Plasma Concentration of Interleukin-10 and Interleukin-6 can Predict Pain at 48-Hours Following a Musculoskeletal Injury to the Shoulder External Rotator Muscles

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Context: Acute musculoskeletal pain is normally transient and protective in nature, alerting an individual that injury is present, and homeostasis has been disrupted. If acute pain persists beyond a normal time period without intervention, it can transition to post-acute pain, and eventually, chronic pain. The purpose of this study is to determine if inflammatory cytokines can predict pain after a musculoskeletal injury in a high-risk pain group [determined by pain catastrophizing and positive for the catechol-O-methyltransferase (COMT) polymorphism rs6269]. This could help athletic trainers identify individuals who may need more extensive pain treatment following injury, thereby potentially decreasing chronic pain cases.

Methods: Fifty-four participants [$X=30$ $Y=24$, $\mu_{age}=21.4$ years ($\sigma_{age}=4.06$ years), $\mu_{weight}=68.89$ ($\sigma_{weight}=15.6$ kg), $\mu_{height}=170.54$ cm ($\sigma_{height}=10.83$ cm)] identified as pain catastrophizers (Pain Catastrophizing Scale ≥ 5) and tested positive for the COMT polymorphism rs6269 volunteered to be part of the cohort study, which was conducted at the Clinical and Translational Science Institute at the University of Florida. Researchers initially collected baseline pain measurements using the Brief Pain Inventory and a blood draw to analyze plasma concentrations for the inflammatory cytokines TNF α , IL-1 β , IL-6, IL-8, and IL-10. Participants then completed a high-intensity resistance exercise protocol for the external rotator muscle group of the shoulder, which induced a musculoskeletal injury characterized by delayed-onset muscle soreness. Follow-up pain measurements and blood collection occurred on Day 2 and Day 3 (24- and 48-hours post-injury). Pearson bivariate correlation coefficients were calculated between inflammatory cytokines and peak pain intensity on Day 2 and Day 3. Once significant correlations were identified, a stepwise multiple linear regression analysis was conducted to predict pain intensity. Models were developed when 3 or more cytokines from the same time point had a significant correlation with pain. Alpha was set a priori at 0.0167.

Results: There were 13 significant correlations between inflammatory cytokine concentrations and pain ($p < 0.0167$), these correlations had at least a weak relationship ($r \geq 0.3$). Three separate multiple regression analyses were conducted:
1) IL-1 β , IL-6 and IL-10 concentrations on Day 2 with pain on Day 2
2) IL-1 β , IL-6, IL-10 and TNF α concentrations at Baseline with pain on Day 3
3) IL-1 β , IL-6, IL-10 and TNF α concentrations on Day 3 with pain on Day 3
Multiple regression analyses #2 identified that baseline IL-10 plasma concentrations contributed to pain ($R^2=0.15$; $p=0.004$; $Y'=1.377+0.094x$) on Day 3. Multiple regression analysis #3 identified that IL-6 plasma concentration on Day 3 ($R^2=0.19$; $p=0.001$, $Y'=1.387+0.28x$) as the only inflammatory cytokine to contribute to pain experienced in the shoulder on Day 3. Multiple regression analysis #1 was insignificant ($p > 0.0167$).

Conclusions: Plasma concentrations of IL-10 at baseline, and plasma concentrations of IL-6 24-hours following injury may play a significant role in identifying the pain response 48-hours following musculoskeletal injury.

Total Word Count: 437

207402ED

Post-Surgical Complications Following Hip Labral Tear Repair in Professional Hockey Player: A Level 4 Clinical Case Report

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Background: A 32-year-old male professional hockey player post-surgical complications following repair of right hip labral tear. Prior to initial labral injury, patient's previous history was non-significant. Following initial acute injury, patient complained of pain in right hip, weakness, when and inability to jump. Initial diagnosis was superior acetabular labrum tear in right hip and femoral-acetabular impingement (FAI). Initial post-op report recovery was non-significant. At post-op 6 months, patient complained of low back pain and reoccurring weakness in right hip. Post-op 9 months, a platelet rich plasma (PRP) injection did not resolve symptoms, and diagnostic imaging was inconclusive. Patient release form to participate in a case study has been completed.

Differential Diagnosis: Possible differential diagnoses included reoccurring hip labral tear, FAI, sectioning of the circumferential fibers of the labrum (due to combination FAI repair during initial surgery), adhesions of capsule to labrum, chondral lesion, avascular necrosis, or neuromuscular pathology. Both radiographs and magnetic resonance imaging (MRI) were inconclusive to determine diagnosis, but lack of significant findings ruled out the likelihood for reoccurring labral tear, chondral lesion, and avascular necrosis.

Intervention & Treatment: After initial surgery for hip labral repair, the patient made a full, albeit temporary, recovery to full participation in activity. Symptoms reoccurred at post-op 6 months, and initial conservative rehabilitation began with a goal of reducing symptoms. Due to persistent pain and weakness, despite continued conservative rehabilitative efforts, a lack of significant imaging findings, and no response to PRP injection, the patient and treating athletic trainer decided to seek a second orthopedic opinion. The patient and new treating physician agreed to attempt an exploratory hip arthroscopy to determine cause of symptoms. Arthroscopy findings included scarred-down capsular sutures and one suture impacted on the femoral neck (Figure 1). All problematic sutures were removed, and scar tissue was resected. Patient participated in post-surgical rehabilitation plan following surgery and was returned to full activity 6 months after exploratory arthroscopic surgery procedure, approximately 15 months after the initial labral repair.

Uniqueness: Arthroscopic surgery of the hip has a relatively low rate of complications. The surgery is associated with patient satisfaction and good short-term outcomes. A search of the existing literature yielded no reported incidence of a foreign body nature complication. One study reported a total of only 0.58% reported major complications and 7.5% in minor complications of 6,000+ patients for hip arthroscopy with the most common complications being nerve injuries and iatrogenic chondral and labral injuries. Another study of 218 hip arthroscopies identified only one suture-related complication, which was a suture abscess, symptoms from which developed within. With the evidence demonstrating a very low post-surgical complication rate, many clinicians may suspect new or reoccurring pathology when signs and symptoms reoccur 6 months following hip labral repair. Due to the delay between initial repair and reoccurrence of symptoms, post-surgical complications were not initially considered. In this case physical examination and diagnostic imaging all resulted in inconclusive findings, and patient did not respond to conservative treatment. Exploratory arthroscopic surgery, while invasive and not without risk, was the only diagnostic mechanism to determine the root cause of symptoms.

Conclusions: Although extremely rare, suture embedment can cause significant symptoms to the patient, and such symptoms are not likely to develop immediately following surgery. Clinicians should consider this potential complication if symptom re-occurrence occurs within one year of initial repair and imaging is not conclusive. If patient does not respond to conservative treatment, refer for potential exploratory arthroscopy to determine if post-surgical complication is the cause.

Total Word Count: 570

205753LD

Postural Control Deficits Indicate Inadequate Neural Adaptation in Anterior Cruciate Ligament Reconstruction Patients

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Context: Postural control deficits in anterior cruciate ligament reconstruction (ACLR) patients can lead to functional joint instability, which may be associated with neural adaptation in the brain. However, it remains unclear how ACLR influences neural processing in the brain during postural control tasks. We examined postural control and electrocortical activation in the brain during single-leg stance tasks in ACLR patients and healthy controls. We hypothesized that ACLR patients, who were cleared to return to physical activity, would have similar postural control patterns, but higher electrocortical activation compared to healthy individuals.

Methods: This case control study was conducted in a research laboratory. Fifteen unilateral ACLR patients (ACLR: 23.13±3.2yrs, 76.02±17.22kg, 172.55±9.95cm) and 15 healthy controls (CONT: 23.07±3.45yrs, 71.09±11.31kg, 175.68±11.58cm) with no history of knee injury volunteered. All participants performed 40 trials (20s/trial) of single-leg stance under two conditions (VFSP: visual feedback on stable platform, NVFUP: non-visual feedback on unstable platform) on the affected knee for ACLR patients and matched knee for the control group. Prefrontal (Fz) and primary motor (Cz) electrocortical activation in theta frequency band (4-8Hz) were quantified during the single-leg stance tasks. Postural control was calculated as the overall stability index (OSI), while electrocortical activation during the first 3 seconds of single-leg stance was calculated using event-related synchronization (ERS: % increased power relative to a non-active baseline). The OSI and ERS values were compared across groups (ACLR, CONT) and condition (VFSP, NVFUP) using repeated measure ANOVAs.

Results: A significant group by condition interaction effect for OSI ($p=.034$, $F[1,24]=5.057$) was found. The NVFUP resulted in poorer postural control in both groups (ACLR: $p<.001$, 2.72 ± 0.76 ; CONT: $p<.001$, 2.11 ± 0.53) than the VFSP (ACLR: 0.77 ± 0.15 , CONT: 0.75 ± 0.22), with greater postural control impairment in the ACLR compared to the CONT ($p=.010$, 2.05 ± 0.54). Significant main condition effects for electrocortical activation were observed with greater theta ERS in the prefrontal (Fz: $p=.040$, $F[1,26]=4.65$, 2.95 ± 32.68) and primary motor (Cz: $p=.009$, $F[1,24]=8.19$, $.72\pm0.76$) cortices during the NVFUP compared to the VFSP (Fz: 13.67 ± 21.14 , Cz: 22.35 ± 28.35).

Conclusions: The more challenging condition (NVFUP) increased prefrontal and primary motor cortical activation compared to the relatively easier condition (VFSP), indicating increased cognitive processing for muscle coordination and error detection, while maintaining balance, respectively. The ACLR group revealed similar postural control to the CONT group during the VFSP, but greater postural control impairment during the NVFUP. However, there were no group differences in cortical activation during the single-leg stance, regardless of condition. It may indicate that neural processing in ACLR patients was not efficient enough to compensate for deafferented proprioceptive inputs in order to accommodate for more challenging postural control task. Our findings highlight clinicians the need of advanced postural control exercises emphasizing cognitive neural processing responsible for task complexity to optimize patient outcomes.

Total Word Count: 446

[2047940D](#)

Practical Blood Flow Restriction Rehabilitation in Patients With Acute Musculoskeletal Injury: A Case Series

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Background: The study included 4 strains to the hamstring complex, 1 peripheral meniscal tear, and 1 sprain to the medial collateral ligament (MCL). None of the participants had a previous history of blood disorders or illnesses, and no hereditary heart conditions were noted upon examination of medical charts by athletic training (AT) staff.

Patient: Six NCAA Division I football players, with ongoing acute lower extremity musculoskeletal injury, were recruited to this study during the off-season and in-season.

Intervention & Treatment: A 4-week rehabilitation protocol using low-load lower extremity (LL-LE) rehabilitation exercises and an occlusive device at a 7/10 tightness as the practical BFR (pBFR) condition for the injured limb, while the unaffected limb performed the same exercises but did not undergo occlusion. Outcome measures used included: thigh girth measurements that were recorded at 5 and 10 inches superior to the mid patella, and the Disablement in the physically active scale (DPAS) patient reported outcome measures (PRO) weekly through the 4-week protocol, and week 5 (1-week post termination of protocol). Thigh girth was measured to assess circumference of thigh through the protocol, while the DPAS was used to assess subjective patient perceptions to their injury and rehabilitation. In addition, functional outcome measures included in the study were: Romanian dead lift, squat, 53-yard sprint, broad jump, single leg triple-hop for distance (measured using the limb symmetry index for limb asymmetry). All baseline measures except the triple hop were recorded prior to the start of season with the strength and conditioning staff. These measures were used as they are relevant to sport-specific demands of football.

Outcomes or Other Comparisons: Patients followed a pBFR protocol scheme of 1 set of 30 repetitions followed by 3 sets of 15 repetitions subsequently or until failure of a repetition. Patient's followed a standard progression of rehabilitation exercises (ROM, Strength, Proprioception, Plyometrics, Sports Specific). For the first two weeks of the protocol the patients would report daily to the clinic. After the second week, patients were tapered based on their current injury status. Patients were able to participate in team lifts and practices while supervised by AT staff. Average days missed for all patients was 15 ± 4.2 days. Girth measures were compared within limb at week 1 measurements to week 4 measurements. Average girth scores saw a 1.6% decrease 5in superior to mid-patella and 2% decrease 10in superior to mid-patella in the affected limb. Average girth scores in the unaffected limb saw a 5.1% decrease 5in superior to mid-patella and .6% decrease 10in superior to mid-patella. When compared to week 1 to week 5, average PRO scores for the DPAS saw a total score decrease from 31 to 4, respectively. All patients were able to complete both the 53-yard sprint and RDL to baseline measures. In addition, there were no limb asymmetries noted in all 6 patients, with 4 patients demonstrating greater strength in the affected limb. 5 out of 6 completed the squat to baseline measures. Meanwhile 2 out of 6 completed the broad jump to baseline measures. Patient 2 required an additional week to perform functional tests due to injuring their ipsilateral hip, while patient 3 had to modify squat to leg press due to pain.

Conclusions: pBFR with low-load exercise assisted with safe return to functional activities and shows trends in reducing atrophy to the affected limb following acute injury, when compared bilaterally.

Clinical Bottom Line: pBFR is a rehabilitation tool that allows patients to push lighter loads during exercise and may minimize atrophy of musculature.

Total Word Count: 569

[208063RD](#)

Preceptor Perceptions of the Immersive Clinical Environment in Athletic Training Education

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Context: Athletic training students (ATS) are socialized to clinical practice through practical experiences gained during their education in both didactic and clinical settings. Clinical immersion is an emerging concept within athletic training education and preceptors play a critical role in facilitating student learning during those experiences. The purpose of our study was to explore the perceptions of preceptors who are currently supervising athletic training students who participate in clinical immersion.

Methods: We used consensual qualitative research design to examine our primary research questions. We used criterion sampling to identify preceptors who had facilitated an immersive clinical experience within the last year. Twelve participants from various clinical sites participated in a semi-structured one-on-one interview, which were audio-recorded and transcribed verbatim (Zoom®, San Jose, CA). A 3-person data analysis team used a multi-phase process to identify emerging domains and core ideas, ultimately developing a consensus codebook. Trustworthiness and credibility were established with member checking, multiple researcher triangulation, and auditing.

Results: We identified three emergent domains within the experiences of preceptors facilitating clinical immersion (Figure): 1) exposure, 2) benefits, and 3) training insufficiency. Participants perceived, as a result of exposure, they were able to allow students increased responsibility and trust, increased realism, increased inter/intra professional experiences, and increased clinical skill application. Preceptors indicated the immersive experience provided improved quality through exposure to the aforementioned activities, but they also indicated that simply spending more time was beneficial. Preceptors described the added benefits of immersive clinical experiences led to decreased fear and increased confidence in clinical and professional interactions. ATs were able to develop stronger relationships, not only with the preceptors, but also with the patient. Patients demonstrated increased trust and valued the students. Preceptors noted insufficiency in their training, specific to the expectations of an immersive clinical experience. Many preceptors sought out self-directed learning opportunities to enhance their role as preceptor. When describing the information provided from the program, there was an apparent lack of communicated or standardized goals and objectives. There was also a misunderstanding from preceptors as to what the main differences were between traditional and immersive clinical experiences.

Conclusions: Preceptors perceived the immersive clinical experience exposes ATs to more aspects of athletic healthcare, whether that be providing more realistic experiences or simply spending more time. The preceptors indicated the immersive clinical experiences were beneficial for the ATs. The training insufficiency and misunderstanding of the immersive clinical experience is concerning and could be enhanced with clearly set goals and objectives, differentiation between traditional and immersive experiences offered by the program instead of relying solely on the preceptor to seek out self-directed learning opportunities.

Total Word Count: 428

206175QD

Preceptors' Leadership Behavior Frequency Changes With Years of Experience

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Context: Athletic trainers are called to be leaders in multidisciplinary and interprofessional practice, but the practice of leadership takes time to develop. The purpose of this study was to determine which preceptors, categorized by years of clinical experience, demonstrate leadership behaviors more frequently.

Methods: This cross-sectional study utilized BOC survey services to invite 4500 athletic trainers who had attained initial certification within the previous 2 years. Of the invitees, 190 (4%) completed the online, researcher-developed Leadership in Clinical Education survey (161 graduates of baccalaureate programs, 29 graduates of post-baccalaureate programs; 48 male and 142 female respondents). The survey contains questions about 16 leadership behaviors written as 5-point Likert-type items that are replicated into 2 scales: a behavior agreement scale and a behavior frequency scale. Both scales demonstrated excellent reliability as was determined by Cronbach's alpha (0.960 for agreement scale, 0.946 for frequency scale). Preceptors were categorized by years of experience into 5 groups: 0-5 years (n=34), 5-10 years (n=56), 10-15 years (n=42), 15-20 years (n=21), and more than 20 years (n=37). One-way ANOVAs were conducted comparing frequencies with which each of the leadership behaviors were observed by respondents whose most influential preceptor fell into each experience group. Tukey post hoc testing further analyzed significant differences.

Results: Statistical analysis revealed significant differences between pairs of experiences ranges for 5 of the leadership behaviors. Preceptors with 10-15 years of experience permitted students to make decisions affecting their clinical education more often than preceptors with 0-5 years and more often than those with 15-20 years of experience, $F(4, 192)=4.89$, $p<0.001$, $\omega=0.438$. Group 3 and Group 5 preceptors set clear expectations of their learners more often than preceptors in Group 1, $F(4, 192)=3.31$, $p=0.012$, $\omega=0.398$. Preceptors with 10-15 years of experience allow students to make decisions about patient care more frequently than preceptors with 0-5 years of experience, $F(4, 192)=4.28$, $p=0.002$, $\omega=0.486$. Preceptors with 10-15 and those with more than 20 years of experience placed students' needs above their own more frequently than preceptors in groups 1, 2, and 4, $F(4, 192)=4.36$, $p=0.002$, $\omega=0.606$. Lastly, Group 3 modeled mindfulness more frequently than Group 1, $F(4, 192)=3.07$, $p=0.017$, $\omega=0.446$. None of the other leadership behaviors exhibited significant frequency different between experience groups. Figure 1 is a graph of the frequencies of the 5 significantly different behaviors displayed by each experience group.

Conclusions: Athletic training students may observe more leadership behaviors during clinical education if their preceptor has 10-15 years of clinical experience. Preceptors with 0-5 years of clinical practice may not demonstrate leadership behaviors as frequently as preceptors with more experience.

Total Word Count: 416

[209753DB](#)

Preclinical Model of ACL Injury Reveals the Acute Time Course of Mitochondrial Dysfunction in the Vastus Lateralis

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Context: Anterior cruciate ligament (ACL) rupture is a common musculoskeletal injury resulting in significant quadriceps muscle strength loss that drives reduced patient outcomes and accelerates osteoarthritis development. Alterations in the mechanisms underlying muscle atrophy and the time course of changes remain poorly understood. Thus, the purpose of this research was to use a preclinical animal model to identify longitudinal changes in mitochondrial dysfunction, a key mechanism of muscle atrophy, after ACL injury.

Methods: Male Long-Evans rats were randomly assigned to six groups (n=4 per group): one control group and five ACL injury groups (1, 3, 7, 14, 28 days). The right hindlimbs of ACL injury rats were exposed to a single axial load of tibial compression, resulting in non-invasive ACL rupture, followed by normal cage activity. Rats were euthanized as per assigned group and the right quadriceps were dissected and weighed. Mitochondrial dysfunction was determined by assessing the production of reactive oxygen species (ROS) in muscle fibers through Amplex Red assays. One-way ANOVAs with Bonferroni post-hoc were used to determine differences between groups ($P < 0.05$).

Results: Significant loss of quadriceps muscle mass was detected at 3- and 14-days post-injury (control: 1.71 ± 0.07 g; 3-days: 1.43 ± 0.14 g; 14-days: 1.36 ± 0.06 g; $F = 7.28$, $P = 0.008$ and $P = 0.001$ respectively). Increased ROS were present from 7- to 28-days post-injury (See figure 1; control: 9.72 ± 0.37 pmol-s⁻¹·mg⁻¹; 7-days: 14.16 ± 0.84 pmol-s⁻¹·mg⁻¹; 14-days: 21.75 ± 0.39 pmol-s⁻¹·mg⁻¹; 28-days: 25.00 ± 0.42 pmol-s⁻¹·mg⁻¹; $F = 82.64$, $P = 0.003$, $P = 0.001$, and $P = 0.001$ respectively).

Conclusions: ACL induces muscle atrophy that is associated with increased release of oxidative free radicals. Increased ROS are indicative of mitochondrial membrane damage and are associated with accelerated muscle protein breakdown. Further research assessing potential therapeutic strategies to mitigate ROS may provide clinicians with additional tools to combat quadriceps atrophy after ACL injury.

Total Word Count: 308

200545CD

Prefrontal Cortex Activation During Neurocognitive Test Using Functional Near-Infrared Spectroscopy (fNIRS) in Division-I Athletes Following Sports-Related Concussion

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Context: Neurocognitive testing has been called “the cornerstone” of the Sport-Related Concussion (SRC) management. The Immediate Post-Concussion Assessment & Cognitive Testing (ImPACT) has been widely used for SRC management. Word memory test of the ImPACT battery measures working memory capacity, which is the crucial component in understanding the prefrontal cortex (PFC) and dorsolateral prefrontal cortex (DLPFC) functions. Functional neuroimaging techniques have the potential to reveal the complex neurometabolic process related to SRC. However, such potential is not fully explored in the literature. Functional Near-Infrared Spectroscopy (fNIRS) is a non-invasive continuous brain-imaging tool and a portable technique suitable for cost-effective measurement of real-time hemoglobin concentration changes in the brain with good temporal resolution. Given the aforementioned advantages of fNIRS, the integration of fNIRS and ImPACT can be a promising cost-effective, and portable approach to concussion management in the athletic environment. The purpose of this study was to compare prefrontal hemodynamic activation using fNIRS during the performance of a computerized ImPACT in a sample of concussed athletes tested within 72 hours post-injury compared to age-matched healthy subjects.

Methods: We conducted a case-control study in a laboratory setting. Twelve subjects (6 males, 6 females; age 21.08 ± 1.53 years) with a SRC diagnosed within 3 days of injury (2.33 ± 0.78 days) and fourteen age-matched college students (5 males, 9 females; age 21.28 ± 0.83 years) were enrolled in the study. All 26 subjects performed the computer-based ImPACT while wearing a wireless fNIRSIT device (OBELAB Inc, Seoul, South Korea), which is a 48-channel continuous wave wireless fNIRSIT system. Raw fNIRSIT signals were processed and converted to hemoglobin concentration using NIRSIT analysis tool V2.5 software. Independent sample t-tests identified differences between concussed and a comparison groups with a False Discovery Rate (FDR) for multiple comparisons, selecting p-value of 0.05.

Results: The results showed that the differences in the activation level between word memory presentation and word memory recall were significant between experimental and comparison groups at right Brodmann Area 46 (BA46; channel 4, $p < .05$; channel 5, $p < .05$; channel 10, $p < .05$; Figure 1).

Conclusions: Results indicated increased brain activation of the right DLPFC in the concussed groups compared to the comparison groups during the performance of working memory presentation. More specifically, the concussed group had an increased hemodynamic response and decreased working memory capacity when increasing working memory load. This groundwork supports the use of fNIRS as a potential functional neuroimaging technique in combination with other SRC tests. Future research should include a greater number of participants and longitudinal assessments across baseline, post-SRC, and following up after return-to-play.

Total Word Count: 425

209313QD

Preparedness, Confidence and Best Practices in Preventing, Recognizing, Managing Routine and Crisis Mental Health Cases in NCAA Affiliated Institutions

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Context: Incidence of mental illness has steadily risen as one in five adults experience depression, anxiety, or other mental illnesses in their lifetime with highest rates among those 18 to 25. Currently, the National Collegiate Athletic Association (NCAA) recommends policies to assist in the management of mental health concerns for student-athletes when a crisis occurs. The purpose of this study was to examine the characteristics of routine and emergency mental health policies and institutional preparedness

Methods: Based upon previous literature, we developed and piloted an 18-item questionnaire with 4 questions regarding university demographics, 8 items regarding mental health preparedness including policy creation and review of incidence rates, and 6 items for respondents to indicate their confidence in preventing, managing and referring routine and emergency mental health situations (5-point Likert scale: 1= not at all confident to 5=very confident). A web-based survey was distributed to ATs with clinical responsibility at 1091 NCAA member institutions and a reminder email was sent once per week for 3 weeks. In total, 235 ATs completed the survey (response rate=21.5%). We analyzed the data using frequencies and percentages.

Results: Respondents primarily worked in an NCAA Division I institution (33.19%, n=78/235) and provided medical care to 391±158 patients. Most respondents indicated they felt “fairly confident” with screening (40.21%, n=76/189), prevention through education (42.11%, n=80/190), recognizing routine (48.95%, n=93/190) and emergency (46.84%, n=89/190) mental health conditions. Respondents also felt “fairly confident” in referring routine cases (45.79%, n=87/190) and “very confident” (46.32%, n=88/190) referring mental health emergencies. Nearly two-thirds of the respondents noted the presence of a routine (65.84%; n=133/202) or emergency (65.53%, n=154/235) mental health policy. Emergency mental health policies were created 22±26 (range=1-203) months prior to survey, with routine mental health policies being 27±37 (range= 1-203) months prior. Policy reviews typically happened within 3 months (38.54% n=74/192); however, 17.7% (n= 34/192) stated policy review/revision never occurred. Nearly three fourths of respondents indicated that a policy review had occurred within the last 12 months (74.48%, n= 143/192) as is recommended by NCAA best practices. Respondents reported an average of 2±3 emergency mental health situations and 19±27 routine mental health situations within the past year. Respondents participated in professional development related to mental health with variable recency: within the last 3 months (25.64%, n=50/195), longer than one year ago (8.21%, n=16/195, or never (16.92%, n=33/195).

Conclusions: While collegiate ATs generally feel confident in their ability to prevent, manage and refer mental health situations, many institutions lack appropriate written policies recommended by the NCAA to best prepare AT’s to appropriately handle crisis. There is a need for more participation in professional development regarding mental health and policy review/revision.

Total Word Count: 434

208715MD

Preparing for the Wildland Fire Season: Understanding Exercise and Injury History of Smokejumpers

Moody VJ, Callis IG, Brady, ES

Context: Smokejumpers are highly specialized wildland firefighters (WLFF) trained to parachute into fires and often work in remote environments. Environmental factors, long arduous hours and the physical demands of the job cultivate significant occupational risk of injury in these tactical athletes. With the cost burden to both the employer in covering medical costs incurred from injury and also the employee, particularly from time lost working, it is imperative to develop strategies to minimize injury risk. However, little is known regarding Smokejumper injuries and their training preparation for season. The purpose of this study was to examine injury and exercise history of Smokejumpers leading up to the 2019 fire season in hopes of identifying discernable trends that can be addressed through injury prevention programming.

Methods: A cross-sectional paper-based survey was administered to Smokejumpers at a regional Smokejumper Base prior to the 2019 fire season. A convenience sampling strategy was used to recruit a possible 80 Smokejumpers. Respondents included 40 Smokejumpers for a 50% response rate (36 males, 4 females; mean age 35.5 + 7.5 years). The WLFF Injury and Exercise History survey was developed by the researchers using open and closed ended questions to obtain information on exercise history leading up to the fire season and previous injuries sustained while working as a Smokejumper. Eleven subject matter experts reviewed the survey to establish face and content validity and provided feedback regarding clarity, readability, and completion time. Quantitative data from the questionnaire was analyzed using Microsoft Excel to establish exercise history (frequency, duration, location and mode of exercise completed) as well as injury history (number, type, location and severity of injuries). Thematic analysis was conducted on open-ended questions where Smokejumpers could offer further explanation to a closed ended question.

Results: Smokejumpers train at least 4 months prior to the start of the fire season (50%, n=20/40), working out 5 or more days per week (55%, n=22/40) at least 60-90 minutes each day (55%, n=22/40). Running and weightlifting were the most common activities included in preseason training. Ninety percent (36/40) of Smokejumpers reported at least one injury with almost half of those injuries occurring during physical training (49%, n= 46/94) and the other half occurring during a jump or on the fireline (51%, n=48/94). Sixty percent of injuries occurred to the lower extremity (n=65/108) and approximately 26% were joint sprains (n=27/108).

Conclusions: Most of the injuries reported by Smokejumpers were to the lower extremity and occurred equally during physical training and on the fireline. Smokejumper training emphasized longer bouts of high impact aerobic activity occurring 5 or more days per week. The results from this study suggest that further investigation specifically addressing injury risk and injury prevention programming in Smokejumpers is warranted.

Total Word Count: 445

206475CD

Prevalence and Causative Factors of Improperly Fitted Helmets in Youth Football Leagues

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Context: Sport-related concussion prevalence is ~3-12% of all injuries sustained in the youth football population. Youth experience different symptoms and longer recovery than their competitive counterparts. Improper helmet fit is a risk factor for increased concussion symptomology and duration. In youth football, few leagues require coach education regarding helmet fitting. Therefore, the objective was to determine the prevalence of improperly fitted helmets and causative factors in preseason youth football.

Methods: A descriptive cross-sectional research design was utilized. 273 players (10±1y, 46.1±14.6kg, 148.0±8.7cm, 54.9±6.3cm head circumference) participated across 24 teams in 4 recreation youth (7-12y) tackle football leagues in the southeastern US. Researchers participated in standardized helmet fitting training sessions, with an expert, prior to data collection. Data was collected before full contact started and all variables were collected in a station format so players could be examined on an individual basis without interrupting practice time. The dependent variables were: helmet fit (proper or improper) and factor (pads, chin strap, etc). Helmet fit was determined by a checklist of 13 factors developed in previous published research. If one factor was not satisfied, the helmet was categorized as improperly fit. Helmet demographics (brand, acquisition, size, manufacturer recommended size, construction date) were collected. Descriptive statistics were calculated and a chi-square (adjusted for small cell size) was used to compare select variables of interest.

Results: The majority (83%) of helmets were rented by players from the league. Sizes ranged from XXS (1%) to XL (8%), with most (41%) sized medium, and no size found in 3% of helmets. Construction date ranged from 2005 to 2019 with no dates found for 31% of helmets and 5% of helmets expired. The majority (74%) of the helmets did not meet at least one component of the 13 criteria and were considered improperly fit. The most common factors for improper fit were: lack of snugness on all sides (26%), crown of helmet was not 1-2 fingers above eyebrows (26%), facemask slipped up and down (36%), and chinstrap was not equally fit (46%). When controlling for chinstrap, improper fit declined to 53%. There was no difference between brands ($\chi^2_4 = 4.470$, $p=0.346$) or sizes ($\chi^2_6 = 8.920$, $p=0.178$) for fit. Recorded helmet size was significantly different than manufacturer's recommended size ($\chi^2_2 = 145.1$, $p<0.001$).

Conclusions: The majority of youth football players depend on their league to provide and fit their helmets. Ensuring appropriate chinstrap tension would have corrected 21% of improper helmet fits. Development of future education and prevention interventions should target the most common factors related to improper fit. Player's recorded helmet size is different than what the manufacturer recommends. Future research should determine the reason for this difference.

Total Word Count: 435

209614MD

Preventive Training Programs Implemented During a Non-Traditional Season Provide Retention of Motor Control Improvements in Collegiate Soccer Athletes

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Context: Preventive training programs (PTPs) are exercise-based neuromuscular training regimens that improve movement control and reduce lower extremity injuries. Adoption of and compliance with PTPs during traditional, competitive sport seasons can be difficult, limiting program effectiveness. Initial implementation of PTPs during non-traditional athletic seasons may improve adoption of and compliance with PTPs due to decreased focus on competition, increased focus on athlete preparation and schedule flexibility; however, the effectiveness of PTPs implemented during a non-traditional season is unknown. Therefore, the purpose of this study was to evaluate the effect of a PTP on movement control during a non-traditional athletic season. The retention of possible benefits over the off-season was also evaluated.

Methods: Prospective cohort field study. Twenty NCAA Division III soccer athletes on two teams (male: $n=10$, female: $n=10$; age 19 ± 1 years, height: 171.6 ± 9.8 cm, mass: 70.7 ± 11.2 kg) volunteered. Movement control was assessed at three time points: beginning (PRE) and end (POST) of the non-traditional (spring) athletic season and beginning of the next competitive (fall) athletic season (RET) using a jump-landing task. Jump-landings were scored using the Landing Error Scoring System (LESS) via an automated motion capture system (Physimax Technologies, Tel Aviv, Israel). Participants completed a PTP warm-up prior to all practices, 3-4x/week for 4-6 weeks. PTP implementation was monitored by an athletic trainer. Participants were encouraged to continue the PTP during the summer off-season and reported compliance at RET. A two-way, repeated measures analysis of variance (team \times time) was used to evaluate changes in LESS score across timepoints. Significant effects were evaluated post-hoc using 95% confidence intervals (CI). $\alpha\leq 0.05$.

Results: Six (30%) athletes reported PTP compliance during the off-season; however, only 3 (15%) completed the required dosage of 30 minutes/week. There was a significant main effect for time ($p=0.03$). Post-hoc tests revealed significant improvements in LESS score between PRE and POST ($p=0.02$; mean difference= 0.8 ± 0.3 errors, 95% CI [0.1, 1.5]) and between PRE and RET ($p=0.02$; mean difference= 1.3 ± 0.5 errors, 95% CI [0.2, 2.4]) (Figure 1). No difference was found between POST and RET and no significant team or interaction effect was observed ($p>0.05$).

Conclusions: Implementation of PTPs during the non-traditional spring season in collegiate soccer athletes can provide movement control benefits that are retained for at least 3 months, until the start of the competitive fall season. These findings are in contrast to previous work that found movement control benefits following a 3-month PTP degraded within 3 months after program cessation in youth soccer athletes. Initial implementation of a PTP during a non-traditional athletic season may improve adoption of and compliance with the program and can have carry-over benefits for the beginning of the next competitive season, at which time PTP use should resume. Further research is necessary to determine the length of these carry-over benefits.

Total Word Count: 449

[204865AA](#)

Prior Sport Specialization is Associated With Lower Extremity Stress Fracture in Female Service Academy Cadets

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Context: Level of sports specialization has been associated with the risk of lower extremity overuse injuries in adolescent athletes; however, it is unclear if level of sports specialization in high school is associated with the risk of lower extremity stress fracture in service academy cadets during their first year.

Methods: We conducted a prospective cohort study to examine the association between prior sports specialization level and the risk of lower extremity stress fracture during one year of follow-up in US Service Academy cadets. All incoming freshman from the class of 2020 and 2021 were recruited to participate in this study within the first week of arrival at the academy. Those that consented completed a baseline questionnaire that included demographic information, standard items on level of sports specialization using the 3-point scale described by Jayanthi, and lower extremity injury history. Subjects were followed during their first year at the academy to identify all incident lower extremity stress fractures during the follow-up period. Univariate and multivariable logistic regression models were used to analyze the data stratified by sex and odds ratios (OR) and 95% confidence intervals (CI) were calculated.

Results: A total of 2,012 participants consented (470 females, 23.4%) and agreed to participate in this study. Among all participants, 881 (43.78%) reported low, 729 (36.23%) reported moderate, and 402 (19.98%) reported high levels of sports specialization at baseline. During the one year follow-up period 34 incident lower extremity stress fractures were identified in the cohort and the cumulative incidence was 1.69%. Females were over five times more likely (OR=5.42; 95%CI: 2.69, 10.92; $p<0.001$) to experience an incident stress fracture (4.47%) when compared to males (0.84%). There was no association between lower extremity stress fracture and prior sports specialization among males; however, there was a dose response relationship between level of sports specialization and lower extremity stress fracture risk during the follow-up period in females. In univariate models those with moderate specialization were 2.49 times (OR=2.49; 95%CI: 0.75, 8.22; $p=0.135$) more likely to sustain an incident lower extremity stress fracture and those with high specialization were 4.25 times (OR=4.25; 95%CI: 1.25, 14.48; $p=0.021$) more likely when compared to those with low specialization; however, only the latter was statistically significant. Similar results were observed in multivariable models controlling for weight, injury history, and lower extremity movement quality at baseline.

Conclusions: Prior level of sports specialization appears to be associated with the risk of lower extremity stress fracture in females but not males during their first year after entry into a US Service Academy. It is unclear if similar results would be observed in other military training populations; however, this warrants further investigation.

Total Word Count: 434

206642MD

Psychosocial Characteristics of High-School Endurance Athletes Compared to Team Sport Athletes

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Context: Psychosocial factors among adolescent athletes may significantly influence performance or injury risk. Few studies have examined how psychosocial characteristics differ between pediatric endurance athletes and team sport athletes. Our purpose was to compare the psychosocial characteristics of high-school athletes who defined their primary sport as an individual endurance sport (cross-country or swimming) or a team sport (basketball, soccer, baseball, or softball).

Methods: Participants completed the athlete burnout questionnaire (ABQ), Pittsburgh Sleep Quality Index (PSQI) score, and Pediatric PROMIS 25, which included the physical function mobility, anxiety, depressive symptoms, fatigue, peer relationships, pain interference, and pain intensity domains. We compared endurance and team sport athletes on measures of demographics, medical/injury history, and psychosocial characteristics using independent samples t-tests, Mann-Whitney U tests, and Fisher's exact test. We then constructed a series of negative binomial or linear regression models to examine the association of endurance sport participation and psychosocial outcomes. The predictor variable in each model was endurance athlete classification, covariates included age and competition level.

Results: Of the 89 participating athletes, 33% (n=29; 45% female; mean age= 15.9±1.2 years) defined their primary sport as an endurance sport (n=22 cross country; n=7 swimming), and 67% (n=60; 48% female; 15.3±1.2 years) defined their primary sport as a team sport including basketball (n=17), soccer (n=22), baseball (n=6), or softball (n=15). Endurance athletes were older than team sport athletes (p=0.04), and a higher proportion were varsity athletes (48% vs. 28%; p=0.10). The two groups spent a similar amount of time participating in sports per week (10.8±3.8 vs. 10.8±4.5 hours; p=0.99), and a similar proportion of both groups reported a history of time-loss orthopedic injuries (38% vs. 42%; p=0.82), stress fractures (0% vs. 7%; p=0.30), and concussion (17% vs. 17%; p=1.0). The endurance athlete group reported more physical function mobility difficulty (0.3±0.5; p=0.04), higher anxiety symptoms (4.0±3.3 vs. 2.4±3.1; p=0.02) and more fatigue (3.1±3.3 vs. 1.6±2.0; p=0.03). After adjusting for the effect of age and competition level, endurance athletes were significantly associated with greater physical function mobility difficulties (coefficient=1.22; 95% CI=0.20, 2.24; p=0.02), higher anxiety symptoms (coefficient=0.50; 95% CI=0.02, 0.97; p=0.04), and higher fatigue scores (coefficient=0.62; 95% CI=0.08, 1.16; p=0.02) relative to team sport athletes.

Conclusions: Adolescent athletes who participate in endurance sports reported more physical function mobility difficulties, higher anxiety, and more fatigue than team sport athletes. These findings indicate that endurance athletes may experience more psychosocial problems than team sport athletes, although our cross-sectional design cannot account for any causal inferences. Psychosocial health factors may be important to assess for determination of self-perceived health among youth athletes. It is important to understand the differences in psychosocial factors among various athlete groups and how this affects athlete health, performance, and injury risk.

Total Word Count: 443

[207421JD](#)

Pulmonary Contusion and Enlarged Spleen in a Collegiate Football Player

Daly K, Romero J, Wujciak D, DiStefano P, Lowy N

Background: Pulmonary contusions are not a common occurrence in athletics because of the protection that the ribs and surrounding musculature provide. Usually only blunt force can cause a pulmonary contusion. An accurate assessment of pulmonary, visceral, or systemic injuries is difficult because most present very similarly and or have no presentation at all.

Patient: A 20-year-old male Division 3 football player was referred to the emergency room for further examination after receiving a helmet to the chest during practice. He stated that he felt an initial sharp pain in his chest that prevented him from breathing and made him feel as though he was going to vomit. Upon evaluation, bright red blood was observed in the athlete's saliva and mucus. His blood pressure was 140/100mmHg after about 20 minutes of being removed from activity and he began to feel minimal pain when taking a deep breath. Auscultation of the lungs revealed a gurgling, fluid like sound in the right lung. The athlete then disclosed that he had been sick and congested for about two weeks prior to the injury. He was point tender in the LUQ.

Intervention & Treatment: The athlete was transported to the emergency room via ambulance where a chest x-ray, EKG, and CT scan were performed. The CT scan revealed a pulmonary contusion in his right lung, pneumonia in his left lung, and an enlarged spleen. Blood tests were done and revealed an elevated white blood cell count, a low red blood cell count, elevated kidney and liver activity and a negative mononucleosis test. The athlete was given antibiotics to treat his pneumonia and was scheduled to follow up with the team physician. About two weeks post injury, the athlete was admitted to the hospital for appendicitis which was deemed unrelated to the initial incident. The CT scan performed to diagnose his appendicitis revealed that his spleen was now of normal size. During his appendectomy, two appendices were found in the patient's abdomen. This is a rare congenital anomaly seen in 0.004–0.009% of appendectomy specimens.

Outcomes or Other Comparisons: Normally, an enlarged spleen is not a result of a pulmonary contusion or blunt trauma to the abdomen. Pulmonary contusions of this severity usually present with symptoms such as shortness of breath, chest pain, and point tenderness over the affected area. As opposed to most patients with pulmonary contusions, this athlete presented with very little symptoms and was very apprehensive about going to the hospital because he felt it was unnecessary.

Conclusions: Visceral, specifically pulmonary injuries are uncommon in athletics, regardless of the level of contact involved in their sport. The human body relies heavily on the lungs being able to expand and contract without pain or discomfort. The athlete still has not been able to return to play pending recovery from the appendectomy. Before he was diagnosed with appendicitis, a follow up chest x-ray was going to be performed to determine return to play status.

Clinical Bottom Line: While pulmonary injuries are uncommon in athletics, they are emergent because they can be life threatening if not treated properly. The athlete was never necessarily put into a life-threatening situation, but if not handled in a reasonable amount of time by the athletic trainers, the situation could have escalated to a much more serious incident especially if his spleen had ruptured.

Total Word Count: 539

[208094JD](#)

Pulmonary Emboli in a Collegiate Male Basketball Player: A Chronic Occurrence

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Background: The patient was a 21-year-old male collegiate basketball player with a prior history of blood clots. The first episode presented as a sharp pain in the patient's right thigh. The hematologist prescribed Warfarin for six months his senior year of high school. During preseason speed conditioning, sophomore year of college, the patient started to feel ill after being instructed on a flossing technique at a local CrossFit style gym. The patient's symptoms included dizziness, fatigue, nausea, short of breath, and congestion. At the start of his Junior season, the same symptoms arose, blood work was taken, and the same result was found.

Differential Diagnosis: Differential diagnosis included upper respiratory infection, influenza, mononucleosis, Marfan's Syndrome, hemothorax, blood clot, and pulmonary emboli.

Intervention & Treatment: Initial treatment was antibiotics for an upper respiratory infection, with no signs or symptoms of thrombosis, by the team physician. Showing no signs of improvement, he went to the emergency room. A chest x-ray and EKG was initially performed in the emergency department. Testing revealed no significant findings at that time. The emergency room doctor advised the patient to continue the antibiotics. After a week on antibiotics, the patient returned to the emergency room with more severe symptoms; hemoptysis, increased shortness of breath and intense chest pain. Doctors then ordered a chest x-ray, Ultrasound, CT-A, and blood work. The bloodwork indicated an elevated d-dimer which led to a diagnosis of a blood clot, the Ultrasound determined the blood clot was in the right thigh and calf, and the CT-A proved multiple pulmonary emboli in both the right and left lung. Patient went to his family physician, where he was put on Eliquis, informed to have oxygen as needed, and was prescribed a rescue inhaler. One year later, the athlete was instructed to lower the dosage of the Eliquis. This turned into an elevated d-dimer and another diagnosis of a blood clot in the body.

Uniqueness: Multiple pulmonary emboli in an individual <45 years old is extremely rare. Pulmonary embolisms affect 1 in 1,000 Americans each year. Elevated d-dimer is an indication that there are blood clots forming in the body. Research shows that there is a higher chance of thrombosis occurring when an individual had previous experience. There are intrinsic and extrinsic factors that play a role in determining the cause of coagulation. The most common are prolonged travel, inherited clotting factors, and post-operative patients. In this case, the patient presented with none of these factors. The patient had an elevated International Normalized Ratio (INR) of 1.3 (normal being .9-1.1) and a d-dimer of 400 (normal being <200) meaning there had to be a correlation between the coagulation cells in the blood and liver enzymes he produces.

Conclusions: There was no significant onset for the first blood clot, therefore it was difficult to differentiate what intrinsic factors caused the coagulation. The cause of the first occurrence was never determined. After the six months on Warfarin, the patient was advised to stop taking the medication. The flossing technique performed by the patient was likely the source of the second blood clot in the lower extremity. A plethora of doctors' visits and testing concluded the patient will be on Eliquis for life and follow up for routine blood work every three months. Emerging blood flow restriction therapies show signs of improvement in the majority of athletes. Athletic trainers should be aware of the underlying consequences of use without a thorough history of the patient.

Total Word Count: 568

200453CD

Pupillary Responses Indicate Neurocognitive Processing Differences in Working Memory Following Concussion

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Context: The neurophysiological underpinnings of post-concussion neurocognitive deficits, are not well understood given poor clinical utility and ecological validity of neuroimaging techniques. Task-evoked pupillary responses (PR) are established psychophysiological measures for neural resource allocation and cognitive load. During digit-span working memory (WM) tasks, pupils demonstrate incremental dilation proportional to increasing sequence-lengths (i.e., cognitive load)—where response plateau and subsequent decline occurs at and above capacity. Previous literature suggests greater sensitivity of PR to load-dependent neurocognitive processing differences in clinical populations compared to performance-based measures alone. Concussion effects on PR and sex differences have yet to be examined. Therefore, to examine long-term concussion effects in these groups, we tested sex and concussion history effects on PR in healthy individuals during a digit-span task, while controlling for task performance.

Methods: Healthy, physically active individuals [n=40; age=21.9±2.1years; males=50%; with a concussion history=43%] participated in our cross-sectional study during a single laboratory testing session. Participants completed a demographic and medical history questionnaire followed by a backwards digit-span WM task. A virtual reality headset embedded with infrared eye tracking was used to measure PR during the digit-span task. Baseline PR was measured for each trial (3sec) and changes in PR were measured in response to randomly presented digit sequences (3sec) between 4 and 14 digits long, over 6 testing blocks—66 total trials. Following a brief retention/reordering period, Participants reported digits in reverse serial order, and task performance was calculated as the proportion of correctly recalled digits by serial position. Average pupil size (diameter in mm) during the first 2 seconds of the retention period normalized to baseline served as our dependent variable. A mixed effects model with quadratic mean structure was used to examine concussion history [yes versus no], sex [female versus male], and sequence-length effects on PR, while controlling for task performance. Random effects at the level of individuals' PR for each sequence-length were also examined (a priori $\alpha=0.05$).

Results: Average PRs across sequence-lengths are summarized by concussion history and sex in Figure 1. There was a significant interaction between sequence-length and performance on PR ($F_{1,2588}=4.29$, $p=0.04$), whereby higher average performance predicted overall PR at lower sequence lengths ($t_{2588}=2.14$, $p=0.03$). A significant interaction was also exhibited between sex and concussion history on PR adjusting for sequence length and performance ($F_{1,36}=11.69$, $p=0.002$). In males, concussion history predicted overall smaller PR ($t_{36}=-2.02$, $p=0.02$) during the WM task—while concussion history predicted overall larger PR ($t_{36}=2.82$, $p=0.01$) in females—compared to those without concussion.

Conclusions: Concussion history effects on PR, during a digit-span task, were different between males and females while adjusting for performance. This PR assessment may offer an ecologically valid approach to better understand neurocognitive deficits and recovery following concussion.

Total Word Count: 438

208073DD

Quadriceps Strength Characteristics Do Not Significantly Improve From 6- to 9-months After Anterior Cruciate Ligament Reconstruction

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Context: Individuals with ACLR begin to integrate vigorous exercise and sport-related movement into their recreational activities 4-6 months after ACL reconstruction (ACLR). This process is meant to prepare individuals for a return to unrestricted participation in physical activity and diversify physical challenges with the goal of enhancing functional outcomes. Despite this clinical assumption, it is unclear if the integration of vigorous activities results in improved clinical outcomes in the absence of formalized rehabilitation or structured strength training. Therefore, the purpose of this study was to assess change in patient-reported function and quadriceps strength characteristics from 6-months to 9-months after ACLR among young and active individuals. We hypothesized that self-reported knee function and activity level but not quadriceps strength characteristics would meaningfully improve during this time period.

Methods: Twenty individuals (10 women/10 men; age= 19.6±5.0 years) participated in this cohort study. All assessments were repeated 6-months and 9-months after ACLR. Self-reported knee function was evaluated using the International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC). Peak activity level was evaluated using the Tegner Activity Scale (TAS). Quadriceps strength characteristics were assessed during 3 maximal voluntary isometric contractions (MVIC) using an isokinetic dynamometer. Quadriceps strength characteristics included peak torque (Nm*kg⁻¹), rate of torque development 0-100ms after onset of contraction (RTD100, Nm*kg⁻¹*s⁻¹) and rate of torque development 100-200ms after onset of contraction (RTD200, Nm*kg⁻¹*s⁻¹). Limb symmetry indices (LSI) were calculated by dividing the ACLR limb values by the contralateral limb values and multiplying by 100. Quadriceps strength characteristics were compared between limbs and time points using separate 2x2 repeated measures ANOVAs. One-way ANOVAs were used to assess the change in IKDC score and quadriceps strength characteristics LSIs between time points. A Mann Whitney U test was used to compare participants on TAS between time points.

Results: IKDC score (6-months= 83.3±8.2, 9-months= 89.7±8.2, p= 0.01) and TAS (6-months= 6 [4 to 8], 9-months= 8 [4 to 10], p= 0.01) significantly improved over time. ACLR limb peak torque (p<0.001), RTD100 (p=0.05), and RTD200 (p<0.001) performed worse than the contralateral limb, regardless of time since surgery (Table 1). Peak torque LSI (6-months= 79.8±17.7%, 9-months= 86.6±22.0%, p= 0.09), RTD100 LSI (6-months= 94.1±20.5%, 9-months= 87.1±30.2%, p= 0.12), and RTD200 LSI (6-months= 72.4±23.9%, 9-months= 72.7±33.1%, p= 0.98) did not significantly improve over time.

Conclusions: Despite increased activity level and improved self-reported knee function, individuals with ACLR did not experience an improvement in quadriceps strength characteristics from 6-months to 9-months after surgery. Our findings indicate that integration of more intense activity types during this time period is insufficient to facilitate continued improvement in quadriceps strength. Therefore, extended structured rehabilitation and targeted strength training are needed to address quadriceps strength deficits during this critical transition period following ACLR.

Total Word Count: 444

209083RD

Recruiting and Retaining Racially Minoritized Students into Professional Post-Baccalaureate Athletic Training Programs

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Context: Racially diverse individuals are drastically underrepresented in the field of athletic training. Previous research identifies multiple factors that may contribute this lack of diversity including: lack of racially diverse people's access to higher education, institutionalized racism, under representation, financial instability, a lack of programming designed to assist minoritized students through matriculation in healthcare education programs, and a lack of mentoring. The purpose of this qualitative study was to identify current recruitment and retention strategies aimed at racially minoritized students in athletic training

Methods: This qualitative study used consensual qualitative research methodology with the incorporation of multi-analyst triangulation and member checking to establish trustworthiness. The interview protocol consisted of questions regarding current recruitment and retention strategies used by professional post-baccalaureate Program Directors. We recruited participants through email: 14 Program Directors (age=47±7 years; credentialed experience=25±7 years; Program Director Experience=13±7 years) with at least one completed cohort of students participated in this study.

Results: Four domains emerged from the study: (1) benefits of diversity, (2) marketing, (3) individualized support, and (4) enrollment management strategies (Figure 1). Participants expressed diversity can lead to a more inclusive and positive learning environment and improved patient care through establishing race concordant relationships. Participants demonstrated awareness of the need for diverse marketing and imaging through social media, program websites, and other print materials. The creation of inclusive media, use of alumni, preceptors, current students, and faculty, and the location of the institution where currently employed by Program Directors. When describing current methods of supporting racially diverse students, the participants mentioned recognizing student groups, church groups, hair salons, scholarships, mentoring, and tutoring. Participants were keenly aware of the costs associated with their programs and expressed how they worked to identify financial support for students. Program Directors demonstrated a lack of awareness relative to professional resources and the difference between creating equal versus equitable strategies. Many of the resources discussed were established for all students and did not address the specific needs of racially minoritized students. Participants demonstrated variability in their awareness of enrollment management strategies, specific to admissions resources and professional resources. Participants were aware of some resources, but all indicated a perception of unawareness for more resources.

Conclusions: Findings in this study suggest Program Directors appreciate the benefits of racial diversity and are actively engaged in marketing strategies to recruit minoritized students. They are also working to retain minoritized students, but may be providing equal rather than equitable resources. The profession must continue to develop and promote effective strategies for admissions, support the matriculation of racially minoritized students, and increase identifiable and equitable resources to better serve minoritized students.

Total Word Count: 428

[209971ID](#)

Relationship Between Hip Range of Motion and Power Output in Collegiate Baseball Players

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Context: During overhand throwing, the lower extremity plays a pivotal role in generating and transferring power to the upper extremity. Additionally, due to the asymmetric loading of the lower extremity, differences often develop in hip rotational range of motion (ROM) between limbs in baseball players. These changes may influence shoulder kinetics of baseball throwing, but it is unknown if hip ROM influences the ability to produce power in the lower extremity. Therefore, the purpose of this study is to identify differences in hip rotational ROM between limbs and positions, and determine if there is a relationship between hip rotational ROM and peak power output of a countermovement jump (CMJ).

Methods: Thirty-six collegiate baseball players (age: 19 ± 4 years, height: 1.8 ± 0.05 cm, weight: 85.1 ± 6.96 kg, 35 right-handed, 1 left-handed) were tested during preseason screenings. Participants performed 3 double leg CMJs on two force platforms to calculate peak positive power in each limb. Hip internal and external ROM was collected in the prone position with the knee bent to a 90 degrees and a strap placed across the low back. The average of internal and external rotation across 3 trials was used to calculate total arc of motion (internal rotation + external rotation = total arc). A 2x2 ANOVA was used to assess the difference in hip rotational ROM between stance and stride limbs (based on arm dominance) and between player positions (position and pitcher). Pearson's product-moment correlation coefficient ($p < 0.05$) was used to assess the association between total arc ROM and peak positive power for each limb

Results: There was a statistically significant main effect of limb on total arc ROM ($F = 16.84$, $p < 0.01$). Irrespective of player position, post-hoc analysis revealed that total arc ROM was significantly greater on the stance leg compared to the stride leg ($72.18 \pm 8.04^\circ$ vs. $68.86 \pm 7.60^\circ$, $p < 0.01$). There was also a significant main effect of limb on CMJ peak power ($F = 9.84$, $p < 0.01$). Irrespective of player position, post-hoc analysis revealed that peak power was significantly lower on stance leg (32.27 ± 3.14 W) compared to the stride leg (31.32 ± 3.31 W, $p < 0.01$). Pearson coefficient revealed that there was no relationship between ROM and CMJ power for either limb ($p > 0.05$).

Conclusions: Although differences are present between limbs with regards to lower extremity ROM and lower extremity power, there was no relationship between ROM and power production. The presence of differences between limbs for hip rotational ROM and lower extremity power indicate that clinicians may need to identify lower extremity changes during injury screenings. Future studies may investigate the mechanisms behind the differences in lower extremity power, as we are currently unaware if this is a positive or negative adaptation to sport.

Total Word Count: 439

200585GA

Relationship Between Shoulder Range of Motion, Strength and Posture and Injury Risk in Collegiate Baseball Athletes

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Context: Adequate glenohumeral range of motion (ROM) and strength, as well as appropriate posture of the shoulder complex are integral for proper throwing mechanics in baseball. However, research examining the role of these variables on injury risk in collegiate baseball athletes is limited. The purpose of this study was to determine whether pre-season clinical measures of glenohumeral ROM, shoulder strength and forward shoulder posture are predictive of sport-related injuries during a collegiate baseball season.

Methods: This prospective longitudinal cohort study included 80 baseball athletes (35 pitchers, 45 position players, age: 20.5 ± 1.2 years, height: 182.7 ± 6.9 cm, mass: 86.5 ± 12.3 kg, years of play: 13.7 ± 3.3) from two intercollegiate teams that were tracked for two consecutive years. Participants were tested in a single session during the pre-season and tracked weekly during the two competitive seasons for sport-related injuries. Pre-season measurements included: bilateral passive glenohumeral internal rotation (IR), external rotation (ER), and total arc (IR+ER) ROM (degrees) measured using a digital inclinometer with participants supine and in 90° of shoulder abduction and elbow flexion; throwing arm glenohumeral horizontal adduction ROM (degrees) using a digital inclinometer in the supine position and 90° shoulder flexion; bilateral supine shoulder IR and ER strength (%BW) measured with a hand-held dynamometer; and the bilateral difference (mm) in standing forward shoulder posture measured with a double-square. Bilateral ROM, strength, ER:IR strength ratios, and posture differences were analyzed. Four investigators with ICC >0.75 intra-rater reliability for their assigned measurements performed the same measurements on all participants. Each team's athletic trainer provided weekly in-season injury reports that included: injured body part, injury mechanism, diagnosis, and participation status. A forward stepwise logistic regression of the variables, with mass, age, and level of play as covariates, was used to develop a model for prediction of injury ($p < 0.05$).

Results: Out of 80 total athletes, 31.2% ($n=25/80$) sustained a sport-related injury (7 pitchers, 18 position players). When controlling for mass, age, and level of play, throwing shoulder adduction ROM ($p=0.009$) and throwing shoulder IR strength ($p=0.01$) significantly and uniquely predicted injury. For every 1-degree decrease in shoulder horizontal adduction ROM, the odds of players being injured increased by 10%, OR=1.10, CI:1.03, 1.19. For every 1-kg increase in throwing shoulder IR strength, the odds of players being injured increased by 36%, OR=1.36, CI:1.08, 1.71. No other ROM, strength, or posture variables on the throwing or non-throwing side were significantly related to injury risk ($p > 0.05$).

Conclusions: The results suggest throwing shoulder horizontal adduction ROM and IR strength are uniquely related to increased odds of sport-related injury in collegiate baseball athletes. These results may be useful in identifying pathological shoulder characteristics prior to injury and may also be used during the rehabilitation of various baseball related injuries.

Total Word Count: 442

207735MD

Relationship of a Novel Movement Assessment and Athletic Performance Tests in Softball Athletes

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Context: Movement proficiency can yield optimal athletic performance. The fundamental aspects of softball (e.g., hitting, throwing, and running) require combinations of muscular strength, endurance, dynamic stability, anaerobic fitness, power, balance, and coordination. Performance in softball may be due in part to the synergy between mobility and stability of body segments. Softball athletes are predisposed to movement dysfunction by virtue of repetitive motions creating side dominance. A new movement assessment which features ground based movements has been developed and tests the postural control of the front functional oblique kinetic chain (front shoulder to opposite hip adductor) and back functional oblique kinetic chain (posterior shoulder to opposite glut), and may expose stability issues in side dominant athletes. The purpose of this investigation was to identify the relationship between this movement assessment and athletic performance in NCAA Division I softball athletes.

Methods: All data were collected on a single day in an indoor practice facility at the beginning of the non-championship fall season. Fifteen National Collegiate Athletic Association Division I softball (n=15; age 19.93 ± 1.28 yrs) completed the movement assessment [beast with contralateral limb lift right hand and left foot planted (beast RHLF), beast with contralateral limb lift left hand and right foot planted (beast LHRF), crab with contralateral limb lift right hand and left foot planted (crab RHLF), and crab with contralateral limb lift left hand and right foot planted (crab LHRF)]. Each position was scored (1=poor, 2=fair, or 3=good) based on the compensations made during the test, by a clinician with 6 years of experience using the assessment. Next the participants completed the performance tests. Performance tests were the Pro-Agility (PA) test (s), vertical jump (VJ) test (m), and rotational medicine ball throw to the right and left (RMTR and RMTL) (m). We used Pearson's r to assess relationships between movement assessment scores and the athletic performance tests. Significance levels were set a priori ($p \leq 0.05$).

Results: There were significant relationship between beast RHLF and VJ ($r=0.73$, $p=0.007$), beast LHRF and VJ ($r=0.54$, $p=0.04$), beast RHLF and PA ($r=-0.59$, $p=0.02$), and beast LHRF and PA ($r=-0.67$, $p=0.006$). All other relationships were not significant.

Conclusions: Stability of the contralateral front functional oblique kinetic chain as measured by the beast movement assessment appears to be related to performance running (PA) and jumping (VJ) tasks. Stability of the contralateral front and back functional oblique kinetic chains does not appear related to RMTR and RMTL. Perhaps trunk rotary power generation is more a function of the trunk mobility rather than the ability to generate stability in softball athletes.

Total Word Count: 419

[209454LA](#)

Relationships Between Direction-Specific Center of Pressure Outcomes and Lower Extremity Injury History in D-I Athletes

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Context: Force plated based center of pressure (COP) outcomes are frequently used to evaluate balance function in the context of athletic injury. COP behavior is often summarized through component (anteroposterior, AP; mediolateral, ML) or resultant (R) descriptors, which may not coincide with movement axes most affected by injury. One method of assessing directionally-specific balance effects involves partitioning force plate time series into heading bins and independently quantifying spontaneous COP motion within each bin. Similar methods have been used to quantify sport-specific training adaptations, but thus far no study has investigated such relationships between COP motion and injury history. Our objective was to quantify relationships between direction-specific COP motion and lower extremity injury history in a sample of collegiate athletes.

Methods: We recruited a sample of Division-I collegiate female athletes to participate in this cross-sectional research design. Participants were assigned to one of two groups based on injury history (healthy [H, n=8]: 18.38±0.52 years, 172.50±5.33 cm, 72.19±8.00 kg) or (injury history [I, n=9]: 18.78±1.20 years, 168.79±7.92 cm, 65.06±11.53 kg). Participants completed a 10-second balance trial (eyes closed, hands on hips, barefoot) while standing on the non-dominant limb. Ground reaction forces were recorded with a force plate at 100 Hz and used to calculate COP. Each COP datapoint was assigned one of eight nonoverlapping heading bins based on its instantaneous direction relative to the previous point. Each bin accounted for a 45° arc [lateral (0°), anterolateral (45°), anterior (90°), anteromedial (135°), medial (180°), posteromedial (225°), posterior (270°), and posterolateral (315°)]. Profile analysis was used to assess group differences in heading-specific COP excursion (EX) and average velocity (V), each represented by a separate vector (length 8) for each group. Significant effects for parallelism and equality were followed with pairwise testing as indicated with Benjamini-Hochberg corrections for false discovery rate.

Results: Combined COPEX and COPV profiles {0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°} were as follows: COPEX(cm) = {6.74±2.35, 10.04±2.79, 9.91±4.64, 6.74±3.08, 6.34±2.79, 10.15±3.32, 10.49±4.10, 6.24±2.61}; COPV(cm/s) = {5.82±1.68, 7.32±2.44, 7.09±2.46, 6.52±2.15, 5.83±1.59, 7.72±2.51, 7.85±2.41, 5.76±1.42}. Parallelism was rejected for COPEX (Wilks $\Lambda=0.17$, $F(7.00, 9.00)=6.42$, $p=0.006$). Pairwise contrasts identified a significant difference in COPEX in the 315° heading (H=8.58±3.52 cm, I=5.10±1.30 cm, $p=0.014$). Neither parallelism nor equality was not rejected for COPV (parallelism Wilks $\Lambda=0.33$, $F(7.00, 9.00)=2.63$, $p=0.089$; Equality $F(1.00, 15.00)=1.49$, $p=0.240$).

Conclusions: Our findings suggest that directionally-specific COP motion may help differentiate balance behaviors between healthy athletes and those with history of injury. Particularly, athletes with history of injury may be characterized by lower COPEX in the posterolateral heading when compared with healthy controls. Future work might seek to identify a mechanistic explanation for the observed pattern of group differences.

Total Word Count: 433

200263ED

Relationships Between Fear of Re-injury, Balance Self-Efficacy and Dynamic Balance Performance in Those with Chronic Ankle Instability

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Context: In the updated model of CAI, the importance of understanding the interactions of sensory-perceptual and motor-behavioral impairments is emphasized for success in the assessment and treatment of the condition. One of the most consistently reported motor-behavioral impairments is poor reach performance in a dynamic balance task. Fear of movement and re-injury has been recognized as an important sensory-perceptual impairment, and those with higher levels of fear may engage in protective movement strategies found to be associated with reach deficits. Elevated levels of fear may also impact one's perception of ability, or self-efficacy, which has demonstrated positive associations with balance performance in other balance-deficient populations. These relationships have yet to be investigated in the CAI population; therefore, the purpose of this study was to examine the inter-relationships between fear of re-injury, balance self-efficacy, and dynamic balance performance in those with CAI.

Methods: We recruited 19 individuals classified with CAI (F:10, M:9, 23.9±3.4yrs, 168.4±9.0cm, 76.5±4.1kg) to participate in a single laboratory session. Participants' fear of re-injury was measured with the Tampa Scale of Kinesiophobia (TSK-11), and the Fear-Avoidance Beliefs Questionnaire Work (FABQ-W) and Physical Activity (FABQ-PA) subscales. The Self-Efficacy of Balance Scale (SEBS) was utilized to capture participants' level of confidence in maintaining their balance across a variety of balance tasks. Dynamic balance performance was assessed on the involved limb with 3 trials of the Star-Excursion Balance Test in the anterior (SEBT-A), posteromedial (SEBT-PM), and posterolateral (SEBT-PL) directions in order to calculate a composite (SEBT-COMP) score to capture overall performance. The averaged, normalized SEBT scores were used for analysis. Pearson product moment correlations were used to analyze associations between fear of re-injury, self-efficacy, and performance. Significance was set at $P<0.05$.

Results: Moderate negative correlations were identified between TSK-11 scores and SEBS scores ($r=-0.49$, $P=0.03$), indicating individuals with CAI that demonstrated higher levels of kinesiophobia demonstrated lower levels of balance self-efficacy. Moderate positive correlations were identified between SEBS scores and SEBT-COMP ($r=0.51$, $P=0.03$), SEBT-PM ($r=0.48$, $P=0.04$), and SEBT-PL ($r=0.61$, $P<0.01$), indicating that individuals with CAI who perceived themselves as more confident in their balance ability demonstrated better dynamic balance performance. No other significant relationships emerged in our data.

Conclusions: Levels of injury-related fear did not have a direct relationship with dynamic reach performance in individuals with CAI, but may have an indirect relationship with dynamic balance performance by impacting one's balance self-efficacy. Self-efficacy can be enhanced by successful performances, verbal persuasion, vicarious experiences, and positive imagery. These are areas that could be targeted in balance interventions which may help to mediate injury-related fear and may improve balance performance in those with CAI. Further investigation of these inter-relationships in other tasks and with intervention programs may be valuable to expand upon these findings.

Total Word Count: 446

200042CD

Reported Symptom Type and Time to Symptom Resolution Among Football Athletes in the Ivy League-Big Ten Epidemiology of Concussion Study

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Context: Following a sport-related concussion (SRC), athletes experience an array of symptoms, and differences in symptom presentation may influence recovery. Concussion reporting is also suggested to vary across sports. Investigating this within a sport with a high incidence of concussion is warranted. Here, we examine differences in reported symptom type and time to recover among football athletes within a large, ongoing concussion surveillance system of collegiate athletes.

Methods: The Ivy League – Big Ten Epidemiology of Concussion Study spans 28 sports at the 8 Ivy League and 12 of 14 Big Ten universities. Athletic trainers identify and enroll athletes who sustain an SRC into this large prospective cohort study (N = 2,720). Data on 22 symptoms from the SCAT3 and demographics are collected and entered into the online database. We focus on football athletes from 2013-2019. Athletic trainers monitor athletes; time is calculated as number of days from SRC injury to recovery outcome, symptom resolution. We use factor analysis to identify symptom domains and Kaplan-Meier survival curves to determine differences in time to symptom resolution by profile type and severity.

Results: Among 418 football athletes with SRC, the 5 most common positions were linebacker, defensive lineman, defensive back, receiver, and running back. Median symptom count was 11 and the most common symptoms endorsed were headache and pressure in the head, prevalence 94% and 78%. The 22 symptoms had excellent internal consistency ($\alpha=0.87$) and loaded on FOUR domains: representing 1) emotional, 2) headache/light sensitivity, 3) groggy, and 4) dizziness/remember/concentrate. Drowsiness and difficulty sleeping loaded on no domains. 16 distinct symptom profiles emerged, indicating the way athletes experienced concussion varied considerably. Each athlete was classified as being “High” (H) or “Low” (L) endorsers of each symptom domain. The most common symptom profile was HHLH (11.5%) followed by HHHH (9.1%). Endorsing as High versus Low on each symptom domain was associated with a 3-5 day delay in time to symptom resolution ($p<.001$). At the extreme, athletes who were High on at least 3 of the 4 domains took 8 days to symptom resolution compared to only 4 days for athletes who were Low on all four domains. Time to symptom resolution varied with symptom severity in a dose response fashion ($p<.001$), ranging from a median of 4 days for the least severe to 18 days for the most severe (See Figure 1).

Conclusions: In this large sample of football athletes, the types of symptoms they endorsed and symptom severity varied greatly. Ultimately, being more symptomatic corresponded to slower recovery, with a 14-day delay in symptom resolution among those who endorsed the most symptoms. These results suggest athletic trainers could tailor treatment and recovery plans for an athlete’s given symptom profile.

Total Word Count: 443

205365FD

Research Dominance Definitions May Not Identify Higher Risk Limb for Anterior Cruciate Ligament Injury

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Context: Extensive work has explored prediction of anterior cruciate ligament (ACL) injuries. As ACL Injuries are understood to occur unilaterally, study design has focused on lower extremity (LE) behaviors utilizing the dominant limb. Recent work has identified non-significant correlations of established limb dominance definitions to the LE at greater risk for ACL injury in an active, non-athletic sample. As competition levels increase, athletes develop a unilateral pattern that differs from their non-athletic peers. What is unknown is if athletes display different correlations with limb dominance versus the general population. Therefore the purpose of this study was to explore the correlation of the most common LE dominance definition with the limb identified at greater risk of ACL injury in NCAA D3 athletes.

Methods: We utilized an Observational Descriptive study design in a university motion analysis laboratory. An a-priori analysis indicated that a minimum of 34 participants would be needed for a Power of .80. Forty-six student-athletes (Female=32, Male=14. age:19.48±1.225years, height:171.754±10.473cm, mass:77.256±18.737kg) that were active on their NCAA D3 football, field hockey, volleyball, and soccer team rosters were recruited. Upon completing consent, participants performed two tasks (kicking a ball; unilateral land) in a counterbalanced order. Kicking task: Participants completed 5 trials of jogging 3 meters to, and kicking a soccer ball that was stationary on the ground towards a goal 1-meter wide. The LE the subject chose to kick the ball with 3 out of 5 trials was defined as their preferred kicking LE. Landing task: Participants performed 5 trials of a drop land from a 30cm high platform. Participants were instructed to land on 1 leg. The LE the subject chose to land with 3 out of 5 trials was defined as their preferred landing LE. Data were entered into and analyzed with a commercial statistical software package where a phi coefficient and Chi-squared analysis were performed.

Results: Twenty-five participants kicked and landed with the same limb. Twenty participants chose kicking and landing with different limbs. The Phi Coefficient ($\Phi=0.001$; $P=0.970$) indicated little to no relationship between the LE a subject kicked and landed with. Likewise, the Chi-square statistic revealed no differences between observed and expected frequencies ($\chi^2=0.001$; $P=0.970$).

Conclusions: NCAA D3 athletes display a statistical absence of predictability in definitions of LE, especially as it correlates to identifying LE at risk of ACL injury. Even though athletes develop greater unilaterality as level of competition increases, the results suggest that the most prevalent dominance definition is problematic when exploring ACL injury risk in this population. As ACL injury risk is elevated in the preferred plant limb, that LE should be the operationally defined LE for future injury risk studies.

Total Word Count: 434

200054JD

Retinal Neovascularization in Collegiate Football Player: Level 4 Case Study

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Background: A 19-year-old collegiate football player with no significant past medical history, reported to the athletic training facility with a sudden onset, upon waking, of blurred vision in the right eye. He denied any trauma and did not experience any pain, flashes or floaters. The athlete applied over-the-counter eye drops that morning with no resolution of symptoms. The athletic trainer's initial evaluation revealed irritation and inflammation of the conjunctiva with no other significant findings. The athlete's chief complaint continued to be blurred vision and he was referred to an optometrist for a comprehensive eye exam. After the initial exam, an immediate referral to a retinal specialist was recommended. Later that day the athlete was examined by an ophthalmologist who identified vitreous hemorrhage and fibrovascular proliferation (retinal neovascularization) in the right eye. A B-scan ultrasound showed no evidence of retinal tear or detachment. Additional tests were ordered to identify the etiology of the neovascularization and hemorrhage. These included a CBC, comprehensive metabolic panel, ANA, sickle prep, FTA-ABS (syphilis test), fasting blood sugar, TB test and chest radiograph.

Differential Diagnosis: Diabetic retinopathy, detached retina, conjunctivitis, ocular ischemic syndrome, sickle cell retinopathy, systemic lupus erythematosus, infectious disease.

Intervention & Treatment: The patient was instructed to avoid heavy lifting and sport participation. Initial ocular medication included one drop of artificial tears as needed to both eyes. Three weeks after the initial visit, the patient reported back for examination with continued blurred vision and no evidence of flashes or floaters. Upon clinical examination the vitreous hemorrhage was resolving. A fluorescein angiography was performed to examine the vasculature and was followed by panretinal photocoagulation (spot size: 200 μ m, power: 140mW, and pulses: 821) to seal and destroy the abnormal blood vessels. At the seven-week follow-up visit the patient continued to complain of mild blurred vision that was worse upon waking. All previously ordered laboratory tests were negative and ruled out the more common causes of vitreous hemorrhaging and retinal neovascularization. The vitreous hemorrhaging continued to resolve but the administration of 1.25mg/0.05 ml of Avastin (an angiogenesis inhibitor) was necessary. The patient was cleared for light aerobic exercise but was instructed to avoid any contact activity. Although the patient responded to the treatment and symptoms resolved, he continued to be monitored by the athletic trainer and ophthalmologist for the development of any new signs or symptoms.

Uniqueness: Identifying and treating retinal neovascularization is essential to preventing partial or complete vision loss. Retinal neovascularization and hemorrhage are clinical findings present in many ocular and systemic diseases, including diabetic and sickle cell retinopathies, infection or autoimmune disease. These findings can also be idiopathic as it appears in this case, since the results of all diagnostic tests were not significant and the etiology of the vitreous hemorrhage and retinal neovascularization was not determined.

Conclusions: Retinal neovascularization is the growth of new pathologic vessels on the retinal surface in response to ischemia and is often secondary to other systemic diseases or conditions. If left untreated, these vessels will continue to bleed spontaneously, and may cause retinal detachment and permanent visual impairments. As evident, atypical pathologies with mild or benign symptoms can potentially impact quality of life and early recognition and management is essential. Athletic trainers should broaden their knowledge base to include conditions associated with sickle cell, diabetes, and autoimmune disorders. In this case, it was important that the athletic trainer recognized the need for a comprehensive ophthalmic exam to evaluate potential retinal pathologies.

Total Word Count: 564

[207912GD](#)

Return-to-Professional Football Following Latarjet

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Background: Shoulder instability is relatively common in football, especially in defensive players. The high velocity impacts and forces can make conservative management and arthroscopic soft tissue repair unsuccessful. A Latarjet coracoid transfer procedure can be effective in returning individuals to a high level of play after shoulder instability. There have been several studies done evaluating return to play rate of contact athletes that have undergone a Latarjet procedure. A systematic literature review done by Bliven and Parr reviewed outcomes of the Latarjet procedure compared with bankart repair for recurrent traumatic anterior shoulder instability. They found that individuals who had a Latarjet procedure had less recurrent dislocations and better patient reported outcomes, in addition to more successful return to high level sport when compared to Bankart soft tissue repairs. This level 1 CASE report compares the outcomes following a Latarjet coracoid transfer procedure in which the athlete returned to compete at the professional level following multiple failed arthroscopic stabilizations to the before mentioned systematic literature review.

Patient: A 24-year-old male professional football linebacker presented in October of 2017 due to multiple anterior dislocations/subluxation events of the right shoulder. Three prior arthroscopic labral repairs had been done; March 2013, December 2013, and September 2015. All failed after he attempted to return to football. Upon physical examination he had limited external rotation, positive apprehension test, positive relocation test, positive surprise test, but no sulcus or posterior load and shift. Radiographs, MRI and CT scan were done. Bony fragment anterior/inferiorly, bone loss of 8-9mm of the anterior glenoid, and a Hill Sachs Lesion, were all observed from the imaging as a result of previous instability events.

Intervention & Treatment: The patient underwent an open Latarjet coracoid transfer procedure of the right shoulder with removal of multiple suture anchors (from previous surgeries), extensive scar debridement, and removal of loose bodies. Patient had regular follow up appointments as well as radiographs at each post-operative visit. A CT scan at 3 months showed good positioning and healing of the coracoid transfer.

Outcomes or Other Comparisons: Patient successfully completed the full 2018-2019 season with no shoulder instability events or complaints. In the systematic literature review there were no follow up scans performed, and outcomes were just evaluated using Rowe scores and ROM. This case report supported the systematic literature review findings in that this athlete returned more successfully to high level of play after the Latarjet than he did after soft tissue Bankart repairs.

Conclusions: Following 3 failed soft tissue surgeries and a successful Latarjet procedure the athlete fully returned to playing professional football at 9 months post-operatively and completed his entire season. He had no complaints or recurrent shoulder instability. His ability to return to such a high level of competition with high velocity of forces and collisions coincides with the success and satisfaction rates in the systematic literature review by Bliven and Parr. The main difference between these two were that our case study is of a professional football athlete and their study included individuals returning to work, sport and throwing activities with no specific sports listed.

Clinical Bottom Line: Open Latarjet coracoid transfer procedures can be very successful in stabilizing anterior/inferior instability of the shoulder in high level contact athletes after failed attempts to manage conservatively or stabilize arthroscopically. This case study supports the literature. It is important for athletic trainers to be knowledgeable of surgical procedures and why one would be chosen over the other to support currently reported outcomes.

Total Word Count: 563

208355ND

Return-to-Sport Following Bowel Perforation in a High School Athlete

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Background: A 16 year old male baseball player reported to athletic trainer with clearance from physicians to return to sport following an all-terrain vehicle (ATV) crash. The patient was ejected from the ATV resulting in a concussion and a perforated bowel. Patient was six weeks post partial colectomy. Colectomy bag had been removed and incisions were healing with no signs or symptoms of infection. Patient had decreased core strength as well as decreased trunk flexion, extension, and rotation due to discomfort. Concussion signs and symptoms had resolved at this time. Patient had also been weaned from Attention Deficit Hyperactivity Disorder (ADHD) medications during this time frame by physician. Also plans to return to training for golf and basketball at the conclusion of baseball season.

Differential Diagnosis: Blunt trauma, hernia, gastrointestinal distress, contusion

Intervention & Treatment: Patient had undergone partial colectomy and cleared by surgeon to begin physical activity. He was initially limited to fielding and throwing baseball activities only. He was also instructed to wear an abdominal binder during all activity. Additional padding was added with the athletic trainer to protect against further impact. Patient had also been cleared by physician to begin a graduated return to play protocol for concussion. A return to play progression was designed by the athletic trainer to challenge both concussion and abdominal symptoms. The patient was able to clear the graduated concussion return to play protocol without any exacerbation of symptoms in any phase but the process was slowed by the presence of increased abdominal pain in the early stages of return. A return to throwing program was used to decrease the risk of developing secondary injury while returning to play. The program also consisted of a fielding progression of fielding line drives from a stationary position, fielding ground balls from a stationary position, fielding a mix of line drives and ground balls from a stationary position, fielding a mix of line drives and ground balls from a variety of directions, fielding with a throw to another player, fielding with covering a base, fielding/throwing as part of a double play, and covering a base in a run-down situation. Two weeks into the program, the athlete was cleared to swing a bat as well as run the bases. Appropriate progressions were followed for this aspect of return to play under the supervision of the athletic trainer. The patient was compliant with daily wound checks pre and post activity.

Uniqueness: Little research exists on return to activity following partial colectomy for high school aged patients or return to competitive athletics following partial colectomy. The associated risk of developing a hernia needed to be considered in return to play. This patient was able to return to the safely baseball field two months after a traumatic motor vehicle accident

Conclusions: Over the course of 3 weeks, a 16 year old male high school baseball player was able to return to baseball following a concussion and bowel perforation sustained in an ATV accident. Upon conclusion of the season, he was cleared to begin a weightlifting program and also returned successfully to golf and basketball without further complication.

Total Word Count: 510

207751KD

Right Lower Quadrant Pain in a Women's Soccer Player

Mosier JD, Gray CE: Ithaca College.

Background: The Alvarado score is a clinical-decision making tool used by emergency department physicians to aid in the diagnosis of acute appendicitis, and potentially reduce the cost of un-needed hospitalization or unwarranted radiology tests. The Alvarado score includes the following criteria and scoring: migration of pain to the right iliac fossa +1, anorexia +1, nausea/vomiting +1, tenderness in the right iliac fossa +2, rebound pain +1, elevated temperature +1, leukocytosis +2, and a shift of leukocytes to the left +1 for a total possible score of 10. The patient score gives the clinician a likelihood for a diagnosis of acute appendicitis. A score of 5-6 indicates a likely diagnosis of acute appendicitis, a score of 7-8 indicates a probable appendicitis, and a score of 9-10 indicates a very probable appendicitis. In studies the sensitivity was found to be 93.5% and the specificity was found to be 80.6%. The use of the Alvarado score by athletic trainers, may help identify patients presenting that should seek medical care due to higher suspicion of acute appendicitis.

Patient: A 20-year old women's collegiate soccer player presented to the athletic training clinic complaining of right lower quadrant pain and nausea that has been persistent for the past 15 hours. She denied any loss of appetite and had last eaten breakfast. With questioning, she also denied any potential for pregnancy. On examination the patient was afebrile. She was point tender with palpation over McBurney's point but did not display any rebound tenderness or muscular rigidity. She also had pain with a Markle's (heel jar test). The Athletic Trainer utilized the Alvarado score and found the patient to only score a 4 out of 10, though blood-work values could not be used in the total score.

Intervention & Treatment: The athletic trainer had concern for appendicitis or a possible ovarian cyst rupture or torsion, so the patient was referred to the Emergency Room. At the ER she was examined by a physician, had blood-work done and a diagnostic ultrasound to her abdomen. The ultrasound revealed free fluid in the peritoneal area while her white blood cell count was within normal limits.

Outcomes or Other Comparisons: Due to the test results, the patient was released with the diagnosis of a ruptured ovarian cyst. She was instructed to treat with a steady dose of hot-packs to her abdomen and ibuprofen, and she could return to sport when she felt better. She had a follow-up the next day at the Health Center and was cleared to participate as tolerated.

Conclusions: Athletic trainers' use of the Alvarado score could help predict the need for referral for suspected acute appendicitis, and may also be helpful in determining referral in other acute abdominal conditions. Although athletic trainers cannot score information about white blood cells, there is enough information in scoring to make an informed clinical decision for referral. This patient was in the lower percentile, putting her at low risk for acute appendicitis, but warranted further care and investigation due to her case presentation.

Clinical Bottom Line: Athletic trainers should be familiar with the best evidence-based practice for recognition and examination of general medical issues. General medical conditions are frequently encountered by athletes, and athletic trainers are often their first line of care. Clinicians should know the typical key features of illnesses and conditions associated with the abdominal and genitourinary organs. The Alvarado score can be an effective clinical tool for a clinician to use to help rule-in or rule-out the need for referral. This will allow the clinician to make the best treatment decisions, whether that be conservative management or referral.

Total Word Count: 586

205193RD

Role Ambiguity in Athletic Training Students Within the Clinical Setting

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Context: Role ambiguity is a lack of clarity of what is expected and effective behavior in a given role, which can lead to job stress and dissatisfaction. However, no previous research exists that examines how role ambiguity affects athletic training students (ATs) in new clinical settings, nor how it could affect their learning. The purpose of this study was to examine what factors impact role ambiguity.

Methods: This was a cross-sectional survey design. A survey was sent to 34 Program Directors of professional programs in District 3 to solicit student participation. The survey was adopted from Beauchamp et al., 2002 and included questions on role responsibilities, behavior, evaluation, and consequences and was validated by content experts, with an alpha coefficient threshold of .70 demonstrating high internal consistency. Comparisons were made to the gender of the student, National Collegiate Athletic Association Division of the institution, level of the student within the program (e.g., junior, senior, first-year master's, etc.), number of clinical experiences completed, and the ratio of students to preceptors. Pearson Correlations and Kruskal-Wallis tests were run to compare categories and role ambiguity.

Results: Fifty-three students completed the survey. The participants ranged in age from 19 to 26, with 76.2% being female. Using a Kruskal-Wallis test, a significant difference was found between the level of student and understanding responsibilities, $H = 9.583$, $p = .022$. (Table 1) Similarly, a significance difference was found between the number of clinical rotations and understanding responsibilities ($H = 16.383$, $p = .012$), understanding how to adjust behavior ($H = 14.217$, $p = .027$), understanding what criteria is used to evaluate role ($H = 15.572$, $p = .016$), and that they are unclear about how their role is evaluated ($H = 13.973$, $p = .030$). Additionally, a significant difference was found between the ratio of ATs to preceptor and respect to understanding the behaviors one must perform ($H = 9.765$, $p = .021$), as well as knowing what behaviors are necessary to carry out responsibilities ($H = 12.018$, $p = .007$).

Conclusions: Role ambiguity exists in athletic training students that are completing clinical experiences and engaging in patient care. These findings help to highlight the need for a systematic orientation to the clinical site, especially for students who are early in their clinical experiences. The ratio of students to preceptor is also an essential factor for programs to consider, to ensure students are receiving adequate supervision and exposure to patients. Future research should examine the formal and informal orientation strategies used in clinical settings as a mechanism to reduce role ambiguity in athletic training students.

Total Word Count: 425

209393QD

Routine and Crisis Mental Health Policy Reviews in NCAA Affiliated Institutions

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Context: One in five adults experience mental health illness annually, with higher incidence in college-aged individuals. Student-athletes experience mental health illnesses at the same rate as their non-athlete peers, but are more likely to have concomitant injury. The National Collegiate Athletic Association (NCAA) has communicated best practices for mental health support at an institution. We conducted a policy review to determine how member institutions are conforming to best practices.

Methods: Using the Mental Health Best Practices Checklist, we developed a tool to assess conformity; content experts content validated the tool. We contacted 1091 NCAA affiliated institutions via email and requested they provide their written policies for emergency and routine mental health incidents. We evaluated the policies by assessing the presence of clinical licensures of practitioners providing mental healthcare, procedures of identification and referral of student athletes for routine and emergency health situations, pre-participation mental health screening, and health promoting environments that support mental wellbeing. We pilot tested the tool with four policies assessed by all members of the research team and one member of the team reviewed the remaining policies. In the event they were unsure if a policy element was present, the team met to come to consensus. We used a Kruskal-Wallis non-parametric one-way ANOVA and separate Mann Whitney U tests to determine the differences between NCAA divisions on the presence of emergency and routine mental health policies. We used frequencies and percentages to summarize the chart review findings.

Results: ATs (n=235) from NCAA institutions responded to our email (response rate=21.5%) and 36 policies were provided. We identified a significant difference between divisions for emergency ($\chi^2 = 13.056$, $df=2$, $p=0.001$) and routine policies ($\chi^2 = 9.264$, $df=2$, $p=0.010$), whereby Division 1 institutions, proportionally, had more policies than Division 3 institutions (emergency policies $p<0.001$; routine policies $p=0.002$). Of the policies reviewed, all indicated the mental health evaluations and treatments were provided by qualified mental health practitioners. Most of the NCAA member institutions have policies that appropriately identify characteristics of mental health emergencies (72.2%, n=26), when to contact emergency medical services (77.8%, n=28), communication of management expectations during a crisis (80.6%, n=29), and providers for nonemergency mental health concerns (83.3%, n=30). Among the policies reviewed, most did not have written procedures for management of acute delirium/confusional state (86.1%, n=31) and management of acute intoxication/drug overdose (80.6%, n=29). Only two policies identified local protocols for involuntary retention (5.6%, n=2). The table summarizes the remaining data.

Conclusions: The findings suggest that NCAA member institutions are creating policies related to emergent and routine mental health conditions. However, these policies are not comprehensive. Policies should be adapted to include procedures for the management of acute mental health conditions, particularly self-harm, substance use and delirium.

Total Word Count: 443

[208921GD](#)

Scaphoid Lunate Advanced Collapse Wrist in a Collegiate Rugby Player

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Background: Level 3 case study on the diagnosis and treatment of an athlete with a Scaphoid Lunate Advanced Collapse (SLAC) wrist. SLAC wrist is often the end stage of an untreated scapholunate interosseous ligament (SLIL) injury. SLIL injuries are common in football lineman or athletes who participate in contact sports due to the high impact, forced dorsiflexion of the wrist for many years. If left untreated, scaphoid fractures can lead to necrosis and can result in arthritis in the wrist which can develop months to years after the initial injury. Injuries to club sport athletes may be overlooked because club sports do not typically have athletic training services readily available to them.

Patient: Patient is a 23-year-old male rugby club athlete who has been participating in the sport for several years. During an away game, patient fell on the hand causing wrist extension, ulnar deviation, and intercarpal supination. Patient visited the Athletic Trainer (AT) 2 days later with complaints of slight pain in right wrist. Patient has no prior history of injury to the wrist and Compression test and Tuning fork test reported some pain but were not overwhelming. The AT diagnosed a radial carpal sprain and suggested follow-up treatment with the AT. However, the patient participated in a study abroad program for an entire semester and did not return for treatment as planned. While overseas, the patient continued to experience pain and visited a doctor who provided the same diagnosis as the AT and placed the athlete in a splint. Once the patient returned home, he returned to the AT, still experiencing pain. Patient reported point tenderness at the scaphoid as well as other parts of the wrist with palpation. The AT's evaluation noted both AROM and PROM were positive for pain with extension of the wrist and the Watson test and Scaphoid Lunate Dissociation test were both positive. Patient complained of decreased ROM with mild pain and pain with joint mobilization. Differential diagnosis included scapholunate disassociation, scaphoid fracture, scapholunate dislocation. The patient was referred to a hand specialist. X-rays showed necrosis of the scaphoid and surgery was performed the next day.

Intervention & Treatment: Patient underwent surgery seven months following initial injury. Surgery revealed a SLAC wrist and the surgeon used a bone graft from the radius to support the joint and repaired the scaphoid union, ligamentous support, and reduced carpal distraction. Three pins were used to stabilize the scaphoid and promote healing. A soft cast was worn for 2 weeks. The pins were then removed and the patient wore a hard cast for 3 months to ensure complete healing.

Outcomes or Other Comparisons: Patient is currently awaiting the start of rehabilitation following the removal of the hard case. He is cleared to play while casted, however, rugby rules do not allow the use of a cast during games.

Conclusions: This case illustrates a prolonged timeframe leading up to surgery and return to play for a wrist injury. Due to an academic experience out of the country, this athlete did not receive timely treatment and experienced the effects of delayed healing, which could lead to serious long-term disability of the wrist. Instead of the typical 2-6 week healing period for a SLIL, the patient is in the midst of an 8 month recovery period. Access to proper medical care for all athletes is important and follow-up treatment in a timely manner is crucial to proper healing and long-term function.

Clinical Bottom Line: Scapholunate Interosseous Ligament (SLIL) injury if left untreated, can lead to SLAC (Scaphoid Lunate Advanced Collapse) wrist which can result in long-term disability.

Total Word Count: 584

209335CA

Secondary School Athletic Trainers' and School Nurses' Confidence in Assessment and Perceived Roles during Concussion Management

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Context: Concussion clinical incidence in secondary schools is 1.7/100 athletes/season with an average 1 day of school missed. Heightened attention is on athletic trainers' (ATs) knowledge and management of concussion due to proximity to student-athletes; less emphasis is on interdisciplinary management. The purpose was to compare knowledge, confidence, and perceived roles during concussion management between ATs and school nurses in secondary schools.

Methods: A cross-sectional online survey was distributed as a larger project exploring interprofessional health-care providers' perceptions of concussion management regarding return-to-learn. Surveys were sent to 1,000 ATs via the NATA survey distribution center, and school nurses were contacted via state organizations. ATs and school nurses were asked: 1) to rate general concussion knowledge (1-not knowledgeable to 10-very knowledgeable) and 2) to describe formal concussion training experiences within the previous year. Participants rated agreement on a 5-point Likert scale regarding: 1) concussion management practices, 2) confidence in concussion management practices, and 3) perceived roles of health-care providers during concussion management. Chi-square analyses, and Fisher's exact tests when cell counts <5, were used to determine associations between group responses ($p \leq .05$).

Results: ATs (56.6%, $n=120/212$) and school nurses ($n=43.4\%$, $92/212$) rated general concussion knowledge at 9.26 ± 0.8 and 8.26 ± 1.4 , respectively. A greater proportion of ATs (85.6%, $n=101/118$) reported formal concussion training within the last year compared to school nurses (60.7%, $n=54/89$; $\chi^2=16.75$, $p \leq .001$), with online and in-person CEs most common. Agreement differed between school nurses ($p \leq .001$) and ATs ($p = .005$) as to who should coordinate a return-to-the classroom (Table 1). ATs indicated greater confidence in assessing physical ($p = .002$), cognitive ($p \leq .001$), and affective ($p = .05$) symptoms (Table 1). ATs more frequently agreed that a return-to-play decision is "always" made by a health-care provider (AT: 80.2%, $n=73/91$; school nurse: 50.8%, $n=31/61$; $p \leq .001$). Also, ATs more frequently agreed that the school nurse (AT: 74.8%, $n=68/91$; school nurse: 54.1%, $n=33/61$; $p \leq .001$) and AT (AT: 84.7%, $n=77/91$; school nurse: 59.0%, $n=36/61$; $p = .002$) are "always" or "most of the time" notified of a concussion. No group differences existed for how frequently a return-to-learn decision is made by a health-care provider ($p = .06$), or how often a teacher is notified of a concussion ($p = .37$). ATs and school nurses indicated no differences on the importance of gradual return-to-the classroom ($p = .12$), qualifications for academic accommodations ($p = .18$), impact on academic performance ($p = .07$), or willingness to participate in concussion management ($p = .19$).

Conclusions: A disconnect exists between ATs and school nurses confidence in assessing concussion symptoms, as well as who is and who should be involved during concussion management. Interprofessional, patient-centered care, should be a priority in secondary schools which employ both ATs and school nurses. Concussed students should have care that spans all health-care professionals in the secondary school setting. Encouraging conversation between ATs and school nurses can only improve the care of the students and student-athletes.

Total Word Count: 445

200415RD

Self-Efficacy and Coping After an 18-Week Immersive Clinical Experience

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Context: All athletic training programs must include an immersion clinical experience as part of the curriculum starting in 2020. While several programs have used immersion clinical experiences, the student experience has not been explored. The purpose of this study is to describe the burnout of athletic training students who recently finished an 18-week full immersion clinical. Students did not have classes during this time.

Methods: A convenience sample of junior athletic training students at a southeastern public university completed a full immersive clinical where they completed 40-60 hours a week at a college or university; this was their first immersive experience. Data collection occurred over two years; 44/48 (91.67%) of eligible subjects completed the study. Subject included 18 males and 26 females; average age was 21.18 ± 1.37 years. Subjects completed the Copenhagen Burnout Inventory (CBI) through Qualtrics during the last week of the clinical experience. The CBI is specific for health-related professions and has three scales with good reliability: 1) personal burnout ($\alpha=0.87$), 2) work-related burnout ($\alpha=0.87$), and 3) patient-related burnout ($\alpha=0.85$). Burnout scores were calculated for the three subscales and the total burnout score. Scores are on a 0-100 scale and a score of greater than 50 is considered high burnout. Means, standard deviations, and frequencies were calculated for total burnout and the three subscales.

Results: Average scores for each subscale and total score were the following: total 28.61 ± 15.12 , personal 35.99 ± 18.93 , work-related 30.68 ± 18.56 , and patient-related 18.84 ± 14.85 . The frequency (%; $n=35$) of subjects who score high were the following: total = 5(11.36%), personal = 9(20.46%), work-related = 7(15.91%), and patient-related = 1(2.27%).

Conclusions: This is the first study exploring the burnout experienced by athletic training students during immersive clinical experiences; previous results from the same study of an immersive experience during the senior year where students took courses concurrently were presented previously. The results of the study indicate that athletic training student experience burnout. However, these were less than the senior students (total 35.15 ± 17.75 , personal 45 ± 21.38 , work-related 39.26 ± 19.54 , and patient-related 20.48 ± 17.13) and previous research in athletic training (total= 30.5 ± 13.3 ; personal= 41.3 ± 17.3 , work= 31.6 ± 16.3 , and patient= 18.8 ± 15.4). The results indicate that immersive clinicals while taking courses increase all areas of burnout; this should be explored further. When exploring the subscales, more subjects suffered from personal burnout, which is defined as a burnout related to self. This indicates that students during immersion clinicals could benefit from stress reduction exercises, time management skills, and other interventions that address exhaustion and burnout. The lowest frequency of burnout was patient-related, which is defined as burnout related to the person's work with patients. This is a positive result and important for their longevity as professionals. Burnout and exhaustion should be a consideration when structuring and preparing students for immersive clinical experiences.

Total Word Count: 450

208132ID

Self-Perceived Lack of Recovery from Previous Injury Results in Lower Patient-Reported Outcome Scores and Increased Risk of Future Injury

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Context: History of previous injury is frequently cited as a risk factor for injury. However, the use of patient-centered outcomes, such as patient-reported outcomes (PROs), and self-reported lack of recovery to identify individuals at risk for further injury has not been well studied. Therefore, the objectives of this study were 1) to examine differences in pre-season PRO scores between individuals reporting an unresolved previous injury and those reporting no ongoing injury sequelae and 2) to determine if individuals who do not perceive themselves as fully recovered after injury are at greater risk for future injury.

Methods: For this prospective cohort study 45 student-athletes (31 female, 14 male) participating without restriction in collegiate soccer and field hockey were enrolled prior to the start of pre-season training. Participants completed the Modified Disablement of the Physically Active Scale (mDPAS), Lower Extremity Functional Scale (LEFS), a modified Functional Arm Scale for Throwers (mFAST), and the Optimal Screening for Prediction of Referral and Outcome-Yellow Flag Assessment (OSPRO-YF). Additionally, participants completed an injury history questionnaire by listing any previous injuries and indicating if they felt they had fully recovered from each injury. Injuries were then tracked prospectively over the course of one year. Independent Mann-Whitney U tests were used to compare differences in baseline PROs between those with a history of injury and those with no history of injury, and between those who reported an unresolved injury and those who did not ($p < 0.05$). Risk ratios were calculated for those reporting an unresolved previous injury compared to those who did not to examine the relative risk of subsequent injury during the following year.

Results: Seven participants reported no previous injuries. There were no differences in PRO scores between those with a history of injury and those without ($p \geq 0.221$). Of the 38 individuals reporting a history of previous injuries, 15 indicated they did not feel fully recovered. Those that indicated they had not fully recovered reported greater levels of disablement across all pre-season PROs ($p \leq 0.005$, Table). A total of 21 participants sustained an injury during the prospective surveillance, 11 (52%) of which had reported unresolved previous injuries. The relative risk ratio for injury during the season for those reporting unresolved injuries was 2.2 (95% CI: 1.2-4.0; $p = 0.009$).

Conclusions: Pre-season PROs have the potential to quantify patients' perceived functional deficits from previous injuries. Furthermore, those who self-identified as having unresolved previous injuries had over twice the risk of suffering an injury compared to those reporting full recovery or no previous injuries. It is important to incorporate PROs into injury evaluation and recovery. They may also have a role in screening for injury risk factors, such as self-perceived deficits in recovery.

Total Word Count: 426

206285DD

Self-Report of Pain, Function, Improvement and Disablement at Return-to-Play Following a Knee Sprain Injury: A Report from the Athletic Training Practice-Based Research Network.

Lam KC, Valovich McLeod TC*, Marshall AN†: *A.T. Still University, Mesa, AZ; †Appalachian State University, Boone, NC.*

Context: Recent findings suggest that patients with ankle sprain injuries experience some level of pain, function limitation, and disablement at return-to-play. Little is known if similar deficits exist in patients returning from knee sprain injuries. Our objective was to evaluate self-report of pain, function, improvement, and disablement at return-to-play following a knee sprain injury.

Methods: We conducted a retrospective review of electronic medical records within the Athletic Training Practice-Based Research Network. Records were created by athletic trainers working in 57 athletic training clinics (secondary schools=45, colleges=11, clinic=1) between 2009-2019. Patient cases were included if the patient was diagnosed with a knee sprain injury, restricted from sport following injury, and subsequently cleared for full and unrestricted participation (return-to-play). Patients received usual care from an athletic trainer and completed a series of single-item patient-reported outcomes at return-to-play including self-report of pain (Numeric Pain Rating Scale [NPRS]), function (Global Rating of Function [GROF]), improvement (Global Rating of Change [GROC]), and disablement (Global Rating of Disability [GROD]). All patient-reported measures have established measurement properties (eg, reliability, responsiveness). Variables included patient demographics, sport, number of days to return-to-play, number of episodes of care (EOC), and patient-reported outcome scores at return-to-play including NRPS (0-10 points), GROF (0-100%), GROC (15-point Likert-scale) and GROD (7-point Likert-scale). Descriptive statistics (percentages, frequencies, mean \pm standard deviation, median, interquartile range [IQR]) were used, as appropriate.

Results: One hundred sixteen patients (male=58.6%, age=17.0 \pm 2.6 years, height=170.9 \pm 13.0 cm, mass=75.1 \pm 20.2 kg) were diagnosed with a knee sprain injury (MCL=58.6%, n=68; LCL=21.6%, n=25; cruciate ligament=19.8%; n=23) during the study period. Most knee sprain injuries occurred during basketball (32.8%, n=38), football (32.8%, n=38) or soccer (17.2%, n=20). On average, patients were under care for 28.2 \pm 59.8 days (median=9.0, IQR=3.0-19.8) and received 10.1 \pm 13.4 EOC (median=5.0, IQR=2.0-11.8) before returning to play. Despite returning back to play, only 11.2% (n=13) of patients were fully discharged from care, with the majority (81.9%, n=95) requiring continued treatment. At return-to-play, a majority of patients (69.0%, n=80) reported some level of pain (NPRS=1.9 \pm 1.8, median=1, IQR=1.0-3.0) and just over half (50.9%, n=59) reported functional deficits (GROF=83.3 \pm 19.0%, median=90.0, IQR=80.0-95.0). While the vast majority of patients (82.8%, n=96) reported some level of improvement since injury (GROC>"a little bit better"), 40.5% (n=47) reported some level of disablement (GROD>"very mild difficulty with my activities of daily living") at return-to-play.

Conclusions: Despite self-perceived improvements, patients continue to experience some level of pain, functional deficits, and disablement at return-to-play following a knee sprain injury. It has been recommended that patient outcomes be assessed throughout care and particularly for return-to-play decisions. Future research should determine if deficits at return-to-play predispose patient to recurrent injuries, chronic conditions, or decreased quality of life.

Total Word Count: 434

206261AA

Self-Reported Injury History and Health-Related Quality of Life in Competitive, Collegiate Baton Twirlers

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Context: Baton twirling is a sport that emphasizes strength, athleticism and artistry. Injury epidemiology and health related quality of life (HRQoL) has been researched in sports and dance, however, there is currently no information regarding baton twirling. This study had 3 purposes: 1.) describe self-reported, time-loss injuries sustained by competitive, collegiate baton twirlers, 2.) identify the relationship between twirling training volume and reported injury number, and 3.) establish HRQoL differences based on injury status.

Methods: We completed a cross-sectional study using a 4-part, online survey that measured training volume, number of time-loss injuries within the preceding 12-month period, current injury status, and HRQoL via the Short Form-36 (SF-36). Self-reported, time-loss injuries were defined as causing participation restriction(s) for at least 24 hours. Training volume was the average hours spent in activity per week (practice, drills, conditioning, and competition). We attempted a census of collegiate baton twirlers (total population estimate ~300-400) using social media outlets to recruit within the twirling community. One hundred forty-two participants (age = 20 ± 1.43 ; female = 139, males = 3) met inclusion criteria and provided injury data while 100 completed the SF-36. Participants were placed into injury categories: no injury history (No Injury); history of injury but no symptoms (Injury Hx, No Sx); and currently injured (Current Injury). The dependent variables included total time-loss injuries and the SF-36 subscales and composite scores. Time-loss injury data were quantified with descriptive statistics. The relationship between twirling activity volume and injury frequency was analyzed with a 2-tailed Pearson product moment correlation. The effect of injury status on SF-36 scores were analyzed with a Kruskal Wallis and Dunn-Bonferroni post-hoc analyses.

Results: One hundred twenty-eight (90%) participants experienced a time-loss injury and reported 295 twirling injuries (2.1 ± 1.4 ; range = 1-9 injuries per participant). There was a non-significant relationship ($r=.024$) between training volume and the number of injuries. Injuries described ($n=262$) were recurrent (57%), sudden in onset (55%), occurred during practice (65%), and affected the hip/thigh (30%) most often. Most injuries ($n=162$, 62%) were still producing symptoms. The Current Injury group had worse SF-36 bodily pain ($p=.003$), vitality ($p=.001$), and physical composite ($p=.015$) scores compared to the No Injury group (table). Both the No Injury and Injury HX, No Sx groups performed better than the Current Injury group on physical function scores ($p=.007$ and $p=.020$ respectively).

Conclusions: Injury prevalence in collegiate baton twirlers were comparable to self-reported dance injuries. However, the injury characteristics (location, timing, and nature of injuries) are unique to this population. The burden of current injury on aspects of HRQOL, including bodily pain, vitality and physical function is important for clinicians who work with baton twirlers to note.

Total Word Count: 434

[207633LA](#)

Sensory Contributions with Postural Control Constraints in Individuals With Unilateral Chronic Ankle Instability and Healthy Controls

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Context: Chronic ankle instability (CAI) individuals have sensorimotor deficits that can elicit reduced postural control during single-leg stance. Research indicates that CAI individuals rely more on visual feedback while maintaining postural control due to sensorimotor impairments. The Sensory Organization Test (SOT) evaluates the contribution of three systems (somatosensory, visual, vestibular) to maintaining postural control and research indicates that healthy individuals weight their somatosensory system contributions to maintain stability when balancing with and without vision. CAI individuals may weight their sensory systems differently because of their impairments. Thus, our objectives were to identify postural control and sensory system differences in single-leg stance for individuals with CAI and healthy controls.

Methods: Twenty-three physically active individuals with CAI (20.57±1.90yr, 169.70±10.60cm, 70.35±15.10kg; 5 females, 1 male; N=6,) and healthy controls (20.71±2.37yr, 168.80±9.24cm, 70.74±13.23kg; 13 females, 4 males; N=17) participated in this case-control study in a research laboratory. Participants were assigned an injured-leg (IL) and uninjured-leg (UL). The IL for CAI was identified as the leg with a history of ankle sprains and healthy controls were assigned an IL. The UL was contralateral to the IL. Participants remained as motionless as possible in single-leg stances while completing the SOT on a force plate. The SOT consists of 6 conditions that manipulate the support surface (sway-referenced, fixed), visual surround (sway-referenced, fixed), and vision (eyes-open, eyes-closed) to compute 6 equilibrium sway scores and sensory ratios that quantify the contributions of the three sensory systems to maintaining postural control. Each condition consists of three 20-seconds trials and participants were allowed to touch-down quickly any time after the initial 10-seconds to prevent falling. Mixed-model repeated measures ANOVAs analyzed group by leg interactions and group main effects (alpha=0.05). Cohen's d effect size (ES) values also were computed to assess group differences.

Results: No statistically significant group by leg interactions or group main effects were found for equilibrium sway scores or sensory ratios ($p>.05$). However, weak to moderate effect sizes were found in somatosensory, visual, and vestibular systems with the IL and visual and vestibular systems for the UL among CAI individuals compared to healthy controls (IL: Somatosensory: CAI=.85±.08, Healthy=.88±.07, ES=.40; Vision: CAI=.93±.05, Healthy=.91±.07, ES=.33; Vestibular: CAI=.68±.10, Healthy=.72±.12, ES=.36; UL: Somatosensory: CAI=.88±.03, Healthy=.88±.10, ES=.00, Vision: CAI=.98±.05, Healthy=.95±.06, ES=.54; Vestibular: CAI=.77±.07, Healthy=.75±.11, ES=.22).

Conclusions: CAI individuals maintained posture very similar to healthy controls compared to healthy controls. However, our effect size analyses suggest that CAI individuals may use less somatosensory and vestibular feedback and weight more visual feedback in the IL. Additionally, CAI individuals may use more visual and vestibular feedback in the UL compared to healthy controls. These findings may suggest that CAI individuals reweight sensory systems to obtain relevant environmental information to coordinate postural control in IL and UL.

Total Word Count: 445

209825MD

Septic Bursitis in Competitive Cyclists: A Case Series

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Background: Competitive cyclists routinely experience impact and collision based injuries. The high rate of speed achieved by a cyclist during competitive activity factors into the pathologies incurred through racing accidents. Internal and dermal injuries are common and the superficial bursae of the elbow and knee are uniquely subject to trauma following a high speed accident¹. Septic bursitis refers to severe inflammation of the bursa that is due to bacterial infection²⁻³. Factors that increase the risk of septic bursitis include loss of skin integrity, impaired response to infection (e.g., diabetes mellitus, alcohol abuse), and host factors that lead to an increased amount of bursal fluid or tissue (such as rheumatoid arthritis or gout)⁴⁻⁶. Common sites for septic bursitis are the superficially located olecranon, prepatellar, and infrapatellar bursae. For these superficial bursae, joint motion may be relatively preserved; in contrast, septic arthritis is associated with marked limitation of joint motion^{2, 5-6}.

Patient: This case series involved three healthy male competitive cyclists experiencing similar pathologies and intervention approaches from cycling accidents. The competitive cyclists presented with superficial dermis trauma to both the elbows and knees following traumatic bicycle accidents.

Intervention & Treatment: Septic bursitis requires antibiotic therapy for 10 days and possibly routine drainage of infected bursal fluid⁷. There is minimal published data to support corticosteroid injection of an infected bursa will eliminate persisting pathology²⁻³. Patients with septic bursitis typically present with point tender pain and peribursal erythema and warmth; fever is present in 40 to 44 percent of patients with septic bursitis^{5, 8-9}. Clinical evidence suggests that treating septic bursitis with antibiotics alone is often inadequate¹⁰. Bursal drainage can be achieved without surgical intervention through needle aspiration. Surgical or catheter drainage may be needed for complicated septic bursitis at superficial sites and for a deep bursal infection¹¹⁻¹³.

Outcomes or Other Comparisons: The first case experienced a pre-patellar dermal laceration from falling off a bicycle onto finished concrete requiring approximation and closure of the wound via skin staples. While initial trauma management was successful, septic bursitis followed in the pre-patellar bursa. The second and third cases resulted in septic bursitis following a dermal laceration to the olecranon bursa from accidents incurred on asphalt while training on urban/city roadways. Both cases required sutures to close the wounds. While initial trauma management was successful, septic bursitis followed in the olecranon bursa.

Conclusions: Persisting bursal injuries are problematic for athletes due to the high frequency of use to the involved joints. This case series of competitive cyclists pursued routine acute wound closure interventions for dermal lacerations. Underlying bursal tissue was compromised during initial trauma in the affected joint resulting in eventual infection. Superficial dermal injury management cannot exclude the possibility of underlying tissue involvement. Proactive antibiotic therapy should be considered to address the probability of superficial dermal lesions impacting underlying tissue and structures of major joints. Wound management of obvious superficial dermal injuries independent of consideration of underlying tissue is contraindicated. This intervention approach could be utilized to reduce recovery time of injured cyclists and promote earlier return to activity. Additional benefits could include scar reduction, minimal secondary trauma to the joint, along with reduction in prolonged prescription medication usage.

Clinical Bottom Line: Clinical findings of superficial dermal pathology are similar to those seen in septic bursitis. Thorough clinical examination of dermal trauma to joints containing superficial bursas is imperative. Athletic Trainers should maintain close collaboration with supervising physicians to ensure varying interventions are considered prior to wound closure.

Total Word Count: 560

[209683CD](#)

Serum S100B is Increased in Special Operations Forces Combat Soldiers With Mild Traumatic Brain Injury History

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Context: Special Operations Forces (SOF) combat soldiers sustain high rates of blast and blunt neurotrauma. Most of these injuries are classified as mild traumatic brain injuries (mTBI). Repetitive mTBI increases the risk of developing long-term neurological sequelae. However, the underlying neuropathological mechanisms by which these conditions develop are poorly understood in both civilian and military medicine. Detecting the effects of cumulative exposure to mTBI in the absence of chronic symptoms is essential for recognizing early risk and therapeutic intervention. The S100 calcium-binding protein B (S100B) is an extensively studied mTBI biomarker that is predominately expressed by astrocytes. Astroglialosis caused by mTBI may lead to pathological S100B expression which promotes tau hyperphosphorylation and neurofibrillary tangle formation. Additionally, peripheral concentrations of S100B may increase as a result of blood brain barrier disruption. The purpose of this study was to study the effects of mTBI history and lifetime incidence on serum S100B concentrations in SOF combat soldiers.

Methods: Special Operations Forces combat soldiers (n=143, age=33.4±3.6 years) provided consent and participated in our cross-sectional study. This convenience sample completed a concussion battery within which they self-reported concussion history (67 reported no mTBI history; 76 reported mTBI history). We also collected mTBI lifetime incidence (0, 1, 2, 3+). Fasting blood samples were collected from participants from an antecubital vein at a standardized time point for all participants. Serum was separated and stored in a temperature-controlled -80°C freezer until subsequent analysis. The S100B concentrations were quantified using enzyme-linked immunosorbent assay (ELISA) kits according to manufacturer instruction (Alpco, Salem, NH). Medians and interquartile ranges (IQRs) were reported in Figure 1 because S100B concentrations (dependent variable) were not normally distributed. A Wilcoxon rank-sum analysis compared S100B concentrations between those with and without mTBI history. A Kruskal-Wallis test compared S100B concentrations across mTBI lifetime incidence groups.

Results: We observed a significant difference in S100B serum concentration (z=2.93; P=0.003) between those with (median=20.7 pg/mL; IQR=17) and without (median=14.3 pg/mL; IQR=13.5) mTBI history. Additionally, there were differences across mTBI lifetime incidence in observed S100B concentrations ($\chi^2(3)=16.99$, P<0.001). Specifically, those reporting 3+ mTBI (median=25.9 pg/mL; IQR=20.1) had higher S100B concentrations than those reporting no mTBI (median=14.3 pg/mL; IQR=13.5; z=3.68; P=0.001) or only 1 mTBI (median=17.0 pg/mL; IQR=6.2; z=2.90; P=0.02).

Conclusions: The S100B serum concentrations are elevated in SOF combat soldiers reporting an mTBI history and, additionally, trend higher in those who report a greater mTBI lifetime incidence. These data are interesting because they are observed in a cohort of otherwise healthy and asymptomatic SOF combat soldiers. This suggests S100B may be a useful biomarker for detecting lifetime mTBI burden. Future studies should address mTBI recency and implications related to acute blast and blunt exposures.

Total Word Count: 438

[209403DA](#)

Sex Differences and Hip Muscle Strength After ACL-Reconstruction

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Context: Traditional rehabilitation after anterior cruciate ligament reconstruction (ACLR) is focused on correcting quadriceps and hamstring strength asymmetries. However, hip weakness, specifically abductors, has been described to increase knee valgus motion potentially leading to secondary ACL injury. Few studies have described hip abductor strength adaptations in the ACLR versus contralateral limb that could be leading to poor outcomes and decreased function post-ACLR. Furthermore, previous research has not yet elucidated if strength discrepancies of the hip musculature post-ACLR could be influenced by sex differences. It is known that females tend to have a higher injury/reinjury rate compared to males, indicating that it is necessary to account for sex difference when assessing hip strength measures. The purpose of this study was to compare any compensatory hip adaptations post-ACLR via examining the relationship between hip abductor strength of ACLR versus contralateral limbs in males and females.

Methods: Thirty-seven patients with primary, unilateral and uncomplicated ACLR (20.78±6.56 years, 20M/17F, 171.244±12.23cm, 78.62±22.65kg, 8.90±6.72 months post-ACLR) voluntarily participated in this study. We measured isometric hip abduction and adduction in supine with hips and knees flexed at 45-degrees and knees flexed to 90-degrees. Participants completed three maximum voluntary contractions of abduction and adduction, peak torque from each trial was recorded. We used a 2X2 repeated measures ANOVA (sex-by-limb) to determine whether within-subject (side-to-side) differences in hip muscle strength varied by sex. In the event of a significant interaction non-normalized strength measures were compared within subjects post hoc using dependent samples t-test comparing ACLR to contralateral limb. Post hoc analyses were separated by sex. Cohen's D effect sizes were calculated using the pooled standard deviations and reported with associated 95% confidence intervals. All tests were considered statistically significant if the p-value was 0.05 or less.

Results: For hip abductor strength, there was a significant sex-by-limb interaction ($F(1,35)=4.3$, $p=0.04$). For males, ACLR limb hip abduction (338.70±80.73Nm) was significantly weaker than the contralateral limb hip abduction (352.10±88.04 Nm, $p<0.001$). In females there was no statistically significant difference between hip abduction in the ACLR side (229.06±60.01Nm) and the contralateral side (232.71±61.90Nm, $p=0.251$). We observed no significant side differences or interaction for hip adduction strength in males or females (all p 's>.05, Table1.).

Conclusions: Our results post ACLR side-side differences in hip abduction strength varies among the sexes. Males exhibit statistically significant side-to-side differences with a weak effect size in hip abduction strength post ACLR whereas females did not. Implications of this subtle strength discrepancy in males may affect functional movement and outcomes following ACLR. Further research should explore clinical importance of post-operative differences in hip abduction strength post-ACLR in males and females.

Total Word Count: 426

[208583LA](#)

Sex-Specific Brain Activation During Single-Leg Movements

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Context: Anterior cruciate ligament (ACL) injury is the most common knee trauma sustained in sports. Females have a higher relative incidence of ACL injury compared to males. Neuromuscular control has been a primary scientific and clinical focus of ACL injury risk. Poor lower extremity neuromuscular control during dynamic activities are thought to be associated with greater risk. To maintain lower limb neuromuscular control, the brain plays an important role in integrating and processing sensory information. While sex differences in brain activity during upper extremity motor tasks have been widely understood, less is known about sex-specific brain function during lower limb control. Understanding potential sex differences in brain neuronal processes may further elucidate the observed sex differences in lower extremity neuromuscular control.

Methods: Thirteen males (23.7±3.8 yr) and seventeen females (20.6±0.2 yr) who were physically active and right-handed/footed were included. A 3T MRI scanner obtained functional magnetic resonance images (fMRI) during lower leg movement tasks. Participants performed 30s of continuous knee extension-flexion movements of the left leg followed by 30s of rest, for a total of 4 cycles. Ninety whole-brain images were obtained. Brain image data were analyzed using FSL-FEAT. Pre-processing of data included normalization, temporal filtering, spatial smoothing, interleaved slice timing correlation, and motion correction. Then, the motion-related artifacts were removed. The first-level analysis was performed using a cluster-based threshold with z threshold at 2.3 and p threshold at 0.05 to contrast between the movements and rests. Finally, the group-level analyses were performed using unpaired samples t-test to contrast between sexes (Female-Male, Male-Female).

Results: Absolute head motion during the scan showed no statistical sex differences (M: 0.35±0.12 mm, F: 0.39±0.2 mm; p=0.52). fMRI comparisons between groups revealed that females showed higher cortical activation in the left lateral occipital cortex (cluster size = 342 voxels, Zmin-max=2.3-3.64, P≤ .019; MNI coordinates Z-max X=-42, Z-max Y=-84, Z-max Z=8) and lower activation in the right cerebellum compared with males (cluster size = 345 voxels, Zmin-max=2.3-3.36, P≤ .0183; MNI coordinates Z-max X=14, Z-max Y=-46, Z-max Z=-36) (Figure 1).

Conclusions: The lateral occipital cortex plays a primary role in visual processing. Thus, increased activation of the lateral occipital cortex may suggest a greater reliance on visual information in females when executing simple lower extremity movement tasks. The cerebellum has an important role in coordinating voluntary movements. The current findings may indicate a heavier cortical visual strategy at the expense of a cortico-cerebellar strategy during motor control in females. While sex differences in lower extremity biomechanics are well established, the current findings suggest that these differences may be in part centrally mediated. Future neuromuscular control and injury-risk studies may consider sex-specific differences in neural function as a contributor to neuromuscular control.

Total Word Count: 440

209792MD

Sexual Behaviors of Collegiate Student-Athletes

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Context: Whole person healthcare is a multi-faceted approach to medicine which incorporates all dimensions of wellness including sexual health. Sexual health screening is vital in sports medicine as it has been linked to behavioral health concerns and sexually transmitted illnesses; yet there is a lack of data to guide screening practices for athletic trainers. Therefore, the purpose of this study was to describe the sexual behaviors of collegiate student-athletes.

Methods: As part of a larger 5-year study, collegiate student-athletes (n=862, 17-23 years old) were recruited from a NCAA Division I institution to complete a web-based survey containing demographics variables and a 30-item tool exploring the sexual health behaviors throughout the last year, in the last 30 days, and during their most recent sexual encounter. The participants (females=552, 64%; males=310, 36%) were distributed between academic status (freshman=247, 28.7%; sophomore=219, 25.4%; junior=213, 24.7%; seniors=161, 18.7%; graduate/5th year=22, 2.5%) and were predominately Caucasian (n=624, 72.4%). Data were analyzed post-hoc using demographic variables (oral contraception use, gender, and academic status). Partial data were used for all comparisons.

Results: In the past year, the participants reported having oral, vaginal, or anal sex with 4 ± 7 partners with most reporting 2 partners (n=230, 31.7%). Males had 6 ± 10 sexual partners as compared to females reporting 3 ± 2 sexual partners. Female participants taking oral contraception had a significantly higher ($P<0.01$) number of sexual partners (mean= 3 ± 2) as compared to those not on oral contraception (mean= 2 ± 1). The participants reported engaging in heterosexual encounters most frequently, with a small sample reporting same-sex partners (female with female=23, 5.5%; male with male=5, 2.7%) with no participants reporting their sexual partners were transgender. Participants reported having vaginal (n=346, 48.1%) or oral (n=315, 44.4%) sex in the past 30 days with a smaller sample having anal intercourse (n=11, 1.7%) in that timeframe. Contrastingly, 38% of participants have never engaged in oral (n=206) or vaginal (n=208) intercourse. A one-way ANOVA identified significant differences between and within groups when comparing by academic status for oral ($P=0.18$) and vaginal ($P=0.15$), but not for anal intercourse. Follow-up Mann-Whitney U tests revealed a significant difference for freshmen engaging at a higher rate of oral and vaginal intercourse compared to junior ($P=0.049$, $P=0.037$), senior ($P<0.01$, $P<0.01$), and graduate/5th year ($P=0.030$, $P=0.027$) college student-athletes, respectively.

Conclusions: Most college student-athletes reported being sexually active. Overall, the data suggests that male, freshman student-athletes are engaging in sexual behaviors more frequently; however, female student-athletes on oral contraception are also partaking in more sexual encounters. We suggest athletic trainers implement pre-season screenings relative to sexual practices to provide patient-centered education on these behaviors to prevent illness and promote wellness. Future investigations are warranted to help explicate the interrelationships of sexual risk-taking behaviors

Total Word Count: 440

209525QD

Socioeconomic Status Impacts Athletic Healthcare in U.S. Secondary Schools

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Context: Research quantifying athletic trainer (AT) services has determined that 66% of secondary schools (SSs) have access to AT services in the US. SS administrators in schools without AT services have determined that a lack of funding was a key barrier to the provision of AT services and furthermore, a recent investigation identified median income (MI) and free reduced lunch as being significantly associated with access to AT services. Given these findings, the purpose of this study was to examine the odds of a school having healthcare provided by an AT and socioeconomic status (SES) within the US.

Methods: This cross-sectional survey-based questionnaire examined the level of AT services in SSs throughout the United States (US). AT services data from the Athletic Training Locations and Services (ATLAS) database from June 2015 to April 2018 were used. Data for each school in all 50 states and the District of Columbia were obtained from the National Center for Educational Statistics while MI for households were extracted from US Consensus Data based on the SSs zip code. Middle class (MID) was defined as a MI between 67-200% of the state's MI, lower class (LOW) was defined as <67% and upper class (HIGH) defined as >200% of the state's MI. Separate 2x2 chi-square analyses, and odds ratios (ORs) with 95% confidence intervals (CI) were calculated. A-priori levels were set at $p < 0.05$.

Results: AT services and SES were determined for 100% ($n=20,267$) of SSs in the US with athletics programs. Sixty-six percent ($n=13,456$) have AT services while 34% ($n=6,811$) do not. The frequency distribution of SSs by SES was: HIGH (2%, $n=407$), MID (86%, $n=17,365$), and LOW (12%; $n=2,433$). Findings indicate that HIGH SES schools were at a greater odds of having AT services, compared to LOW SES schools (OR=6.25; [CI: 4.73-8.26]; Chi-square= 202.91; $P < 0.001$) and MID SES schools (OR=3.09; [CI: 2.36-4.05]; Chi-square=74.839; $P < 0.001$). Similarly, MID SES schools were at greater odds of having access to ATs than LOW SES (OR=2.02 [CI: 1.86 to 2.20]; Chi-square= 266.71; $P < 0.001$).

Conclusions: Thirty four percent of SSs in the US provide no athletic healthcare in the form of an AT to their student athletes. These findings suggest that SES is a key factor in determining those without. Schools in HIGH and MID SES communities had greater odds of having access to AT services than LOW SES schools giving merit to targeted efforts and funding to assist those athletes without AT services.

Total Word Count: 399

200184AD

Sport-Related Concussion Recovery Trajectories Among Men's and Women's Collegiate Sports

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Context: Sport-related concussion (SRC) rates in college sports have increased in the last decade, likely attributed to increased attention, awareness, and changes in management. Females previously displayed longer recovery times compared to male athletes, however recent reports suggest contrasting results. Therefore, highlighting patterns of recovery across sports is warranted. The aims were to identify trajectories of recovery outcomes in collegiate student-athletes and compare outcomes between sexes.

Methods: Ivy League and Big Ten student-athletes who sustained a diagnosed SRC (n=2,717) from 2013-2018 were identified and enrolled by athletic trainers into the Ivy League-Big Ten Epidemiology of Concussion prospective cohort study. Athletic trainers monitored athletes' recovery outcomes (symptom resolution, return-to-full academics, return-to-limited play, return-to-full play). Time to each outcome was calculated as days between SRC event and the recovery event. Demographic information, characteristics of the SRC event, and recovery outcome dates were entered into the online database. Men's and women's sports were excluded if <30 SRC occurred within the study period. Included sports are presented in Table 1. Kaplan-Meier curves were used to assess each recovery outcome between sexes and sports and Peto tests were used to determine whether recovery outcomes differed between males and females ($p \leq 0.05$).

Results: A total of 2,096 – male (1,131, 62.4%) and female (783, 37.4%) – student-athlete participants on club and varsity teams were included. Mean age was 20.27 ± 0.5 years old, and roughly 50% reported a history of ≥ 1 concussions (male: 63.8%, female: 36.3%). Overall, median time to symptom resolution was 7 [3, 16] days, 7 [3, 14] days to return-to-full academics, 11 [7, 21] days to return-to-limited play, and 14 [9, 26] days to return-to-full play. Males took 7 [3, 16] days for symptom resolution, 6 [2, 12] days to return-to-full academics, 10 [6, 19] days to return-to-limited play, and 13 [9, 24] days to return-to-full play. Females took 8 [4, 18] days for symptom resolution, 8 [3, 16] days to return-to-full academics, 12 [7, 24] days to return-to-limited play, and 15 [9, 32] days to return-to-full play. There was a significant difference between males and females in two of the four measured outcomes; symptom resolution ($p \leq 0.01$) and return-to-full academics ($p \leq 0.001$) (See Table 1). Differences between sexes in days to return-to-limited play and return-to-full play were not significant.

Conclusions: Median symptom resolution time was 7 days; athletes returned to full play at a median of 14 days. Female recovery trajectories were longer than males'; however, median time for symptom resolution and return-to-full academics were statistically significant. Clinician's should be cognizant that recovery outcomes may vary between athletes participating in different sports. Future research is needed to determine the influence this outcome may have on full recovery.

Total Word Count: 438

205022ID

Sprinters Report Poorer MTSS Outcomes Compared to Endurance Runners over the Course of a Competitive Track Season

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Context: Medial tibial stress syndrome (MTSS) is an overuse injury studied in endurance runners (ED) with minimal data on sprint athletes (SP). It is difficult to manage, but patient reported outcome measures (PROMs) may provide a better way to track and treat MTSS in running athletes. The purpose of this study is to investigate PROMs as a means to monitor MTSS and general wellness in endurance and sprint track athletes during a competitive season.

Methods: This eight week prospective cohort study followed twenty-eight Division II men's (N=10, ED=5, SP=5, BMI: 21.8±2.8kg/m², P<0.001) and women's (N=18, ED=5, SP=13, BMI:20.7±1.7kg/m², P<0.001) track athletes who were currently competing in at least one running event, were cleared for participation, and were between 18 and 25 years old. Weeks 1 and 2 had a response rate of 86% and 89% respectively; all other weeks had a 100% response rate. The independent variables were sprinter vs endurance, gender, and MTSS history. The dependent variables consisted of PROMs that athletes filled out weekly and included the recently validated MTSS score and the PROMIS Scale v1.2 – Global Health (GH), a wellness PROM developed by the National Institute for Health that has been previously used in the general population. Surveys were emailed weekly via Qualtrics. Data was analyzed using independent T-tests, Pearson's correlations, and repeated measures ANOVAs.

Results: PROMs overall showed few MTSS symptoms and good global health (mean MTSS score: 0.35±0.85, mean GH score: 33.6±3.5). Sprinters reported significantly poorer MTSS scores and GH scores (0.54±0.24, p=0.04; 32.5±3.34, p=0.028) than endurance runners (0.04±0.01, 35.5±3.04). There was a main deteriorating effect over time for the MTSS score (p=0.047).

Conclusions: Sprinters reported more MTSS symptoms than endurance runners, and need to be further researched as an independent population. PROMs may be useful in tracking symptoms and modifying practices for individual track athletes in order effectively treat and prevent MTSS.

Total Word Count: 299

209345RA

Standardized Patient Encounters Impact Teaching Pedagogy and Programmatic Improvements

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Context: Educators are challenged to prepare competent practitioners to meet the evolving needs of healthcare. Standardized patients are one technique utilized by multiple healthcare disciplines to provide a consistent patient experience during professional education with emphases in improving student's clinical skills, communication, and confidence. With increasing use in athletic training education, it remains unclear how educators use these standardized patient encounters to continuous quality improvement. The purpose of this investigation was to explore how athletic training educators use information learned from standardized patient encounters/simulations and student debrief to inform pedagogy and curriculum development.

Methods: We employed a consensual qualitative research design and purposefully recruited athletic training educators with known use of standardized patients for teaching or assessment during athletic training professional education. 13 educators (12 female, 1 male, age = 36+4.79 years, 10+5.83 years teaching experience) participated in the study. Telephone interviews or in-person interviews were conducted using a semi-structured interview guide to gain insights into how athletic training faculty were using standardized patient encounters to guide teaching pedagogy. The interview guide was reviewed by a panel of experts for content validity and comprehension. Following transcription, the data were coded into themes and categories. Each researcher independently coded the data, then the team met to reach final consensus ensuring accuracy and representativeness of the data. Trustworthiness of the data was ensured by member-check, multi-analyst triangulation, and external review.

Results: Three themes emerged regarding how faculty used standardized patient encounters to inform teaching pedagogy and curriculum development: (1) identifying patterns in student performance and behavior for curricular improvement, (2) promoting systematic curricular review, and (3) fostering transition to practice readiness. Information gained drove programmatic enhancements such as didactic course development (e.g., identifying curricular gaps, course changes), informed clinical education decisions (e.g., placing students during clinical experiences), and identified faculty and preceptor development opportunities. Educators expressed the ability to identify patterns in student performance and behaviors both in individual students (e.g., clinical skills, development of soft skills, professionalism) and within student cohorts (e.g., communication, listening, confidence). These patterns were particularly useful for individual student development and global curricular course improvements. Fostering transition to autonomous clinical practice was also identified as important, as participants shared how these encounters provided authentic experiences that prepare students for the rigors of patient care.

Conclusions: Standardized patient encounters are being used by athletic training educators to inform not only classroom teaching, but also serve as data points in making data informed decisions regarding programmatic improvements. As standardized patients gain wider use in athletic training education, it will be imperative for educators to reflect on how these encounters can inform teaching pedagogy, but also serve as a mechanism for programmatic improvement and student professional development.

Total Word Count: 443

[208784ED](#)

Surgical Treatment of 1st Metatarsophalangeal Joint Kissing Lesions: Return to Professional Ballet

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Background: Kissing lesions of the 1st metatarsophalangeal joint (MTPJ) involve osteochondral defects (OCD) on the 1st metatarsal head and proximal phalanx. This injury causes significant pain and may be career-ending for a patient whose profession requires stress to the forefoot. Use of cartilage allografts to treat kissing lesions has been applied minimally to the 1st MTPJ, with little evidence on returning to high level activities. This level 3 case study describes treatments and outcomes following use of cartilage allograft to treat 1st MTPJ kissing lesions, after which the patient returned to professional ballet.

Patient: 27-year-old female professional ballerina experiencing ongoing right great toe pain for 3 years with no specific mechanism of injury. She described a recent aggravation of symptoms when she was en-pointe 3 months prior. Upon physical examination, she was unable to perform a single leg heel rise on her right foot. She presented with ecchymosis and tenderness along the lateral aspect of the 1st metatarsal head. A palpable bone spur on the dorsal aspect of the 1st metatarsal was present. ROM measured 40 degrees of 1st MTPJ dorsiflexion; 60 degrees of 1st MTPJ plantarflexion without MTPJ instability. Crepitus occurred with anterior and posterior gliding of the 1st MTPJ. MRI of the MTPJ detailed a chondral flap along the lateral to dorsolateral aspect of the 1st metatarsal head with subchondral bone flattening and edema. Chondral thinning and defect to the dorsolateral aspect of the proximal phalanx base with bone flattening and edema was also present. After a comprehensive history, physical examination, and imaging, she was diagnosed with right great toe OCDs on the dorsolateral 1st metatarsal head and lateral aspect of the proximal phalanx.

Intervention & Treatment: Patient consented to surgical treatment involving right 1st metatarsal head debridement, arthrotomy, chondroplasty, microfracture and cartilage allograft implantation, with arthroscopy, chondroplasty, and microfracture of the proximal phalanx. Bone marrow aspirate was harvested from the right iliac crest for mesenchymal stem cells which were injected into the patient's right great toe for biological healing augmentation. Postoperative treatment consisted of non-weightbearing for 6 weeks. Partial weight-bearing and physical therapy were initiated at 6 weeks postoperatively and the patient was full weight-bearing at 8 weeks. A return to barre work was initiated at 3.5 months. At 4 months, she began dance classes. At 5 months, the patient returned to floor ballet and began jumping. At 6 months, she returned to ballet without restrictions. At 7 months, the patient danced in her first performance.

Outcomes or Other Comparisons: Upon examination at 7 months postoperatively, the patient demonstrated 45 degrees plantarflexion; 75 degrees dorsiflexion with 5/5 strength of the right great toe without pain. Radiographs showed well-preserved right 1st MTPJ space. A follow-up examination approximately 4-years later revealed 40 degrees plantarflexion; 65 degrees dorsiflexion of the right 1st MTPJ. MRI showed slight narrowing of the 1st MTPJ with mild grade 3 chondral thinning and subchondral cystic change of the joint. At that time, the patient was still dancing professionally without complications.

Conclusions: Surgical intervention using cartilage allograft transplantation is a promising treatment option for articular cartilage lesions of the 1st MTPJ and may provide the highest potential for patients to return quickly to elite level activity. Most surgeons treat OCDs of this kind with micro-fracture procedure alone. Fusions and implants are also options for treating these defects when hallux rigidus is present, but may prove career-ending for a high-level dancer.

Clinical Bottom Line: This case highlights the ability of a professional ballerina to return to full performance following a possible career-ending injury after intervention of a novel surgical technique to repair complex kissing lesions of the 1st MTPJ.

Total Word Count: 590

207005AA

Survey Responses and Self-Reported Concussion History Identify Persistent Concussion Effects on Musculoskeletal Injury among College Football Players

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Context: Risk for musculoskeletal injury is approximately 2 times higher following sport-related concussion (SRC), and risk for another SRC is as much as 3 to 5 times greater. Identification of athletes who possess elevated susceptibility to musculoskeletal sprains and strains is complicated by the extremely subtle nature of long-term neural processing impairments resulting from SRC, which are likely to be missed using conventional measures.

Methods: A cohort of 77 college football players (20.1 ± 1.5 years of age; range 18 – 23) completed the Sport Fitness Index (SFI) survey prior to participation in 23 pre-season practice sessions over a 25-day period. The SFI consists of 10 items that quantify persisting effects of prior musculoskeletal injuries on a 0-100 scale, questions pertaining to SRC history, and an inventory of musculoskeletal injuries sustained during the previous 12 months. Receiver operating characteristic (ROC), logistic regression, and time-to-event analyses were used to assess any associations between survey responses and the occurrence of a core or lower extremity injury (CLEI) during any pre-season practice session.

Results: History of SRC was reported by 30% (23/77) of the players and 21% (16/77) sustained a CLEI during the pre-season period. Backward stepwise logistic regression retained SFI score ≤ 76 (AdjOR=3.40) and SRC history (AdjOR=3.76) as the strongest factors (model $\chi^2[2]=10.31$, $P=.006$; Goodness-of-Fit $\chi^2[2]=0.328$, $P=.849$; Nagelkerke $R^2=.196$). Area under the ROC curve was .722 for the 2-factor model (0, 1 or 2 positive). Incidence of CLEI among players who exhibited at least 1 of the positive factors was significantly greater than that for players with neither factor positive ($\chi^2[1]=5.88$, $P=.015$; Sensitivity=.75; Specificity=.59; OR=4.32). Incidence of CLEI among players who exhibited both factors positive was significantly greater than that for players with 0 or 1 factor positive ($\chi^2[1]=6.71$, $P=.010$; Sensitivity=.38; Specificity=.93; OR=8.55). Time-to-event analysis demonstrated a significant association with the number of positive factors (model $\chi^2[2]=17.15$, $P<.001$; Figure). The risk for CLEI occurrence during any given pre-season practice session was 2 times greater for players with either factor positive (HR1:0=2.23), and over 9 times greater for those who had both factors positive (HR2:0=9.37).

Conclusions: Combining the SFI score with self-reported SRC history appears to provide a very efficient means to accurately identify college football players who possess elevated CLEI risk. Efforts to reduce risk of CLEI could be most effective when time and resources are focused on the subset of players who possess the highest level of susceptibility. Although the mechanism responsible for increased incidence of CLEI following SRC is not understood, nor can a cause-effect relationship be inferred from a cohort study design, our results strongly support the acquisition of SFI survey responses to quantify a susceptible state that would otherwise remain undetected.

Total Word Count: 439

[209593LD](#)

Systematic Review and Meta-Analysis of the Hamstrings Muscles in Individuals With ACL Reconstruction, Part I: Neuromuscular Function

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Context: Hamstrings neuromuscular function is a crucial component of functional movement, and changes after anterior cruciate ligament reconstruction (ACLR) contribute to risk factors for secondary injury and long-term sequelae. To effectively treat muscular impairments, an accurate understanding of hamstrings neuromuscular function in patients with ACLR is needed. This systematic review and meta-analysis was undertaken to describe differences in neuromuscular function of the hamstring muscle complex after ACLR. Specifically, this review sought to identify neuromechanical alterations of the hamstring muscles, as measured by surface electromyography (EMG), after ACLR compared to healthy individuals.

Methods: This systematic review was completed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement and was registered with PROSPERO prior to completion of the initial search (registration No: CRD42018110824). We searched PubMed, Web of Science, SPORTDiscus, CINAHL, and EBSCOhost databases in October of 2018 for studies evaluating the difference in hamstrings EMG between individuals with ACLR and healthy controls. Studies were included if: (a) the study population included adults following primary unilateral ACLR, (b) autograft was used, and (c) EMG derived outcomes of the hamstrings were published. Two independent reviewers assessed each paper for quality using a modified Newcastle Ottawa Scale. Where possible, we extracted means and standard deviations from each included study to allow for fixed-effect meta-analysis calculations. We assessed group comparisons using effect sizes and 95% confidence intervals (ES [95%CI]).

Results: Thirty-five studies (877 ACLR, 824 controls) were included for final review. From these, 5 categories of neuromuscular outcomes were identified, and studies were grouped accordingly: (1) muscle activation (EMG amplitude), (2) onset timing, (3) electromechanical delay, (4) hamstrings-to-quadriceps co-activation, and (5) time-to-peak activity. Individuals with ACLR demonstrated greater total hamstrings activity ($n=29$, $ES=0.27$ [0.12, 0.41]), longer onset time (slower time to EMG activity) ($n=3$, $ES=0.47$ [0.14, 0.81]), longer electromechanical delay (slower time to contraction) ($n=4$, $ES=1.24$ [0.82, 1.67]) (Figure 1), and higher co-activation ($n=10$, $ES=0.47$ [0.27, 0.67]) compared to healthy controls. Individuals with ACLR demonstrated no differences in time to peak activity ($n=6$, $ES=0.09$ [-0.19, 0.37]) compared to controls. These findings are supported by a large body of moderate quality evidence with high heterogeneity ($I^2=0.0-77.0\%$).

Conclusions: Individuals with ACLR demonstrated large magnitude deficits in electromechanical delay compared to controls. Additionally, individuals with ACLR demonstrated moderate magnitude deficits in onset time, moderate magnitude increases in hamstrings-to-quadriceps co-activation, and small magnitude increases in overall hamstrings activity compared to controls. The impaired ability to rapidly initiate a muscle contraction may place individuals at greater risk for reinjury. It is possible that an increase in hamstrings activity and co-activation may act as compensatory mechanisms to stabilize the knee joint. From a rehabilitation perspective, these impairments are modifiable, and have implications for secondary injury risk.

Total Word Count: 446

[208655EA](#)

Talar Cartilage Deformation Following Static Loading Associates With Mechanical and Sensorimotor Variables in Those With Chronic Ankle Instability

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Context: Those with chronic ankle instability (CAI) demonstrate deleterious changes in talar cartilage composition, an early marker of cartilage degeneration and posttraumatic osteoarthritis. As a result, talar cartilage behavior in response to mechanical loads is altered in this population as cartilage behavior is driven by changes in joint tissue composition. Identifying mechanical and sensorimotor outcomes that associate with altered cartilage behavior may provide insights into possible therapeutic targets capable of slowing cartilage degeneration in those with CAI. Therefore, the purpose of this study was to identify mechanical and sensorimotor outcomes that associate with the magnitude of talar cartilage deformation following a static loading protocol in those with CAI.

Methods: Thirty individuals with CAI (11M, 19F; 20.5 ± 2.2 years, 1.7 ± 0.7 m, 75.7 ± 16.2 kg) volunteered to participate. Inclusion criteria followed International Ankle Consortium guidelines. After a 60-minute off-loading period, US images of the talar cartilage were acquired using the Phillips Lumify tablet-based ultrasound immediately before and after a static (2-minute single-leg standing with approximately 45° of knee flexion) loading protocol. Talar cartilage images were taken with the ankle in 140° of plantar flexion, and manually segmented to calculate a medial, lateral, and overall average thickness (mm). The percent change, relative to the average baseline thickness, was used for further analysis. Mechanical outcomes included anterior-posterior (mm) and inversion-eversion ($^\circ$) joint laxity captured with an instrumented ankle arthrometer as well as dorsiflexion range of motion (cm) captured via the weight bearing lunge test. Sensorimotor outcomes included time-to-boundary (s) means and standard deviations in the anterior-posterior and medial-lateral directions captured from an instrumented force plate, normalized Star Excursion Balance Test reach distances (%) (anterior, posterior-medial, posterior-lateral), and performance on functional hop tests (s) (i.e. Figure-8 and Side Hop tests). Pearson correlations were used to determine associations between cartilage deformation magnitude and the mechanical and sensorimotor outcomes (alpha established a priori at $p \leq 0.05$).

Results: Increased inversion laxity was moderately associated with greater overall ($r = -0.423$, $p = 0.022$) and medial ($r = -0.460$, $p = 0.012$) talar cartilage deformation following a 2-minute static loading protocol. Similarly, worse medial-lateral static balance (i.e. lower time-to-boundary scores) associated with greater medial ($r = 0.457$, $p = 0.014$), lateral ($r \geq 0.456$, $p \leq 0.007$) and overall ($r \geq 0.435$, $p \leq 0.002$) talar cartilage deformation following a 2-minute static loading protocol. No associations between talar cartilage deformation following a static loading protocol and dorsiflexion range of motion, dynamic postural control, or hop test performance were observed ($p > 0.05$).

Conclusions: Our data illustrates relationships among inversion laxity and poor static postural control with increased talar cartilage deformation following a 2-minute static loading protocol. These results suggest that targeting mechanical instability and poor balance via rehabilitation strategies may improve how talar cartilage response to a static load in those with CAI.

Total Word Count: 438

208542MB

The Ability of a Web-Based Questionnaire to Accurately Evaluate Best Practice Adoption in Secondary Schools

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Context: The NATA recommends many best practices related to environmental conditions and musculoskeletal injury to promote safe secondary school sport participation. A paucity of knowledge exists regarding current adoption of these best practices. A validated questionnaire regarding best practice adoption is critical to understand current practices, and inform future dissemination efforts to improve sport safety. The purpose of this project was to compare athletic trainers' (ATs) self-reported adoption of best practice written policies via a web-based questionnaire with on-site verification.

Methods: ATs from 19 secondary schools in Connecticut (n=7) and North Carolina (n=12) volunteered to participate. ATs completed a web-based questionnaire regarding written policies at their secondary school pertaining to environmental risk management and musculoskeletal injury. Questions were developed using NATA Position Statements, and reviewed by subject-area content experts. Fifteen questions were presented using the Precaution Adoption Process Model (PAPM), which classifies current readiness to act on the adoption of written policies into several stages (e.g., "unaware", "acting"). PAPM responses were dichotomized into adoption (i.e., "acting", "maintaining") or not adopting (i.e., "decided not to act", "unaware", "not considering", "considering", "planning to act"). Investigators, blinded to web-based responses, performed an on-site review regarding the presence of written policy for the best-practices. Cohen's kappa tests were conducted to evaluate the agreement between the web-based questionnaire and the on-site review for each best practice. Sensitivity and specificity between the questionnaire and on-site review were also calculated.

Results: Questions pertaining to lightning (sensitivity=0.92), safe evacuation locations (sensitivity=0.92), equipment modification during adverse environmental conditions (sensitivity=0.91), modified work:rest ratios based on environment (sensitivity=0.89), and heat acclimatization (sensitivity=0.83) demonstrated high sensitivity. Moderate agreement existed for questions pertaining to heat illness prevention and management ($k = 0.47$, $p = 0.04$), rectal temperature ($k=0.56$, $p=0.02$), cold-water immersion ($k=0.65$, $p=0.004$), and cool-first, transport-second ($k=0.40$, $p=0.03$) best practices. There was little to no agreement for the remaining questions ($k < 0.40$).

Conclusions: These findings demonstrate that specific best practices related to environmental risk management can yield valid responses on a web-based questionnaire. However, responses related to musculoskeletal injury were not consistent between the web-based questionnaire and on-site review. This indicates that the questionnaire may not be asking the question appropriately, that the AT may be doing these activities, but does not have them organized into a written policy, or that the AT didn't understand or want to admit that they are not currently implementing these written policies. Finally, agreement existed between the web-based questionnaire and on-site review for the other risk management questions when response indicated a policy was not being adopted, but agreement was not present when the AT reported current adoption on the questionnaire. These results will guide refinement of a web-based questionnaire to capture national adoption of best practices.

Total Word Count: 445

205333FD

The Association Between High School Cutting Policy and School Size With Sport Specialization Status and Multisport Participation

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Context: Previous studies have demonstrated that adolescents believe club sport participation and specializing is necessary to make their high school roster. Therefore, school cutting policies may be a primary influential factor for high school athletes to specialize in sport. Research also demonstrates that school size is an important factor in specialization prevalence with larger schools having more highly specialized athletes. However, no research exists investigating the relationships between cutting policy, school size, and sport participation habits. The purpose of this study was to determine whether cut policy is associated with school size, sport specialization and club participation in female high school volleyball athletes.

Methods: Cross sectional survey. Female high school volleyball players (n=2,216, age 15.6±1.1 years) from 83 high schools across Wisconsin (2018-2019 school year). School size was categorized based on student enrollment ((Large: >800, n=29), medium (400-800, n=29) and small (<400, n=25)). Cutting policy was described by cutting at all levels or no cutting. Participants completed a sport participation survey that included questions about their interscholastic participation in all sports (2017-18 school year). Additionally, participants reported their club volleyball participation (year prior). Sport specialization status was determined using a common 3-point classification system (low, moderately, and highly specialized). Athletes that reported participation in more than one sport were classified as multisport (as compared to volleyball only). Responses were summarized via frequency and proportions(%). Chi-square tests were calculated between schools and sport participation habits.

Results: Specialization level was associated with school cutting policy (p<0.001). Of schools that cut at all levels, 62.6% were highly specialized athletes while a majority of low specialization athletes attended schools with a no cutting policy (62.1%). Club volleyball participation was also associated with cutting policy (p<0.001). Athletes who did not play club attended schools with a no cutting policy (61.6%), whereas athletes who participated in club were more likely to attend schools that cut at all levels (56.7%). Multisport status was associated with cutting policy (p<0.001). Of schools that cut at at least one level, 53.5% were volleyball only athletes. School size was associated with cutting policy (p<0.001). A majority of small schools had a no cutting policy (91.7%) as compared to large high schools that cut at all levels (76.2%).

Conclusions: Attending a high school that cuts at all levels is associated with sport participation characteristics such as being highly specialized, club volleyball participation, and single sport participation. Large schools are more likely to implement a cutting policy than small schools. School policies, such as cutting, may influence sport participation habits and sport specialization rates. Schools should investigate programs and policies that uphold their competitive nature without limiting the participation of athletes at all levels.

Total Word Count: 437

208441MD

The Association Between Self-Reported, Accelerometer and Heart Rate-Derived Training Loads in Collegiate Soccer Athletes

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Context: Training loads (TL) assist in capturing the magnitude and intensity of sport participation, and monitoring TL in athletes may assist in reducing the risk of injury. Global positioning systems (GPS), accelerometers, and heart rate (HR) monitors have been utilized to derive TL. However, these measures are not feasible in all settings as they are costly and require significant training. The emergence of self-reported measures, such as session rating of perceived exertion (sRPE), may be useful to monitor TL in clinical settings with many athlete populations. Therefore, the purpose of this study is to determine the association between sRPE and both accelerometer- and HR-derived TL in collegiate soccer athletes.

Methods: Thirty-two female soccer athletes (age: 19.8 ± 1.1 years, height: 165.5 ± 5.5 cm, weight: 64.9 ± 6.6 kg) participated in the study. Participants recorded duration of activity in minutes and rate of perceived exertion (RPE) via Borg CR10 on a mobile phone following activity each day. The product of self-reported duration of activity (SRDA) and RPE was calculated to attain the daily sRPE ($SRDA \times RPE = sRPE$). Participants wore accelerometers and HR monitors (BeyondPulse) during their competitive season for practices and games to determine session duration, time spent above 70% of maximum heart rate (HR70), and a proprietary Active Participation (AP) score. The product of session duration and HR70 was calculated to attain a similar HR-derived sRPE ($Session\ duration \times HR70 = HR\text{-}derived\ sRPE$). Linear mixed models were used to assess the association between the subjective TL outcomes (SRDA, RPE, and sRPE) and the accelerometer-based TL outcomes (session duration, HR70, and HR-derived sRPE) for each day while accounting for interpersonal random effects.

Results: There was a significant association between RPE and HR70 ($F=204.3$, $p<0.01$), and RPE accounted for 27% of the variance in HR70 ($\beta=7.25$, $p<0.01$, $R^2=0.27$). There was no association between SRDA and session duration derived from the accelerometer ($F=0.21$, $p=0.64$). There was a significant association between sRPE and HR-derived sRPE ($F=67.18$, $p<0.01$), and sRPE accounted for 13% of the variance in HR-derived sRPE ($\beta=4.87$, $p<0.01$, $R^2=0.13$). There was a significant association between sRPE and the proprietary AP ($F=78.22$, $p<0.01$), and sRPE accounted for 14% of the variance in HR-derived sRPE ($\beta=0.0001$, $p<0.01$, $R^2=0.14$).

Conclusions: Athletic trainers may benefit from using self-reported measures such as RPE and sRPE to monitor TL in collegiate women's soccer athletes. These measures have been shown to correlate with total load and active participation obtained by accelerometer devices. Self-reported duration of activity did not have an association with accelerometer derived session duration, and there is still considerable variance unexplained that may be due individualized playing times. The use of these measures provides a cost-efficient, clinically relevant, and feasible alternative to assessing TL with wearable devices.

Total Word Count: 443

208913QD

The Collegiate Student-Athletes' View of Patient-Centered Care in Athletic Training Services

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Context: Patient-centered care (PCC) refers to interactions in medicine that are tailor-made to each patient while ensuring their values and preferences are guiding clinical decisions. The views of PCC have not been examined in sports medicine from the lens of the patient. Therefore, the purposes of this study were to evaluate college student-athletes' perceived level of PCC from athletic trainers (AT) both globally and during their most recent patient encounter.

Methods: We used a cross-sectional design administered through a Qualtrics® survey. We asked compliance officers or athletic directors from National Collegiate Athletic Association (NCAA) institutions (n=1110) to forward an anonymous survey to all active student-athletes. After providing consent and demographics, each participant completed the content validated, 16-item Likert-scale instrument exploring the global agreement (0=unsure, 1=strongly disagree to 5=strongly agree) about the ATs at their college/university on the eight principles of PCC. Next, each participant was asked if they had seen an AT for medical services, and if so (n=453/532, 85.2%), to complete the valid and reliable, 14-item Patient Perception of Patient-Centeredness instrument. A total of 968 student-athletes accessed and started the survey with 611 completing >60% of the tool for the analysis. The participants (age=20±1 year; female=384/610, 63.0%) represented all 3 NCAA divisions (D1=157, 25.7%; D2=190, 31.1%; D3=263, 43.1%) and were equitably distributed by classification (freshman=181, 29.7%; sophomores=170, 27.9%; juniors=151, 24.8%). Partial data were analyzed for measures of central tendency with an exploratory mode comparison between NCAA divisions.

Results: On the global agreement scale of PCC tool, the participants expressed a strong agreement (mode=4) with 12 of the 16 statements. Providing culturally competent care with regard for protected classes (mean=3.52±0.93; n=432, 70.9%) and delivering care that was respectful of their preferences (mean=3.49±0.77; n=339, 59.7%) were the two highest ranked statements. The two lowest ranked statements (mode=3) included fears and anxiety regarding their clinical status, finances, and impact on others (mean=2.75±1.15) and involving family and friends in healthcare decision-making (mean=2.96±1.06). Interestingly, 8% (n=48) of participants strongly disagreed that an AT had the ability to make a health status decision without influence from coaches. Moreover, 18.8% (n=109) of participants reported that an AT made them participate when they were medically disqualified. On the patient perception instrument, participants expressed that the AT was completely (mode=4) patient-centered for all dimensions during their most recent encounter (Table 1), which remain the same when exploring the mode of each statement by NCAA Division of the participant.

Conclusions: Most NCAA student-athletes believed that their AT provided care that kept their best interest in mind. This study is valuable to the profession of athletic training as it helps us recognize how college student-athletes perceive all the dimensions of PCC and contributes directly to the athletic training research agenda.

Total Word Count: 446

200563FD

The Development of Achilles Tendinopathy and Medial Tibial Stress Syndrome in Two Runners During an Experimental Transition to Maximal Running Shoes

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Background: In this case series, conditions of interest were Medial Tibial Stress Syndrome (MTSS) and Achilles Tendinopathy (AT). MTSS is a complex injury involving repetitive stresses to lower leg muscles and fascia. MTSS presents anteromedial lower leg pain with weight bearing and impact. AT is term for multiple conditions affecting the Achilles tendon, including tendinosis, tenosynovitis, or tendonitis. AT presents as pain at the insertion or within the tendon and occurs with loading of the gastrocnemius and soleus muscles. Both conditions are common and associated with increased or high-volume training loads. These conditions can be debilitating, challenging to treat, and recurrent. Patients in this study are unique because their injuries occurred during participation in a research study examining running biomechanics, 3-D kinematics, and vertical ground reaction forces (VGRF), prior to and following participation in a 6-week transition program to running in maximal running shoes. 1. Recent research reported that runners with MTSS and AT have longer durations of eversion². This case study supports that finding and shows associations with maximal shoe transition.

Patient: The patient who developed MTSS (Patient 1) was a 38-year-old female. The patient who developed AT (Patient 2) was a 46-year-old female. Both were running at least 15 miles per week, had not suffered a major injury in at least 6 months, and had never trained in a minimal or maximal shoe. Their total years of running experience fell within the range of 10.5 ± 6.8 years. The patients volunteered to participate in research investigating the effects of a 6-week transition into maximal shoes on running biomechanics. Patient 1 described “tightness in shins and ankles” while wearing the maximal shoe week one, which progressed to sharp pain in the right medial tibia during the fourth week. Patient 2 reported an “ache” in the left Achilles tendon in week one, and by week five, could not walk without pain. Research procedures dictated both patients be withdrawn from the study and referred to their clinicians. The clinicians made the diagnoses of MTSS and AT. The clinicians were not affiliated with the research so no additional information was available.

Intervention & Treatment: All study participants agreed maintain their normal training but to increase the proportion of their running mileage in the maximal shoe by 20% each week, reaching 100% of training in the maximal shoe during weeks 5 and 6. Patients 1 and 2 followed this protocol but withdrew due to injury in weeks 4 and 5 respectively.

Outcomes or Other Comparisons: Both patients demonstrated prolonged eversion during stance phase in the maximal shoe (AT & MTSS: 99% of stance phase). Participants were also tested in a traditional shoe. Eversion duration was reduced for Patient 1 and 2 (AT: 80%; MTSS: 95% of stance phase). Reference Figure 1. VGRF revealed the loading rate of Patient 1 (82.75 BW/s) and Patient 2 (59.78 BW/s) was lower than average for the healthy participants (85.85 BW/s), further implicating prolonged eversion. This coincides with the past research². However, these findings are unique because they correspond with transition into maximal shoes and testing demonstrates the maximal shoe prolonged eversion.

Conclusions: Prolonged eversion has been cited as a risk factor for developing AT and MTSS. Because eversion was prolonged in the maximal shoe for both patients, it is possible the maximal shoe was a contributing factor for injury. Further research on the relationship between maximal footwear and injury is warranted.

Clinical Bottom Line: Athletic trainers should recognize prolonged or excessive eversion as a possible risk factor for lower extremity overuse injury. Gait should be analyzed after transition to a new shoe type. Maximal shoes may prolong eversion and increase injury risk in some runners.

Total Word Count: 588

[206591DD](#)

The Effect of Anterior Cruciate Ligament Reconstruction on Circulating Biomarkers of Muscle Hypertrophy and Atrophy.

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Context: Patients with an anterior cruciate ligament reconstruction (ACLR) frequently experience quadriceps muscle atrophy. Myostatin and transforming growth factor-beta (TGF-beta) are the biomarkers leading muscle atrophy. On the other hand, insulin-like growth factor-1 (IGF-1) and decorin are considered as the biomarkers inducing muscle hypertrophy. However, the relationships between ACLR and variation of circulating biomarkers is not clear.

Methods: Cross-sectional research design was used to compare the variation of circulating biomarkers between pre-operative (PRE) and post-operative (PO-1: 48-72hours, PO-2: 7days after surgery) concentration. Research was conducted at a local hospital and university research laboratory. Fourteen patients (4 females, age=30.4 ± 5.9years, height=170.8 ± 8.6cm, mass=69.9 ± 10.8kg) who were scheduled for a unilateral ACLR voluntarily participated. Four ml of venous blood was elected from patient's median cubital vein or cephalic vein into serum separator tube containing clot activator and serum separator gel. Then the blood in serum separator tube was kept for 30 minutes for solidification and centrifuged at 4000RPM for 15minutes for serum distribution. The concentration of circulating biomarker was analyzed from serum sample in duplicate for each time point. Each biomarker analysis was conducted according to the manufacturer's instructions. Enzyme-Linked Immunosorbent Assay (ELISA) was performed to measure circulating level of myostatin, TGF-beta, IGF-1, and decorin at three time points (PRE, OP-1, OP-2). One-way repeated measure ANOVA was used to compare variation of each circulating biomarkers between time points. Partial eta squared was calculated to assess effect size across time point.

Results: The hypertrophy inducing factors, IGF-1 (ng/ml) exhibited a significant reduction between three time points (PRE=171.79 ± 33.55, OP-1=145.29 ± 26.82, OP-2=143.43 ± 32.97, F(2,12)=6.24, p=0.006). Pairwise multiple comparisons revealed that PRE IGF-1 level was significantly greater than OP-1 (p=0.02) and OP-2 (p=0.01). Decorin (pg/ml) didn't show a significant differences but exhibited moderated to large effect size (PRE=4251.97 ± 1395.82, OP-1=3656.89 ± 1246.92, OP-2=3830.18 ± 1464.61, F(2,12)=1.64, p=0.218). The atrophy inducing factors, myostatin (ng/ml) (PRE=3.34 ± 1.83, OP-1=3.63 ± 2.17, OP-2=5.37 ± 4.90, F(2,12)=2.47, p=0.104) and TGF-beta (pg/ml) (PRE=7297.86 ± 2105.00, OP-1=6679.24 ± 2655.43, OP-2=6473.55 ± 2293.17, F(2,12)=0.881, p=0.427) didn't show significant differences among three time points.

Conclusions: Hypertrophy inducing factor, IGF-1 significantly reduced in the entire periods. Since hypertrophy inducing factor was decreased, it may indicate that ACLR directly influenced on circulating biomarkers causing alteration of muscle morphology. Therefore, preserving IGF-1 level in the early phase of ACLR rehabilitation may provide a pharmaceutical option to prevent muscle atrophy after an anterior cruciate ligament injury.

Total Word Count: 402

208371MD

The Effect of Lacrosse Equipment on Time to First Chest Compression and First Automated External Defibrillator Shock

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Context: Cardiac arrest is one of the leading causes of sports related deaths. In the event of a cardiac emergency, athletic trainers have to manage the athletic equipment to gain access to the chest prior to performing cardiopulmonary resuscitation (CPR). Evidence is mixed regarding the ability to provide quality CPR over lacrosse shoulder pads. Recently, some lacrosse shoulder pads are made with the NOCSAE approved commotio cordis breast plate. Initiating the first compression cycle over the shoulder pads may speed the time to first compression and potentially improve patient outcomes, but should only be considered if it doesn't affect CPR quality. The purpose of this study was to determine if different chest access procedures and different shoulder pads affected CPR quality.

Methods: This crossover study was performed with thirty-six licensed athletic trainers (21 females, 15 males; age=30.58±7.81) in a simulation lab. Participant pairs performed 3 minutes of 2-rescuer CPR with AED intervention according to 2015 American Heart Association standards in a simulated cardiac emergency. Participants completed a total of 8 trials (2 access techniques X 2 shoulder pad types X 2 participant roles) on a simulation manikin (Q CPR manikin, Laerdal Medical, Wappingers Falls, NY). The independent variables were shoulder pad type [Warrior Hitman (WH) vs. Warrior Nemesis (WN)] and chest access procedure [shoulder pad retraction (RT) vs. full shoulder pad removal (FR)]. In the shoulder pad retraction procedure, the compressions were performed over the shoulder pads for the first CPR cycle. The WN shoulder pads contained the new NOCSAE approved commotio cordis breast plate. The mannequin was properly fitted with shoulder pads and a Cascade R helmet for all trials. All data collection sessions were counterbalanced. We used only the mean of the first 30 compressions for the CPR quality data. We measured the ability to provide quality CPR compressions [mean compression depth (mm), mean compression rate (#/min), full release from chest (%), hand placement accuracy (%), and adequate compression depth (%)]. A 2x2 repeated measures ANOVA was used to evaluate the main and interactive effects of shoulder pad type and chest access procedure on CPR quality during the first cycle.

Results: Under all conditions, participants provided chest compressions within the AHA recommended rate (100-120) and at a depth greater than recommended by the American Heart Association (50 mm). There was a significant main effect of shoulder pad type on full release from chest (WN=56.28±36.71, WH=50.64±39.11, p=.029).

Conclusions: Initiating the first cycle of CPR over the shoulder pads does not affect the quality of chest compressions. The commotio cordis breast plate may help the responder to fully release the chest after performing each compression compared to a softer shoulder pad.

Total Word Count: 436

206055ID

The Effect of Lacrosse Protective Equipment on Cardiopulmonary Resuscitation and Automated External Defibrillator Shock

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Context: In the event of an acute cardiac event, on-field equipment removal is suggested, although it remains unknown how lacrosse equipment removal may alter time to first chest compression and time to first AED shock. Therefore, the purpose of our study was to determine time to first chest compression and first AED shock in 2 chest exposure procedures and 2 different shoulder pad types.

Methods: Thirty-six athletic trainers (21 females, 15 males; age=30.58±7.81) were placed in pairs to provide 2 rescuer CPR intervention in a simulated cardiac emergency. Participants completed a total of 8 trials per pair (2 chest exposure procedures X 2 shoulder pad types X 2 participant roles) on a simulation manikin (QCPR manikin, Laerdal Medical, Wappingers Falls, NY) outfitted with lacrosse pads and helmet (Cascade R; Cascade Inc, Liverpool, NY). We measured time to first compression (s) and time to first AED shock (s) in using a prospective randomized crossover design. Additionally, we measured the ability to provide quality CPR [compression rate (#/min), compression depth (cm), ventilation rate (#/min), ventilation volume (mL), and flow fraction (time participants were engaged in performing chest compressions or ventilations)]. The independent variables were chest exposure procedure with 2 levels (condition 1: removal of helmet while initiating CPR over the shoulder pads followed by shoulder pad retraction and AED application; condition 2: removal of helmet and removal of shoulder pads followed by CPR and AED application) and pad type (Warrior Burn Hitman shoulder pads; Warrior Nemesis chest protector; Warrior Inc, Warren, MI). The Warrior Nemesis pads included the NOCSAE approved commotio cordis breast plate. We used separate 2x2 repeated measures ANOVAs to assess differences in time to first compression, time to first AED shock, and CPR quality (compression rate, compression depth, ventilation rate, ventilation volume, and flow fraction) between the chest exposure procedure and shoulder pad types.

Results: We found a statistically significant interaction between chest exposure procedure and pad type for time to first compression ($F_{1,35} = 4.66$, $P = 0.04$, $\omega^2p = 0.10$) with condition 1 being significantly faster for both the Nemesis pads (16.1 ± 3.4) and the Hitman pad (16.1 ± 4.5) compared to condition 2 (Nemesis pads: 49.6 ± 12.9 , $P < 0.0001$; Hitman pads: 53.8 ± 14.5 , $P < 0.0001$). All other analyses were not significant ($P > .05$).

Conclusions: Completing the initial round of chest compressions over either shoulder pads or a chest protector hastens time to first chest compression which may improve patient outcomes. However, time to first AED shock was not different between equipment condition or pad type. CPR quality did not differ depending on if compressions were completed overtop shoulder pads, chest protectors, or directly on the bare chest.

Total Word Count: 441

209581CD

The Effect of Sex on Length of Recovery from Sport Concussion in Collegiate Athletes

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Context: Sex differences have been purported to influence length of recovery (LOR) following a sport concussion (SC). Previous research that has demonstrated a longer LOR in females, has suggested that females do not receive an initial diagnosis of SC as quickly as their male counterparts. Factors such as time until SC diagnosis, initial symptom burden and other variables, could potentially confound the effect of sex on LOR. The purpose of this study was to evaluate the effect of sex on LOR from a SC while taking into account time between injury and diagnosis and other risk modifiers.

Methods: Participants included 62 (37 male, age: 19.5 ± 1.30 years, 25 female age: 19.8 ± 1.23 years) Division I collegiate athletes with a SC. Participants were included if they made a full, unrestricted return-to-play and had documented date of injury, diagnosis, and symptom resolution. Upon reporting symptom free participants completed a return-to-play assessment, which included ImpACT™ and the revised Head Injury Scale. Modifiers were identified by review of each participant's ImpACT™ report. Independent t-tests were used to compare the number of days until symptom resolution, the number days between the dates of injury and diagnosis between groups, and total symptom burden. Spearman's Rho (ρ) was used to calculate the correlation between the LOR and the number of days between the injury and diagnosis for males and females separately. Chi-squared (χ^2) tests were performed to compare the proportion of males and females who self-reported learning disability, ADHD, autism, dyslexia, speech therapy, special education, grade repetition, substance abuse, meningitis, brain surgery, and headache, migraine, or epilepsy treatment. All analyses were performed with $\alpha=0.05$.

Results: Significant differences were not observed ($t[60]=-0.797$, $p=0.428$; $d=0.22$; 95% CI [-0.3, 0.7]) in for LOR in days between males (9.4 ± 1.57) and females (7.7 ± 4.97) or for days between the injury and diagnosis ($t[60]=-0.392$, $p=0.697$; $d=0.11$; 95% CI [-0.4, 0.6]) between males (0.6 ± 1.74) females (0.5 ± 0.59). Symptom burden was also observed to be similar ($t[60]=-0.682$, $p=0.446$; $d=0.17$; 95% CI [-0.5, 0.5]) between males ($20.3 + 17.46$) and females ($20.3 + 18.14$). No differences were observed between groups for any demographic, psychiatric, or medical history variables ($p's > 0.05$). A significant positive correlation for number of days between the injury and diagnosis and LOR was observed for males ($\rho[35]=0.35$, $p=0.03$) but not females ($\rho[23]=-0.13$, $p > 0.05$).

Conclusions: Though not statistically significant, the LOR for female collegiate athletes was approximately two days shorter than males (Figure 1). In the absence of differences in known modifiers that associated with LOR, only the number of days between the date of injury and diagnosis was observed to have a significant relationship between LOR for male athletes. Further research is needed to explore the relationship between influence of the time of injury and diagnosis on recovery from SC.

Total Word Count: 448

207343ED

The Effect of the TayCo External Ankle Brace on Dynamic Balance, Motion and Performance in Collegiate Athletes

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Context: The TayCo external ankle brace is designed to reduce the mechanical constraints typically found in a semi-rigid ankle brace by being worn outside of the shoe and allowing for more sagittal plane motion. However, the effects of the TayCo have not been examined. This investigation is the first to examine the effects of the TayCo external ankle brace on multidirectional reach distance, balance, and motion compared to traditional lace-up braces.

Methods: Eighteen collegiate athletes (18 males, age=20±1.2yrs, height=189.02±8.54cm, weight=11.66±8.54kg) without history of lower extremity surgery, fracture, or injury in the last three months participated in the crossover study. Participant completed a single 60-minute data collections session in which they completed all testing in each bracing condition (McDavid 195 lace-up brace, TayCo external ankle brace, and no-brace) with a single limb. Condition order, limb tested (dominate, non-dominant), and outcome measure order were counterbalanced. All outcomes were completed in self-supplied shoes. Dynamic balance was assessed utilizing the anterior, posteromedial, and posterolateral reaches of the Y-Balance Test (YBT). Goniometric measurements of inversion, eversion, dorsiflexion, and plantarflexion and the Weight-Bearing Lunge Test (WBLT) were used to assess ROM. Functional performance was evaluated using the Single-leg Figure-8 Hop Test (Figure-8) as well as the Single-Leg Lateral Hop Test (Lateral Hop). One-way repeated-measures ANOVAs were performed to evaluate differences between brace conditions (Lace-up, TayCo, No-Brace) for each dependent measure. When indicated post hoc analysis was completed using paired t-tests. The alpha level was set a priori at $p<0.05$.

Results: Means, standard deviations, and statistical results for all outcomes can be found in Table 1. No significant condition main effects were identified for Figure-8 ($p=0.987$), Lateral Hop ($p=0.620$), anterior YBT ($p=0.155$), posteromedial YBT ($p=0.187$), and posterolateral YBT ($p=0.881$). Significant condition main effects were identified for the WBLT ($p<0.001$), Inversion ($p<0.001$), Eversion ($p<0.001$), Dorsiflexion ($p<0.001$), and Plantarflexion ($p<0.001$). Post hoc analysis indicated significantly greater ROM for no-brace compared to TayCo and lace-up for the WBLT ($p<0.001$), Inversion ($p<0.001$), Eversion ($p<0.001$), Dorsiflexion ($p<0.001$), and Plantarflexion ($p<0.001$). Additionally, greater ROM was found during the TayCo condition compared with lace-up for dorsiflexion ($p=0.043$), and plantarflexion ($p<0.001$) and less for Inversion ($p<0.001$) and Eversion ($p<0.001$). No significant differences were found between the TayCo and lace-up conditions for the WBLT ($p=0.772$).

Conclusions: Greater amounts of motion were demonstrated for the TayCo compared with Lace-up for dorsiflexion and plantar flexion as well as less motion for the TayCo compared to the lace-up for inversion and eversion. Additionally, neither brace demonstrated an impact on functional performance or dynamic balance. This study affords clinicians evidence to support the effectiveness of the TayCo external ankle brace alongside traditional lace-up braces to reduce ankle ROM. Further research is needed to examine the efficacy to reduce ankle injury.

Total Word Count: 446

200121GD

The Effects of Blood Flow Restriction Training on Upper Body Strength of Collegiate Softball Athletes

Destiny Lalaguna

Alysia Cohen, PhD, ATC, CSCS

Context: Resistance training is an essential component of sport conditioning commonly performed at moderate- to high-intensity levels. Blood flow restriction (BFR) allows for training at low intensities and may be effective at improving muscle size and strength. The purpose of this study was to examine the effects of an eight-week, low-intensity, full-body, strength-training program with BFR on upper body strength in collegiate softball players. It was hypothesized that BFR training would improve upper body strength more than a standard low-intensity full-body strength-training program without BFR.

Methods: Division I female softball athletes ($n = 22$, age 19.1 ± 1.2 y, height 1.65 ± 0.06 m, body weight 76.5 ± 15.1 kg) volunteered for participation in this eight-week randomized control trial design study conducted in a controlled clinical setting. Participants were organized by their primary sport position, then randomly assigned to one of two groups: BFR + standard full-body strength-training ($n=12$) or Standard full-body strength-training ($n=10$). The strength-training program included one set of 30 repetitions followed by 3 sets of 15 repetitions for both groups involving upper (e.g. biceps curls) and lower (e.g. body weight squats, heel-toe raises) body exercises. The BFR treatment completed all exercises with bilateral partial occlusion (minimum 150 psi) applied at the upper arm and upper thigh. Dependent variables (maximum isometric dominant and non-dominant handgrip strength, static flexed-arm hang, push-ups, and body fat percentage) were assessed before and after eight weeks of training. Two-way repeated measures analysis of variance procedures were performed to determine the effect of treatment (BFR + Standard, Standard only) and time (Pre, Post), with follow-up analyses completed using Bonferonni adjusted pairwise comparisons.

Results: Percent body fat decreased ($-2.3 \pm 3.3\%$, $P = 0.004$, $\eta_p^2 = 0.34$) regardless of training group. Dominant-hand (Pre 39.7 ± 5.2 , Post 42 ± 5.7 kg, $P = 0.01$, $\eta_p^2 = 0.27$) and non-dominant-hand grip strength (Pre 35.9 ± 4.2 , Post 39.7 ± 5.2 kg, $P < 0.001$, $\eta_p^2 = 0.55$) were increased regardless of treatment, but were not different between groups ($P = 0.39$, $\eta_p^2 = 0.04$, and $P = 0.43$, $\eta_p^2 = 0.03$, respectively). Flexed-arm hang duration was improved from pre to post season with BFR (7.6 ± 8.0 sec, $P < 0.001$, 95% CI 4.092, 11.193) but not standard training (1.7 ± 8.0 sec, $P = 0.37$, 95% CI -2.189, 5.589). Push-up performance increased (8.7 ± 8.9 , $P < 0.001$, $\eta_p^2 = 0.51$) from pre to post season, with no difference between groups ($P = 0.94$).

Conclusions: Strength training improved upper body performance and body fat percentage similarly in our BFR and a standard program. These findings suggest that in a healthy, highly active, collegiate softball sample, BFR does not produce superior strength changes compared to a standard program. Future investigations should evaluate this population in rehabilitation scenarios where intensity and activity may be limited.

Total Word Count: 445

[2046950D](#)

The Effects of Dry Cupping Therapy on Grip Strength in Healthy Individuals

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Context: Dry cupping therapy has been shown to decrease pain, improve range of motion, and improve blood flow in various published trials. Studies have been published that demonstrate cupping therapy may not have a negative effect on lower extremity power. However, there do not appear to be any studies assessing the effects of cupping therapy on grip strength. Negative changes in muscle performance could result in a decrease in performance when attempting to perform sport specific activities. The purpose of this study was to compare the effects of dry cupping therapy on grip strength with a control condition.

Methods: 32 apparently healthy college students (16 males, 16 females, 22.00 ± 1.85 yrs, 190.5 ± 9.37 cm, 77.82 ± 16.70 kg) were recruited and consented to participate in this study. Subjects received the treatment on their dominant arm while their non-dominant arm served as the control and received no treatment. Grip strength, measured in pounds of force, was the primary outcome measure using an electronic hand grip dynamometer. Baseline grip strength measurements were taken three times on the dominant arm followed by three times on the non-dominant arm. Two plastic pneumatic cups were applied to the dominant forearm, with one cup placed 7-cm distal to the medial epicondyle of the humerus and one cup 7 cm distal to the lateral epicondyle of the humerus. Two pumps of air were withdrawn from each cup, and cups were left in place for 10 minutes. Following removal of the cups, grip strength measurements were taken for both arms again. A paired t-test was performed to determine if cupping therapy had a significant effect on grip strength with significance set at $p < .05$. A 2x2 repeated measures ANOVA (condition x time) was performed to determine if cupping therapy had a significant effect on grip strength as compared to a control with significance set at $p < .05$.

Results: Within group measures for grip strength produced significant increases post cupping therapy treatment (85.96 ± 20.46 to 89.03 ± 19.54 , $p < .05$). When compared with the control, cupping therapy resulted in a significant change in grip strength ($F(1,135.85)=10.392$, $p < .05$).

Conclusions: Cupping therapy applied for 10 minutes to the forearm appears to have a positive effect on grip strength. This suggests that cupping therapy prior to activities requiring maximal grip strength would not have adverse effects on performance outcomes. Further studies should be conducted to confirm the effect of cupping therapy on muscular strength. Clinicians should use their discretion if performing cupping therapy with a longer treatment duration or with a larger amount of suction.

Total Word Count: 428

207113CD

The Effects of Physical Exercise on Salivary microRNA Levels

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Context: Concussion diagnosis continues to provide challenges for healthcare professionals. Many current diagnostic protocols are based on subjective input from patients and may ultimately skew diagnoses. Recently, studies performed by Hicks, et al., and LaRocca, et al. have shown a relationship between certain salivary microRNA levels and concussions, but there has been no distinction of whether the link is caused by concussive forces or simply physical exertion. Analysis of this distinction may contribute to further confirm the relationship of concussions and microRNA levels, which would ultimately improve techniques for objective assessments of concussion diagnosis. This study was designed to measure the effects of physical exertion through exercise on the specific salivary microRNA identified by previous research.

Methods: This case series designed experiment was performed in a collegiate Health and Exercise Science laboratory. Twenty participants (10 male, 10 female, 21±1.1 years old), who were not current intercollegiate athletes, were recruited for participation via personal communication between student researchers and classmates. The independent variable for this study was the maximal fatigue during volitional completion of a graded exercise test. After ensuring the participants received a minimum of 6-hours of sleep the previous night, a baseline salivary sample was taken with the p-157: Nucleic acid stabilizing kit (DNA Genotek; Ottawa, Canada). One at a time, the participants completed the graded exercise test on a treadmill following the Bruce Protocol (VO₂ Max). Participants began walking and investigators gradually increased the intensity at regular 3-minute intervals. The increase in intensity was achieved by increasing both the speed and incline of the treadmill until maximal physical exhaustion, as measured by rate of perceived exertion (RPE), was achieved. Physiological measures such as heart rate, blood pressure, and RPE were measured to ensure safety. Immediately following the graded exercise test, a second salivary sample was collected. All samples were sent to Quadrant Biosciences for analysis and NextGen sequencing. Upon receiving normalized data from Quadrant Biosciences (Syracuse, NY), the investigators performed paired t-tests ($\alpha < 0.05$) using SPSS on specified salivary microRNA levels.

Results: No statistical significant differences were found for any of the 6 salivary microRNA previously identified: miR-155-5p [t(19)=1.676, $\alpha = .110$], miR-20a-5p [t(19)=-.819, $\alpha = .423$], miR-182-5p [t(19)=1.770, $\alpha = .093$], miR-221-3p [t(19)=.292, $\alpha = .774$], miR-26b-5p [t(19)=-.738, $\alpha = .469$], miR-29c-3p [t(19)=-1.105, $\alpha = .283$] (Figure 1).

Conclusions: The findings of this study reinforce the relationship between 6 salivary microRNA and concussions. The body of evidence of the aforementioned salivary microRNA's relationship to concussions is strengthened as there were no significant differences found, indicating the concentration of the 6 salivary microRNA are not affected by exercise. With continued research, salivary microRNA analysis may lead to easier, objective concussion diagnosis by clinicians.

Total Word Count: 428

207891CD

The Effects of the 2nd Skull Skullcap® to Attenuate Forces Resulting From Foul Ball Impacts Into Catchers Masks in Baseball.

Neal R, Liberi V, Nicknair J: Adrian College, Adrian MI.

Context: In the U.S an estimated 3.8 million sports-related concussions occur annually. 18.5% of these concussions are sustained as a result of participating in baseball. The mechanism of injury associated with the majority of these concussions is ball contact, specifically from foul ball impacts deflecting from the bat into the catcher's mask. A new piece of protective equipment worn under helmets, the 2nd Skull skull cap® has been shown to decrease linear peak accelerations in batting helmets. No studies exist evaluating the skull cap in conjunction with catcher's masks/helmets in reducing linear acceleration thereby reducing injury risk. The purpose of this study was to evaluate if wearing a skull cap with various catcher's masks was able to attenuate peak acceleration forces compared to catcher's masks with no skull cap.

Methods: This was a randomized-controlled laboratory study. Data was collected in a controlled laboratory setting over the course of two days. The Hybrid III 50th head form and neck were utilized. Two types of catcher's masks were placed on the head form for the 2nd Skull skull cap® and no skull cap conditions. Masks were impacted 24 inches from the point of release of a pitching machine at speeds of 60 MPH. A hockey goalie-style mask and a traditional catcher's mask were each impacted with baseballs, both with and without the 2nd Skull skull cap®, for a total of 4 conditions. Each condition was impacted 6 times; 24 total trials were conducted. Peak acceleration (g's) was measured using an Isotron Tri-axial model 65-10 accelerometer. Separate paired t-tests, Cohen's d effect sizes and 95% confidence intervals (CI) were utilized to compare the skull cap to no skull cap conditions in both catcher's mask styles.

Results: In the hockey goalie-style mask, we observed a significant decrease in accelerations ($P = .03$, $d = 1.38$, 95% CI [0.29 to 2.47]) during the skull cap (93.6 ± 12.9 g's) compared to the no skull cap condition (114.4 ± 16.9 g's), suggesting the skull cap had a large and clinically important effect on reducing linear accelerations. In the traditional catcher's mask, there was no significant difference in accelerations ($P = .26$, $d = 0.62$, 95% CI [-0.38 to 1.63]) between the skull cap (112.3 ± 11.2 g's) and no skull cap conditions (106.3 ± 7.6 g's).

Conclusions: The results from this study display that the use of the hockey goalie-style mask in conjunction with the 2nd Skull skull cap® may attenuate peak linear acceleration values from foul ball impacts; however, the 2nd Skull skull cap® did not have an effect on peak linear accelerations in the traditional catcher's mask style. These findings suggest that 2nd Skull skull cap® may be effective for reducing linear head accelerations in some catcher's mask styles hence reducing head injury risk.

Total Word Count: 446

2047850D

The Effects of Tissue Flossing on Muscular Tenderness in Collegiate Baseball Players

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Context: Tissue flossing bands are a relatively new therapeutic modality that have increased in popularity in recent years. While there is evidence to suggest that tissue flossing bands can decrease pain and increase perceived range of motion, there appears to be little research available to determine the effects of tissue flossing on muscular tenderness. The purpose of this study was to compare the effects of a single tissue flossing band treatment on muscular tenderness in the forearm with a control condition.

Methods: Thirteen apparently healthy collegiate male baseball players (21.54 ± 1.51 yrs, 181.91 ± 5.82 cm, 84.54 ± 8.33 kg) were recruited and consented to participate in the study. Subjects received the treatment on their dominant arm while their non-dominant arm served as the control, and received no treatment. Baseline and post intervention measures being taken for both arms. Muscular tenderness, based off of sensitivity to pressure using a handheld algometer was the primary outcome measured. Baseline tenderness measurements were taken three times on both the intervention arm and the control arm. Marks were placed 7-cm distal to the medial and lateral epicondyles on both forearms to ensure that the same sites were tested during data collection. The tissue flossing band was applied to the wrist of the subject's dominant arm and then wrapped distally to proximally with 50% tension applied until the length of the band was used. The subject then performed 20 clockwise and 20 counterclockwise rotations of their wrist. Following completion of the rotations, the band was removed and tenderness measurements were taken again. A paired t-test was performed to determine if tissue flossing had a significant effect on muscular tenderness with significance set at $p < .05$. A repeated measures ANOVA was performed to determine if tissue flossing had a significant effect on muscular tenderness as compared to a control with significance set at $p < .05$.

Results: A single tissue flossing treatment resulted in a 36% decrease in acute muscular tenderness on the medial forearm (13.46 ± 5.58 to 18.29 ± 6.38 , $p < 0.001$), and a 24% decrease in acute muscular tenderness on the lateral forearm (12.62 ± 4.36 to 15.64 ± 4.88 , $p < 0.001$). When compared with the control group, tissue flossing significantly decreased muscular tenderness ($F(1,59.07) = 39.79$, $p < 0.001$).

Conclusions: A single bout of tissue flossing resulted in a significant decrease in acute muscular tenderness. This suggests that tissue flossing may be a viable treatment when caring for patients suffering from muscular pain and tenderness.

Total Word Count: 412

209042FA

The Effects of Virtual Reality Immersion on Drop Landing Biomechanics

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Context: Using virtual reality (VR) to achieve a more challenging and functional visual environment can lead to improved return-to-play assessment and rehabilitative therapy by increasing ecological validity. Therefore, the purpose of this study was to determine the effects of a VR perturbation on knee kinetics and kinematics.

Methods: Thirty-three healthy physically active adults (8 females, 25 males; 20.4 ± 1.3 years; 1.75 ± 0.11 m; 79.55 ± 4.87 kg) were recruited for this cross-sectional study. Participants performed a drop landing task off a box measuring 31 cm in height onto two adjacent force plates (Bertec, Columbus, OH). Participants performed three trials of the task under eyes-open (EO), eyes-closed (EC), and VR conditions. The VR condition consisted of the individual experiencing a great height from a simulated building or naturalistic environment. Landing errors were measured using the Landing Error Scoring System (LESS). Peak vertical ground reaction force (vGRF), knee flexion at initial contact, maximum knee flexion, knee flexion displacement, knee abduction at initial contact, maximum knee abduction, and knee abduction displacement were evaluated (dependent variables). A multivariate repeated measures ANOVA was conducted with the within subjects factor condition (EO, EC, and VR). Follow-up univariate repeated measures ANOVAs were conducted for each dependent variable if the multivariate ANOVA was significant. Post hoc testing was completed as necessary. Alpha level was set at $\alpha < 0.05$ for all analyses.

Results: The multivariate repeated measures ANOVA was significant for condition ($F(14,15) = 5.18$, $p = 0.002$, $\eta^2 = 0.83$, $1 - \beta = 0.99$). Follow-up univariate repeated measures indicated that LESS errors, peak vGRF, knee flexion at initial contact, knee flexion displacement, knee abduction at initial contact, and maximum knee abduction were significantly different between conditions ($p < 0.05$). VR elicited more LESS errors when compared to EO (mean difference = 1.61, $p = 0.01$) and EC (mean difference = 0.91, $p = 0.01$). VR provoked increased peak vGRF compared to the EO (mean difference = 0.41 ± 0.85 body weight units (bw), $p = .001$) and EC condition (mean difference = 0.340 ± 0.65 bw, $p = .001$). VR decreased knee flexion compared to EO (mean difference = $-4.39 \pm .75^\circ$, $p = .001$) and EC (mean differences = $1.83 \pm .63^\circ$, $p = .021$). EO had increased knee flexion compared to EC (mean difference = $2.55 \pm 0.71^\circ$, $p = .004$). EO had increased knee flexion displacement compared to EC (mean difference = $1.29 \pm .20^\circ$, $p = .020$). VR displayed more knee abduction at initial contact compared to EO (mean difference = $-0.72 \pm 1.83^\circ$, $p = 0.002$) and EC conditions (mean difference = $-.69 \pm 1.79^\circ$, $p = .002$). Lastly, VR increased peak knee abduction compared to EO (mean differences = $-2.01 \pm .71^\circ$, $p = .026$). All other comparisons were not significant $p > 0.05$.

Conclusions: VR may provide a means to increase the degree of neuromuscular perturbation beyond that of EC, increasing injury risk landing biomechanics. This intervention can be applied to currently existing rehabilitation protocols and functional tasks. VR is quickly becoming more affordable and easier to use, allowing clinicians to more readily incorporate its use into current practice.

Total Word Count: 431

206733ED

The Evaluation of Joint Mobilization Dosage on Measures of Motion in Individuals With Decreased Dorsiflexion and a History of an Ankle Sprain

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Context: Mulligan’s Mobilization with Movement (MWM) is a common intervention used to address dorsiflexion range of motion (DFROM) impairments. However, the application of MWMs varies within the literature. The aim of this study is to examine the effect of serial MWM application on DFROM to develop parameter recommendations.

Methods: Nineteen adults (14 females; age=29±12.87yrs; height=67.56±3.56in; weight=170.17±34.00lbs, DFROM=30.26±4.60°) with decrease dorsiflexion (<40°) participated in the repeated-measures cohort design study. Inclusion criteria included history ≥1ankle sprain, ≥18yrs old, no lower extremity injury in the last 6 months, and no history of foot/ankle surgery. Participants completed a single session in which ten sets of MWMs were performed. Each set consisted of the subject kneeling with the affected ankle forward, the mobilization belt was placed around the participant’s malleoli and the researcher to provide an anterior force. The researcher provided stabilization on the talus while the subject moved through maximal dorsiflexion and then return to the starting position continuously for 1 minute. DFROM was taken at baseline and immediately after each intervention set (post1, post2,..., post10). DFROM was measured with a digital inclinometer on the anterior aspect of the tibia during the weight bearing lunge test with the knee straight (WBLT_S) and knee bent (WBLT_B). WBLT consisted of the participant lunging forward maximally, in a tandem stance, while keeping their heel in contact with the ground throughout. The average of 3 trials was used for the analysis for each outcome. Separate 1-way ANOVAs were used to examine changes over time for the WBLT_S and WBLT_B. Indicated t-test contrasts were completed that examined pairwise differences between each time point and baseline measurement as well as between sequential time points. Hedges g effect sizes with 95% confidence intervals were calculated for contrast comparisons between baseline and postintervention measurements along with sequential measurements.

Results: ANOVA results indicated a significant time main effect for WBLT_B ($p < 0.001$) and a non-significant effect for WBLT_S ($p < 0.924$). Contrast analysis indicated that the WBLT_B improved at Post1 (32.65±5.28°, $p = 0.005$, ES=0.46), Post 2 (34.21±5.48°, $p < 0.001$, ES=0.74), Post3 (34.67±6.22°, $p = 0.004$, ES=0.77), Post4 (34.54±5.69°, $p = 0.002$, ES=0.79), Post5 (34.72±7.20°, $p = 0.005$, ES=0.7), Post6 (34.39±6.49°, $p = 0.004$, ES=0.7), Post7 (34.88±7.07°, $p = 0.004$, ES=0.74), Post8 (35.06±6.23°, $p = 0.001$, ES=0.83), Post9 (35.45±6.06°, $p < 0.001$, ES=0.92), Post10 (35.46±6.72°, $p = 0.002$, ES=0.86) compared to baseline (30.26±4.60°). Additionally, Post2 improved compared to Post1 ($p = 0.027$, ES=0.27). No other pairwise sequential comparisons were significant ($p > 0.417$, ES<0.07).

Conclusions: MWMs significantly improved acute knee bent DFROM in people with a history of ≥1ankle sprain and decrease DFROM. Our findings indicate that after two sets of MWMs no further DFROM improvements were identified. Statistically significant improvements were associated with strong effect sizes, which indicates these findings may be clinically relevant. Future research should investigate the lasting effects of DFROM improvements with variable MWM dosages.

Total Word Count: 446

[207295ED](#)

The Evidence for the Use of External Support to Control Subtalar Motion is Strong, but Outdated. A Systematic Review with Meta-Analysis

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Context: Subtalar joint(STJ) instability, as a condition separate from talocrural instability, is understudied. In particular, nonsurgical STJ-specific interventions are almost nonexistent. For clinical STJ research to evolve, critical evaluation of the existing literature is needed. The purpose of this meta-analysis was to critique and summarize the evidence regarding the use of external support(SUPPORT) to control STJ inversion(INV°).

Methods: We searched PubMed, MEDLINE, SportDiscus, and CINAHL from inception through October 2020, for peer-reviewed original articles, published in English. Search terms included iterations and synonyms of subtalar, treatment, and external support. Selection criteria required that studies utilized a pre-post SUPPORT design, actively or passively assessed INV° utilizing motion analysis or manual assessment, and reported INV° pre-post SUPPORT means and standard deviations. Cadaveric and surgical studies were excluded. Selected outcomes were disease-oriented (INV° with no SUPPORT, SUPPORT, and SUPPORT post-EXERCISE). Two investigators extracted participant ankle status (healthy, ankle instability) and sample sizes; TYPE (hinged brace[Hinged], lace-up brace[Lace], tape[Tape], and augmented tape with a STJ sling[Sling]); and INV° at baseline, post-SUPPORT, and/or post-EXERCISE. Three meta-analytic summary models (OVERALL, TYPE, post-EXERCISE), based on Hedge's g effect sizes(ES)[95%CIs], were generated to determine the magnitude of the effect of SUPPORT on INV°. Additionally, the percentage of range of motion change(%ROMchange) was calculated. The PEDro scale was used to assess potential validity threats. Based on technological advancements, an additional quality assessment was applied: 1 PEDro score point was deducted for studies published in the previous decade; 2 points were deducted from studies published in the previous century. The strength of recommendation (SOR) was generated according to the Strength of Recommendation Taxonomy.

Results: Ten studies met selection criteria for SUPPORT and 3 met the post-EXERCISE criteria. Only 2 studies were from the current decade. Nine of 10 studies utilized healthy participants, whereas 1 included ankle instability patients. Original PEDro scores ranged 5 to 7. After study deductions, 8 of 10 studies were reduced to a score of 4 (\bar{x} =4 of 10). The OVERALL effect was strong (ES=1.4[1.1,1.7], $p<.001$, %ROMchange:28.5%±17.7). Based on TYPE, the Sling had the strongest effect (ES=3.2[1.6, 4.9], $p<.001$, %ROMchange:45.5%±19.8), followed by Hinged (ES=1.2[0.7,1.6], $p<.001$, %ROMchange:29.4%±19.5), Lace (ES=1.1[0.5,1.7], $p<.001$, %ROMchange:29.4%±9.8), and Tape (ES=1.2[0.7,1.7], $p<.001$, %ROMchange:24.9%±13.1). The effect of SUPPORT post-EXERCISE was also strong (ES=1.3[0.8,1.9], $p<.001$, %ROMchange:21.5%±13.2).

Conclusions: The use of external support (tape and bracing) for controlling STJ inversion appears promising. Even after exercise, the stabilizing effects of the external support persisted. However, while these effects were strong, the evidence used to generate this conclusion is outdated, limiting the clinical utility of this evidence. The SOR for the use of external support to control SJT motion was C, based on consistent, yet outdated, limited quality, disease-oriented evidence. High quality, patient-oriented studies on controlling STJ motion to reduce injury/reinjury risk are critically needed.

Total Word Count: 447

200301QA

The Experience of Professional Master's Athletic Training Students With Sexual Harassment During Clinical Education

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Context: Sexual harassment is a concern in healthcare professions and on college campuses nationwide. Athletic trainers are healthcare professionals who work in close conjunction with student-athletes, which may predispose them to potential sexual harassment occurrences. This study was conducted to examine the experience of professional master's athletic training students with sexual harassment during their clinical education experiences.

Methods: An online questionnaire based on the current literature surrounding sexual harassment was sent out to CAATE-accredited professional master's athletic training program directors, along with a recruitment email encouraging program directors to send the survey to students currently enrolled in the programs they lead. Expert review and pilot testing provided content validity and clarity. 87 professional master's students completed the questionnaire (68 females, 19 males; age=23.40±1.85 years; 44 first-year students, 43 second-year students). The questionnaire included demographic, quantitative, and qualitative questions. Quantitative data were used to determine frequency of experienced sexual harassment in the collegiate setting and positions of the perpetrators. Qualitative data allowed for collection of in-depth stories providing rich contextualization of sexual harassment during clinical practice. We used a general inductive approach to analyze the qualitative data. Trustworthiness techniques included multiple analyst triangulation and peer review.

Results: Participants from both sexes stated that they had been subjected to sexual harassment behaviors (females: N=24, 35.3%; males: N=1, 5.3%). 33.8% (N=23) of females reported witnessing sexual harassment during clinical practice while 15.8% (N=3) males reported the same. Most female participants (N=62, 91.2%) and almost half of male participants (N=9, 47.4%) thought their sex contributed to job related challenges. The majority of females (N=48, 70.6%) and males (N=11, 57.9%) were aware of current sexual harassment policy at their place of employment but had not seen it put into practice (females: N=10, 85.3%; males N=2, 89.5%). Themes seen through recipients' accounts of sexual harassment defined a timeline that started when sexual harassment most commonly manifested through *inappropriate comments*, followed by athletic training students having to *make adjustments after incidents* instead of the perpetrators, and finally ended with events leading to *insufficient resolution* where victims felt the situations should have been handled differently.

Conclusion: Sexual harassment affects some professional master's athletic training students in clinical education settings. Our findings may assist in identifying potential risk factors for sexual harassment occurrences and can be used to suggest stronger policies, procedures, and educational interventions to assist in changing the culture surrounding sexual harassment in athletics.

Total Word Count: 397

205145CB

The Experiences of Peer Educators Implementing a Novel Peer Concussion Education Program With Collegiate Student-Athletes

William Ernst and Meredith E. Kneavel

Context: Survey research has indicated that 40-50 percent of collegiate athletes continue to play despite experiencing symptoms of possible concussion; however, only 10% reported being unlikely to conceal symptoms from a teammate. The purpose of this paper is to describe the experiences of peer concussion educators (PCE's) who implemented a novel peer concussion education program (PCEP).

Methods: The PCEP trains two student-athletes per team as PCE's to deliver educational material designed to enhance concussion knowledge and reporting. The PCEP features a concussion reporting exercise where teammates list thoughts that impede reporting and replace them with thoughts that facilitate reporting. During a randomized controlled trial, 30 teams with relatively high concussion rates (e.g. men's football; women's soccer) from 10 colleges participating across all 3 NCAA divisions received the PCEP. Twenty/60 (33%) PCE's completed an online debriefing questionnaire that consisted of the following questions: 1) What did you like about being a peer educator? 2) What challenges did you face as a peer educator? 3) What suggestions do you have for improving the program? and 4) What worked well? Data were analyzed qualitatively following a method outlined by Creswell. First, the investigators discussed expected results to mitigate bias during data analysis. Next, significant statements were extracted from the debriefing narratives. Third, clusters of meaning were developed and organized into themes. Steps two and three were followed independently by both investigators and thematic inconsistencies were reconciled through discussion.

Results: The following themes emerged in response to the debriefing questions. Question 1: a) Educating my teammates about concussion, b) The opportunity to learn more about concussions. Question 2: a) Difficulty engaging teammates and being taken seriously during the presentation, b) Difficulty with the complexity of the material describing the scientific aspects of concussion. Question 3: a) Make the science easier to understand, b) Make the material more engaging, c) Change nothing. Question 4: a) Having the support of the athletic trainer, b) The concussion reporting exercise, c) The PowerPoints were helpful, especially the videos and diagrams.

Conclusions: The PCE's appreciated having the opportunity to educate their teammates and the opportunity to learn more about concussions. Positive aspects of the PCEP included the concussion reporting exercise and having the support of an athletic trainer when providing the education modules. Challenges included being taken seriously by their teammates and the complexity of the more "scientific" aspects of concussion (e.g. pathophysiology). Recommendations for improving the PCEP included making the "science" easier to understand and adding more graphics and visual content to make the educational material more engaging.

Total Word Count: 416

208325CD

The High School Athlete's Concussion Reporting Motivation in a Socioecological Context

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Context: The combination of two theoretical streams (self-determination theory [SDT] and the socioecological model [SEM]) may provide incremental insights in concussion reporting. SDT suggests that reporting is associated with increases in autonomous sport motivation and decreases in controlled sport motivation. SEM suggests that the athlete's decision is situated in contextual layers (e.g., interpersonal [family] and community [coach or team]). The role of team culture has been examined with less attention being paid to the impact of family culture. SEM recognizes the agency of the individual within the socioecological context. SDT recognizes the effect of the individual's context on motivation. From an SDT-SEM perspective, this study examines the effect of athlete sport motivation, family culture, and team culture on the athlete's decision to report concussion-like symptoms.

Methods: 1,070 high school athletes (51% female/49% male; average age 16.7;s.d.=1.89; Varsity 39.8%/Select 32.7%/JV 21.0%/Other 6.5%) from the Survey Sampling International (SSI) panel completed an online survey including the sport motivation scale as well as scales to assess their perceptions of transformational parenting (i.e., family culture) and transformational coaching (i.e., team culture). In two scenarios in which concussion-like symptoms were being experienced, the athletes were asked whether they would report or wait to report symptoms on a 100-point scale. Structural equation modeling was used to examine the impact of transformational parenting and coaching on athlete sport motivation (autonomous and controlled) and the impact of these three factors on telling/waiting.

Results: The model showed good fit ($\chi^2(3) = 9.073$, RMSEA = .043, CFI = .993, TLI = .972, SRMR = .016). Autonomous motivation was associated with an increased likelihood of telling someone ($\beta = .102$, $p = .006$) while controlled motivation was associated with a decreased likelihood ($\beta = -.100$, $p = .001$). Transformational parenting ($\beta = .419$, $p < .001$) and coaching ($\beta = .343$, $p < .001$) were significantly related to increased autonomous motivation. Transformational parenting ($\beta = -.290$, $p < .001$), but not transformational coaching ($\beta = .021$, $p = .543$), was associated with decreases in controlled motivation. Transformational parenting ($\beta = .238$, $p < .001$) had a direct relationship with telling someone while transformational coaching ($\beta = .067$, $p = .054$) did not.

Conclusions: As suggested by SEM, the interpersonal context (i.e., family culture assessed as transformational parenting) played a more significant role in promoting concussion reporting by the athlete than the community (i.e., team culture assessed as transformational coaching). Transformational parenting influenced autonomous and controlled motivation in directions that encouraged greater reporting; and had a direct effect on reporting. Meanwhile, transformational coaching operated only through improvements in autonomous sport motivation. The findings suggest that greater study of the young athlete's family situation may lead to new opportunities to enhance concussion symptom reporting.

Total Word Count: 446

208514EA

The Impact of a Theoretical Leg Length Discrepancy on Normalized Star Excursion Balance Test Reach Distance in Adolescent Patients With Chronic Ankle Instability

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Context: The Star Excursion Balance Test (SEBT) is a common dynamic balance measure. Both stance and non-stance legs have been used for normalization procedures. Normalized contralateral limb reach distance is often used as a marker of return to sport readiness. Such comparisons are based on a single leg length measure and the assumption that no leg length discrepancy (LLD) exists. However, the impact of a LLD on normalized SEBT reach distances has not been investigated. Therefore, the purpose of this study was to determine the theoretical percent magnitude of LLD that would result in bilateral SEBT normalized reach distance differences.

Methods: Convenience sample of adolescent individuals (n=43, 20 males and 23 females, 16±1years, 171.75±12.05cm, 69.38±18.36kg) with Chronic Ankle Instability (CAI). Patients reached maximally with their non-stance limb in the posteromedial direction while maintaining a single-leg stance with the stance foot centered in the SEBT grid with their hands on hips. We focused on the posteromedial reach as this direction is less influenced by available dorsiflexion ROM. During each trial, patients lightly tapped a cloth tape measure without weight transfer. This distance was recorded to the nearest cm. Stance limb leg length (cm) was measured from the superior aspect of the ASIS to the distal aspect of the medial malleolus and used to normalize the recorded reach distance values (%). A participant's leg length was then systematically increased by 2%, 4%, and 6% to mimic different magnitudes of LLD with the contralateral limb. Independent t-tests were then used to determine normalized posteromedial SEBT reach distance differences ($p \leq 0.05$) between the original and modeled LLD (2%, 4%, 6%) conditions. Hedge's g effect sizes and 95% confidence intervals were calculated, if applicable, to confirm significant differences.

Results: Significant differences were noted between the original (84.94±11.04) and the 6% LLD condition (80.13±10.41, $p=0.041$). However, this difference was associated with a small effect size and a confidence interval that crossed zero (0.31, -0.11 to 0.74). No significant differences were noted among the original and 2% LLD (83.28±10.82, $p=0.482$), or 4% LLD conditions (81.68±10.61, $p=0.165$).

Conclusions: A LLD $\geq 6\%$ would result in bilateral differences in normalized posteromedial SEBT reach distance in CAI adolescents. This is consistent with research showing that the minimal detectable change of the posteromedial SEBT is 6%. Given that leg length typically represents 49.1% of an individual's height, a 6% LLD represents would equate to a 4.8cm LLD in someone who is 5'4" (162.56cm) and a 5.4cm LLD in someone who is 6'0" (182.88cm). Given the magnitude of these LLD estimations, only extreme LLD would likely impact bilateral normalized SEBT if reach distances stayed the same. Based on these results, it may be unnecessary to bilaterally assess leg length in adolescents with CAI.

Total Word Count: 445

206394CD

The Impact of Sociodemographic Factors on Baseline King Devick Performance in High School Athletes

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Context: Race and socioeconomic status (SES) are two sociodemographic determinants of health that can contribute to an athlete's performance on standardized concussion measures. In order for clinicians to provide better care and tailor individual concussion management plans, it is important to understand how race and SES affect test performance. Following consensus statements prompting the use of oculomotor assessments, the King-Devick (K-D) test has emerged as a valid and quick assessment tool to measure oculomotor dysfunctioning. The objective of this study was to determine how race and SES impact baseline K-D performance.

Methods: This study utilized a cross-sectional design. A total of 914 athletes from 10 high schools participated in this study as they reported for preseason baseline concussion testing. Race was self-reported and SES status was determined by school attendance. Athletes attending Title I schools were categorized as lower SES and athletes attending non-Title I schools were categorized as higher SES. For comparison purposes, any athletes with a history of ADD/ADHD, LD, autism, concussion, or a non-black or white race were excluded. Thus, a total of 564 high school athletes (360 white, 204 black, 138 higher SES, 426 lower SES) were used for analyses. K-D reading times were completed individually with an athletic trainer. K-D baseline tests were completed using test card booklets, and participants were given uniform instructions prior to test administration. A stopwatch on a smartphone was used to record each participant's cumulative reading time. The fastest of 2 trials was recorded as the athlete's baseline score. Data were analyzed using descriptive statistics and a multiple linear regression in SPSS. K-D reading time was the dependent variable; race, and SES were the independent variables, while controlling for sex differences. Statistical significance was set a priori $p \leq .05$.

Results: The overall regression model was statistically significant ($F(3,560)=5.76, p < .01$) suggesting that the model was a good fit for the data. When SES was held constant, race was not statistically significant ($p = .12$), however, when race was held constant, SES was statistically significant ($p < .01$) suggesting that SES is a sociodemographic variable that impacts K-D performance. Cumulative K-D reading time increases among lower SES athletes, indicating a poorer performance. The average K-D reading time among lower SES athletes was 50.86 ± 10.9 seconds versus 47.88 ± 8.7 seconds among higher SES athletes. The average K-D reading time among white athletes was 50.14 ± 9.5 seconds versus 50.12 ± 12.1 seconds among black athletes.

Conclusions: Lower SES negatively impacted K-D test baseline performance, whereas race did not. SES is strongly associated with cognitive ability, and given the depth and breadth of assessment required to treat concussions, clinicians be mindful of how SES and an athlete's sociodemographics may influence performance on concussion assessments

Total Word Count: 434

209234AB

The Incidence of Injuries in Youth Mountain Bike Racing

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Context: Reports of injury rates in cycling exist in competitive road cycling events, but little is known about injury rates in competitive cross-country mountain bike racing. The varying nature of mountain bike race courses (distance and time in competition) makes it difficult to compare events if examining rates of injuries per Athlete-Exposure. Therefore, the purpose of this study is to describe the injuries reported and provide a comparison of different athlete-exposure units in competitive mountain bike racing.

Methods: This prospective epidemiology study conducted during three separate youth mountain bike races examined a population-based sample of 238 riders (male =195, female =43) in school grades 5-12. We examined publicly available race data to identify the exposure in terms of person-race (AE), person-time (minutes), and person-distance (km). Riders treated on site for injuries sustained during competition who had previously consented to releasing medical information were included in the injury analysis. Injury data included body region(s) injured, number of injuries, type of injuries, and participation status (finished race, did not finish). Incidence rates with confidence intervals were calculated for total injuries per person-race, person-distance, and person-time.

Results: A total of 238 participants across three races accounted for 238 AEs, 2,388.9 km, and 9905 minutes spent in competition. A total of 8 riders sustained 11 injuries; 4 injuries were to riders (male =2, female =2) who finished the race, 7 injuries were to riders (male =7, female =0) who did not finish as a result of their injury. Injured body regions included head (n=1), neck (n=1), back (n=2,) arm/shoulder (n=4), and leg (n=3). Injuries included concussion (n=1), concern for fracture (n=2), muscle spasm (n=2), sprain (n=1), and soft tissue trauma (n=4). Rates of 46 injuries per 1000 AEs (95% CI: 18.89, 73.5), 4.6 injuries per 1000 km (95% CI: 1.87, 7.3) and 1.1 injuries per 1000 minutes (95% CI: 0.44, 1.75) were calculated.

Conclusions: This study provides a starting point for reporting incidence rates in competitive mountain bike racing. Mountain bike racing create varying levels of exposure to potential injury and depending on a participant's age or racing category the distance or time spent in competition may change. Using AE as the denominator when reporting incidence rates possibly inflates incidence and makes comparison among different events difficult. Reporting injuries per distance (km) or time (minutes) spent in competition increases precision of reporting and may make data from multiple events more comparable. Due to the small population size followed, further study of these events will result in more robust data and a better representation of injuries and rates associated with mountain bike racing.

Total Word Count: 424

[207813FB](#)

The Influence of Quadriceps Rate of Torque Development on Limb-Symmetry in Knee Moment During Double-Leg Jump Landings in ACL-Reconstructed and Healthy Females

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Context: Lesser quadriceps explosive strength, quantified as the rate of torque development (RTD), following ACL reconstruction may result in asymmetrical landing mechanics. Greater asymmetry in net internal knee moment at initial contact (KM at IC) has been reported to be associated with an increased risk of second ACL injury. However, no previous study has investigated potential associations between quadriceps RTD and KM at IC limb-symmetry. Therefore, this study was aimed to evaluate if greater quadriceps RTD is associated with more symmetrical KM at IC in ACL reconstructed (ACLR) and healthy females.

Methods: Nineteen ACLR (Age: 19.2 ± 1.8 years, Height: 164.1 ± 7.0 cm, Mass: 63.8 ± 7.6 kg, Time after surgery: 20.1 ± 9.5 months) and 19 healthy (Age: 21.1 ± 3.3 years, Height: 167.3 ± 7.3 cm, Mass: 67.3 ± 9.3 kg) female participated in this investigation. Isometric quadriceps torque-time curves were collected using a Biodex System 3 dynamometer during three trials in which participants attempted to extend the knee as hard and fast as possible. RTD was calculated by fitting a line of best fit to the recorded torque-time curve between torque onset and 100 ms after onset and normalized by body mass. KM at IC during three double-leg jump landing (DLJL) trials was calculated using a standard inverse dynamics procedure using data collected via an optical motion capture system interfaced with two force plates, and normalized by body mass and height. RTD and KM at IC was averaged across trials for statistical analysis. A stepwise multiple linear regression model was used to determine the amount of variance in limb-asymmetry of KM at IC that could be explained by Group, RTD, and/or their interaction (Group*RTD).

Results: Quadriceps RTD in the reconstructed limb of ACLR females and the non-dominant limb of healthy females were 7.94 ± 3.62 and 9.01 ± 4.19 ([Nm/s]/kg), respectively. Limb-asymmetry in KM at IC were 0.02 ± 0.01 and 0.02 ± 0.01 ([N*m]/[N*m]), respectively. Limb-asymmetry in KM at IC could not be predicted by any explanatory variables ($p=.137$). We conducted a secondary analysis in which the magnitude of RTD was replaced by limb-asymmetry of quadriceps RTD as an explanatory variable in the regression model. We found that the interaction between Group and limb-asymmetry of quadriceps RTD significantly predicted 23% of the variance in limb-asymmetry of KM at IC ($p=.003$) (Figure1).

Conclusions: Quadriceps RTD in the reconstructed limb of ACLR females and the non-dominant limb of healthy females is not predictive of limb-asymmetries in KM at IC. However, greater quadriceps RTD symmetry in ACLR females is associated with landing with more symmetrical KM at IC during DLJLs. Given that greater limb-asymmetry in KM at IC is associated with a higher risk for a second ACL injury, clinicians should consider incorporating explosive quadriceps muscle strengthening into post-ACLR rehabilitation in an attempt to achieve between-limb symmetry in quadriceps RTD.

Total Word Count: 446

207054QC

The Influence of Student/Preceptor Gender Dyads on the Role of the Athletic Training Student During Clinical Experience: A Report from the Athletic Training Clinical Education Network

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Context: Professional athletic training students (ATs) are required to gain a variety of clinical experience under the supervision of a preceptor, with the goal of an increasing progression of autonomy. Students of all genders will likely experience clinical assignments with both male and female preceptors, but will still need the opportunity to progress to skill performance to an autonomous level prior to athletic training program completion. The objective of this study was to determine if the student role during patient encounters (PEs) at clinical experiences is influenced by the gender dyad between student and preceptor.

Methods: A multi-site, panel design was used to conduct this study. Twelve CAATE-accredited professional athletic training programs participated (7 graduate, 5 undergraduate) by allowing ATs to track PEs using E*Value (MedHub, Minneapolis, MN) software that occurred during the 2018-2019 academic year. The ATs documented personal gender (female/male) and preceptor/supervisor gender (female/male), and their self-reported student role in conducting the PE (observed, assisted, performed), which were operationally defined prior to data collection. Descriptive statistics were used to summarize student role during PEs relative to gender dyad arrangements. A mixed multinomial logistic regression clustered by Student ID was employed ($p < 0.05$) to assess dyad differences.

Results: 363 ATs contributed data on 30,446 PEs. The distribution of encounters by student-preceptor dyad included: 9,646 (31.7%) female students/male preceptors, 6,784 (22.3%) male students/male preceptors, 9,901 (32.5%) female students/female preceptors, and 4,115 (13.5%) male students/female preceptors. Female students with male preceptors devoted more encounters to observation only than any other dyad combination (14.1% versus 10.6% [female student/female preceptor], 11.7% [male student/female preceptor], and 11.4% [male student/male preceptor]). Female students with male preceptors had the lowest percentage of encounters performed independently (67.6% versus 75.0% [female student/female preceptor], 70.7% [male student/female preceptor], and 72.0% [male student/male preceptor]). The multinomial logistic regression indicated there was a significant interaction between preceptor and student gender on student role ($p < 0.001$). Female students with male preceptors were less likely than any other dyad to perform PEs than they were to observe them (OR=0.76, 95% CI: 0.69-0.83, $p < 0.001$), and female students were more likely than male students to assist as compared to observe PEs (OR=0.89, 95% CI: 0.79-0.99, $p = 0.040$).

Conclusions: The autonomous progression of students can be influenced by the gender dyad of the student/preceptor assignment. Female students with male preceptors are apt to observe PEs more frequently than any other gender dyad, potentially negatively impacting their skill development and autonomous practice progression. Preceptor development should focus on addressing the inherent bias that male preceptors may possess when assigned female ATs, and female ATs should be instructed on seeking opportunities to more actively engage during PEs that occur during clinical experience.

Total Word Count: 438

[207253ED](#)

The Investigation of Static and Dynamic Balance Among Levels of Joint Mobility

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Context: Injuries are known to be an inherent risk of sport participation and can lead to short and long-term health detriments, require long term rehabilitation, and come at high healthcare costs. Due to this information, it is important that injury prevention practices are developed to limit acute injuries and the subsequent cycle of disability. Balance and hypermobility have been cited as risk factors for injury, however, there is limited knowledge regarding mobility's effect on balance beyond investigations of individuals with symptomatic hypermobility. The objective of this study was to investigate the effect of joint mobility on balance.

Methods: Thirty participants (19 females, 21.33±2.86yrs, 173.49±10.53cm, 75.61±12.41kg) volunteered to participate in this cross-sectional laboratory design. Inclusion criteria consisted of being physically active and between the ages 18 and 35. Participants were excluded if they had a history of lower extremity (LE) injury in the past 3 months, history of surgery to the LE or conditions that may affect their Beighton score or balance. Participants completed one session in which measures were taken in a counterbalanced order on a single, counterbalanced limb. Beighton Scoring (BS) was used to group participants into hypermobile (HM, Score>3) and Non-HM (Score<4) groups. BS consists of 5 bilateral passive movements: little finger extension, thumb movement to the forearm, elbow and knee hyperextension, and hand placement flat on the floor from a standing position with extended knees. Dynamic balance was measured using the Y-Balance Test (YBT). YBT was performed with the chosen limb as the balancing limb. The average of three normalized reaches were used for analysis. Static balance was measured using the single-leg, firm surface stance of the Balance Error Scoring System (SL-BESS). To examine differences between groups (HM, Non-HM), separate independent T-tests were conducted for each dependent variable (SL-BESS, YBT). Results were deemed significant if $p<0.05$.

Results: Twenty participants were classified as Non-HM (Beighton=1.20±1.11) and ten as HM (Beighton=4.70±1.06). No significant differences were identified for the anterior (Non-HM=60.58±7.54%, HM=61.58±5.04%, $p=0.685$), posteromedial (Non-HM=95.85±14.11%, HM=95.37±11.34%, $p=0.920$), and posterolateral (Non-HM=93.51±10.54%, HM=97.48±14.11%, $p=0.385$) reaches of the Y-balance test between groups. Additionally, no static balance (Non-HM=2.24±2.39%, HM=3.00±2.38%, $p=0.391$) differences were identified between groups as measured by the SL-BESS.

Conclusions: This study found no significant differences in dynamic or static balance measures between those classified as HM and Non-HM. These outcomes provide contrast previous literature which has found correlations between dynamic as well as static balance and high levels of joint hypermobility. The findings indicate that BS and general hypermobility classification is not an appropriate precursor for the identification of individuals may or may not need balance screening. More research is needed to examine the association between these measures using a larger range of Beighton scores and their connection to injury risk.

Total Word Count: 445

205572QA

The Perception and Utilization of Student Aides in the Secondary School Athletic Training Setting

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Context: Secondary school athletic trainers often utilize athletic training student aides in various capacities. The National Athletic Trainers' Association (NATA) published an Official Statement on the appropriate use of student aides in 2014. A dearth of research exists on athletic trainers' adherence to the statement. The purpose of this mixed methods study was to determine to what extent secondary school athletic trainers (SSATs) are following the NATA Official Statement on Proper Supervision of Secondary School Student Aides, and to determine the perceived value of student aides.

Methods: The study utilized an online survey, based on the Official Statement's guidelines, to assess SSATs perceptions of student aides and of the Official Statement. The instrument's content validity was established by a panel review of experienced athletic training researchers. The survey was distributed to 1000 athletic trainers across the United States, and shared on pertinent social media (i.e. the Secondary School Athletic Trainers Facebook group), by an unaffiliated administrator. Participants were invited to participate in a follow-up phone interview to clarify initial findings and glean wider perspectives. Member checks and a peer debriefing established trustworthiness of the qualitative analysis. Subjects were currently practicing SSATs. They did not need to have student aides to be eligible to participate in the study. Subjects were randomly selected from the NATA's survey distribution program database.

Results: One hundred forty-one subjects (age: 35.9 ± 10.4 ; years certified: 12 ± 9.3) completed the online survey, and 24 participated in interviews. Participants worked in secondary school athletic training facilities with an average of 1.7 ± 1.45 full time staff, 0.6 ± 0.88 part time staff, and 5.1 ± 6.96 student aides present. Sixty-two percent of participants utilize SAs. Eighty-four percent of participants have written rules for their SAs, and 66.9% of participants had read the Official Statement on Proper Supervision of Secondary School Student Aides. According to participants, SAs primarily complete basic tasks such as stocking medical kits and rarely complete advanced tasks such as planning patient care (Figure 1). The interview phase of the study revealed that the perceived value of SAs included: 1) ancillary support, 2) allowing athletic trainers to prioritize tasks, and 3) allowing SAs to learn about the profession. Participants perceived that seasoned AT professionals were more accepting of utilizing SAs than young professionals who were more cautious when utilizing them.

Conclusions: Most participants have read the Official Statement. The use of SAs was valued by those interviewed due to the ancillary support they provided the SSAT. Participants reported utilizing SAs in a variety of ways, based on their school size, individual preferences, and needs of their athletic training program. Continued education of SSATs' use of SAs is needed as there is some evidence of SAs' engagement in prohibited activities.

Total Word Count: 440

208083QD

The Presence of Emergency Equipment in Secondary Schools With Athletic Training Services by Employment Provider

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Context: Secondary school (SS) athletic trainers (ATs) are expected to be prepared for emergencies during athletic activity. Preparation includes access to appropriate medical equipment. However, numerous sudden death events occur where proper equipment is not available to the school. Therefore, the purpose of this study was to examine the odds of having emergency equipment by the type of employment provider.

Methods: SS ATs who completed the Athletic Training Locations and Services (ATLAS) survey from August 15th, 2018 to September 29th, 2019; (n=3557) were included in the analysis. Incomplete survey responses were excluded from the analysis due to response bias. Employment provider included the following: school district employee (SD) and medical/university facility (MUF). SD included employees whom also had teaching responsibilities. Respondents selected the following pieces of emergency equipment at their disposal: splint kit, rectal thermometer, cold-water immersion (CWI) tub, blood pressure cuff, stethoscope, first aid materials, CPR mask, protective equipment removal tools, airway and supplemental oxygen, wet-bulb globe temperature device, lightning detector system, epinephrine auto-injector, rescue inhaler, blood glucose monitor, and automated external defibrillator (AED). Pearson's chi-square was used in order to determine if the emergency equipment listed above is independent of employment provider. Cramer's V was utilized post-analysis to determine the strength of the associations between emergency equipment and employment provider. Lastly, odds ratios (OR) with 95% confidence intervals (CI) and likelihood ratios (LR) were calculated in order to determine the odds and likelihood of having emergency equipment by SD and MUF employment providers.

Results: The counts of emergency equipment and odds ratios of emergency equipment by employment provider are available in Table 1. Cramer's V analysis indicated "little to low" strength of association (0.034-0.215) between employment provider and emergency equipment. MUF employment providers had significantly greater odds of having splint kits ($\chi^2= 95.394$, OR=2.778[95%CI=2.234-3.454]), CWI tub, stethoscope, equipment removal tools, epinephrine auto-injector, blood glucose monitor and AED within 1 to 3 minutes. LR ratios for epinephrine auto-injector, splint kit, and BP were especially high, each piece of equipment having LR of 163.6, 95.4, and 89.8, respectively.

Conclusions: Secondary schools with athletic trainers employed by MUF providers had greater odds of having splint kits, CWI tubs, stethoscopes, protective equipment removal tools, epinephrine auto-injectors, blood glucose monitors, and an AED within 1 to 3 minutes. Likelihood ratios for all pieces of equipment in the MUF setting, minus AED, range from 4.3 to 163.6 times more likely for emergency equipment to be present in a school with an AT employed by MUF. These findings are important for stakeholders to consider and to involve the SS AT in equipment purchases for their athletics departments, regardless of employment provider.

Total Word Count: 432

[209714JC](#)

The Relationship Between Athletic Trainers' Perceptions of and Experiences With Social Determinants of Health

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Context: Social determinants of health (SDOH) are conditions in which patients live, age, learn, socialize, and work. The greater health care community has studied SDOH, finding they matter more to patients' health than the healthcare services provided. Given the nature of athletic health care, athletic trainers (AT) are uniquely positioned to recognize and assess these factors. Despite the known importance of SDOH, research related to SDOH in athletic health care is sparse. The purpose of this study was to determine the relationship between ATs' self-perceptions of (familiarity, comfort, and knowledge) and experience with SDOH.

Methods: This was a cross-sectional, survey-based study. The survey was validated and distributed to a sample of 17000 ATs via email. The survey consisted of various questions evaluating ATs' perceived familiarity of, comfort with, knowledge about, and experience with SDOH using several question formats. Perceptions were measured on separate, 4-point Likert scales, and an experience score was calculated that ranged from 0 (no experience) to 18 (greatest experience). Descriptive statistics were utilized to report means, standard deviations, frequencies, and percentages. Spearman rho correlations were used to identify if relationships existed between ATs' perceptions of and experience with SDOH. An alpha level of .01 was used for all analyses.

Results: 1829/17000 (10.8%) ATs accessed the survey and 1,694 completed the survey (completion rate=92.6%; 533 males, 856 females, 5 other, 6 prefer not to respond, 294 missing; age=36.6±10.8 years; AT experience=15.2±10.6 years). ATs self-reported minimal-to-moderate familiarity of (2.6/4.0±0.8), comfort with (2.8/4.0±0.8), and knowledge about (2.8/4.0±0.8) SDOH. ATs experience scores ranged from 0-18 with a mean score of 14.3±3.8. Very strong, positive correlations were identified between ATs' self-reported familiarity of and comfort with SDOH ($r_s=.81, p<0.01$), familiarity of and knowledge about SDOH ($r_s=.87, p<0.01$), and comfort of and knowledge about SDOH ($r_s=.86, p>0.01$; Table 1) indicating that their perceptions are highly correlated. Very weak-to-weak, negative correlations were identified between ATs' self-reported familiarity of ($r_s=-0.17, p<0.01$), comfort with ($r_s=-0.20, p<0.01$), knowledge about ($r_s=-0.19, p<0.01$) and experience with SDOH indicating experience may not be related to ATs' self-reports of familiarity of, comfort with, and knowledge about SDOH.

Conclusions: Overall, ATs report their familiarity of, knowledge about, and comfort with SDOH as minimal to moderate at best, yet they do report experience with many social factors. The disconnect in relationships between ATs perceptions and experience may be related to the newness of the topic in athletic health care. ATs may self-report low on their perceptions because they have not been formally educated on the global concept of SDOH. This study sheds light on potential opportunities to educate ATs on the global concept of SDOH and their importance to individual and population health.

Total Word Count: 439

205924LD

The Relationship Between Human-Rated Errors and Tablet-Based Postural Sway During the Balance Error Scoring System in Military Cadets

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Context: The Balance Error Scoring System (BESS) is commonly accepted as a valid measure of postural stability. However, reliability values have varied and subtle changes undetectable with the human eye may exist post-injury, prompting a search for more objective tools. As a cost-effective alternative to force plates and motion capture systems, the inertial measurement unit in commercially available tablets have been used to quantify postural sway (iBESS volume). The iBESS has not been validated in a military population and the stability of the tests beyond one-week is unknown. Therefore, the primary purpose of this study was to assess the relationship between iBESS volume and human-rated BESS errors and to examine changes in these measures over a 6-month period in military cadets.

Methods: Ninety-eight cadets (39.8% female, 20.06±1.46y, 68.6±4.02in, 165.2±29.3lbs) with no history of concussion or lower extremity injury agreed to participate. All participants completed BESS single-limb (SL) and tandem (TAN) stances on two surfaces (firm, foam) at baseline. A subset of cadets (n=63) completed testing 6-months post-baseline. A single human-rater with four years of experience scored all tests at both time points. During testing, a tablet equipped with an inertial measurement unit was positioned on the participant's sacrum to capture anterior-posterior, medial-lateral, and rotational postural sway. The data captured in each plane of movement was used to calculate an iBESS volume for each stance. Better balance is indicated by less volume. Pearson correlations were used to assess the relationship between iBESS volume and human-rated errors at baseline. Baseline and 6-month scores were compared using separate paired sample t-tests with corresponding effect sizes. Change scores (baseline–6-month) were calculated for all variables. Spearman's rho correlations were used to examine the relationship between change scores in human-rated errors and iBESS volume over time. The significance level was set at $p \leq 0.05$ for all analyses.

Results: Moderate to strong correlations were exhibited between baseline measurements for SL-firm ($r=0.83$, $p < 0.001$), TAN-firm ($r=0.83$, $p < 0.001$), SL-foam ($r=0.59$, $p < 0.001$) and TAN-foam ($r=0.80$, $p < 0.001$). Balance significantly improved at 6-months for SL-firm human-rated errors (ES=0.38), SL-firm iBESS volume (ES=0.45), and SL-foam iBESS volume (ES=0.34). No other differences were identified over time (Table 1). Moderate to strong correlations were exhibited between human-rated and iBESS change scores for SL-firm ($r=0.70$, $p < 0.001$), TAN-firm ($r=0.70$, $p < 0.001$), SL-foam ($r=0.48$, $p < 0.001$) and TAN-foam ($r=0.72$, $p < 0.001$).

Conclusions: Moderate to strong correlations existed between human-rated BESS errors and iBESS volume at baseline and between change scores over time, lending support to the validity of iBESS volume for assessing postural stability in military cadets. Over the 6-month period, subtle changes were detected for the SL-firm stance by both methods and by iBESS volume for SL-foam suggesting that iBESS volume may be more sensitive to balance changes than human-rated errors.

Total Word Count: 449

207212DA

The Relationship Between Injury-Related Fear and Physical Activity Levels in Patients with a History of Anterior Cruciate Ligament Reconstruction

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Context: People with a history of anterior cruciate ligament reconstruction (ACLR) average less steps per day and participate in less moderate to vigorous physical activity (MVPA) than healthy individuals. Injury-related fear, specifically fear-avoidance beliefs (FAB), may be one related factor for these negative physical activity outcomes. The purpose of this study was to examine the relationship between FAB, average daily MVPA (MVPA min/day), and average daily step counts (steps/day) in people with a history of ACLR. It was hypothesized that participants with higher levels of FAB would participate in less MVPA min/day and have lower daily step counts.

Methods: An observational cross-sectional study design was employed. A total of 14 participants with a history of unilateral ACLR (10females/4males, age:22.9±3.4years, height:170.8±9.1cm, weight:70.7±10.5kg) reported to the laboratory on two separate occasions separated by one-week. During the first session, participants completed the Fear-Avoidance Beliefs Questionnaire (FABQ) to measure FAB. The FABQ is a valid and reliable measure of FAB and is measured across two subscales (FABQ-Sport and FABQ-Physical Activity (PA)), where higher scores indicate greater FAB. During this session the participants were provided a wearable accelerometer to capture all physical activity outcomes (average MVPA mins/day and daily steps/day). Participants were instructed to wear the accelerometer on the wrist for one-week, taking the unit off when showering, swimming, or sleeping. After one-week, the participants returned the accelerometer. A valid data collection period was 3 days with a minimum of 10 hours of wear per day. The dependent variables included scores on the FABQ-Sport, FABQ-PA, FABQ-Total, average MVPA mins/day, and average steps/day. Descriptive statistics were summarized (median, interquartile range) for each variable and Spearman rank correlations were used to examine the relationships between the variables. Correlation coefficients were interpreted as 0.8-1.0 (very strong), 0.6-0.8 (strong), 0.4-0.6 (moderate), 0.2-0.4 (weak), and 0.0-0.2 (no relationship). Alpha was set a-priori $p < 0.05$.

Results: Descriptive statistics for each variable can be found in Table 1. There were non-statistically significant weak correlations between steps/day and FABQ-PA ($r=0.31$, $p=0.29$), FABQ-S ($r=0.23$, $p=0.44$) and FABQ-Total ($r=0.29$, $p=0.32$). For MVPA mins/day, there was non-statistically significant weak correlation between FABQ-Sport ($r=0.37$, $p=0.23$) and non-statistically significant moderate correlation between FABQ-PA ($r=0.50$, $p=0.12$) and FABQ-Total ($r=0.53$, $p=0.09$).

Conclusions: There were no statistically significant correlations identified between FAB and objective physical activity outcome measures (MVPA mins/day, steps/day). However, the moderate, positive correlations between MVPA mins/day and FAB suggest that individuals that participate in more MVPA min/day have higher levels of FAB which should be further examined with a larger sample size. Future research should investigate additional psychological variables that may influence this relationship such as resilience and self-efficacy.

Total Word Count: 426

[207234ED](#)

The Relationship Between Lower Extremity Strength and Drive Leg Rate of Force Development in Softball Pitchers

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Context: Injuries to softball pitchers have a detrimental impact on team and individual athletic performance. Often, rehabilitation focuses on improved and balanced muscular strength before return to play. However, this may not fully prepare an athlete for the forces encountered during the windmill pitch. For optimal performance, a softball pitcher must quickly generate great ground reaction forces (GRF) during initiation of the stride phase and transfer those forces through the trunk to the pitching arm. It is important to understand if force production capacity itself translates to a pitcher's ability to develop rapid, high GRF at initiation of the windmill pitch. The purpose of this study was to determine the relationship between lower extremity and trunk muscular strength to the drive leg GRF rate of force development (RFD) during initiation of the windmill pitch.

Methods: Fourteen skilled softball pitchers (17.9±2.3 years, 166.4±8.7cm, 72.2±12.6kg) completed a baseline strength assessment consisting of bilateral concentric, isokinetic flexion and extension strength of the knee, hip and measured simultaneously on the Biodex System III isokinetic dynamometer. Time to peak torque and peak torque normalized to body weight (TQ/BW) were recorded. Each participant was allowed her normal pitching warm-up routine, and then pitched 105 total fastballs windmill pitches broken up between 15 pitches in 7 innings. Drive leg ground reaction forces were collected using a 60cm x 40cm force platform (Type 9286A, Kistler Instrument Corp., Amherst, NY) at a sampling frequency of 1500 Hz. Drive leg GRF were measured in the anterior-posterior and vertical directions for the last 5 pitches of the first and last innings. Anterior-posterior (apRFD) and vertical (vRFD) were calculated and averaged for each inning. To determine if there was a correlation present between baseline measures of strength and GRF rate of force development, a Pearson Correlation Coefficient or Spearman's Rank Correlation Coefficients were used.

Results: A statistically significant negative relationship was observed between knee extension peak TQ/BW and apRFD after the first inning ($r_s = -0.673$, $p = 0.033$). A significant negative relationship was also seen between trunk flexion time to peak torque and apRFD after the first ($r_s = -0.685$, $p = 0.029$) and seventh ($r_s = -0.721$, $p = 0.019$) innings. (Table 1)

Conclusions: This study found limited correlations between muscular strength and GRF RFD. A significant negative correlation was seen between knee extension and apRFD in the first inning. Interestingly, our results also showed a negative relationship with trunk flexion time to peak torque and apRFD. No relationship seen in this study between muscular strength and RFD may suggest that these variables respond to different magnitudes of resistance training. Clinicians should continue to focus on improving force capability under a full spectrum of load, and therefore velocity.

Total Word Count: 435

[206444QD](#)

The Relationship Between Spiritual Well-Being and Burnout Among Collegiate Athletic Trainers

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Context: Burnout is a psychological syndrome that is comprised of emotional exhaustion, decreased personal accomplishment, and depersonalization of patients. Spiritual well-being is the expression of one's spirituality as measured in the dimensions of existential and religious well-being. Smith's Cognitive Affective Model of Athletic Burnout suggests that personality factors such as spiritual well-being and use of religious coping methods may affect burnout, its causes or its outcomes. This has not been examined in collegiate athletic trainers (ATs). The purpose of this study was to investigate the relationship between spiritual well-being and burnout in collegiate ATs.

Methods: A cross-sectional study in the form of a web-based survey was utilized. Participants (n=783) were ATs working fulltime in the collegiate setting. Part-time employees (e.g. interns, graduate assistants) were excluded. Participants were 36.4 ± 11.1 years old (range 22-79 years). The survey, which consisted of items from previously used scales including the Maslach Burnout Inventory (MBI); the Spiritual Well-Being Scale; the Brief RCOPE; and substance use questions from the Monitoring the Future study, took approximately 15 minutes to complete. Following relationships outlined in Smith's Cognitive-Affective Model of Athletic Burnout, multiple regression analyses were used to interpret correlations among independent (existential well-being, religious well-being, positive and negative religious coping) and dependent variables (situational variables (salary, social support, work-family conflict), MBI burnout subscales (emotional exhaustion, depersonalization, personal accomplishment), substance use, and intention to leave the profession). Tests of mediation and/or moderation were conducted when appropriate.

Results: Existential well-being was significantly positively correlated with perceived social support ($B = .709, p < .001, 95\% CI = .588, .829$) and sense of personal accomplishment ($B = .380, p < .001, 95\% CI = .322, .438$). Existential well-being was also significantly negatively correlated with work-family conflict ($B = -.238, p < .001, 95\% CI = -.309, -.167$), emotional exhaustion ($B = -.827, p < .001, 95\% CI = -.932, -.722$), depersonalization ($B = -.328, p < .001, 95\% CI = -.383, -.272$), intention to leave the profession ($B = -.058, p < .001, 95\% CI = -.070, -.045$) and binge drinking ($B = -.023, p < .001, 95\% CI = -.033, -.013$). Existential well-being served as a mediator in three relationships: emotional exhaustion and social support, personal accomplishment and binge drinking, and emotional exhaustion and binge drinking. Existential well-being also moderated the relationship between personal accomplishment and emotional exhaustion.

Conclusions: Spiritual well-being, specifically existential well-being, serves as a protective factor against burnout as well as some of its causes and effects in collegiate ATs. Clinicians should engage in practices that enhance their own spiritual well-being in order to diminish the effects of burnout in their lives.

Total Word Count: 432

[206132ID](#)

The Reliability of an Upper-Extremity and Lower-Extremity Visuomotor Reaction Time Task

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Context: Visuomotor reaction time (VMRT) is the time required to recognize and respond to sequentially appearing visual stimuli. Faster VMRT allows an athlete to successfully respond to stimuli during sports participation, while slower VMRT has been associated with increased injury risk. Commercially available light-based systems are capable of measuring both upper and lower-extremity VMRT; however, the reliability of these assessments are not known. Therefore, the purpose of this study was to determine the reliability of an upper-extremity and lower-extremity VMRT task using a light-based trainer system.

Methods: A reliability study design was used to determine the test-retest reliability of an upper and a lower-extremity VMRT task in physically active, healthy participants with no history of injury in the last 3 months. Twenty participants (14 females/6 males: age=24.1±3.7years, height=167.6±10cm, mass=68.4±11.4kg) reported to the laboratory on two separate testing sessions separated by one-week. For both tasks, participants were instructed to extinguish a random sequence of illuminated LED discs which appeared one at a time as quickly as possible. For the lower-extremity task, the participants were placed at the base of a 180° semicircle with five targets placed every 45° around the semicircle, normalized to shank length. Participants stood on a single limb and completed three 30-second practice trials and one 1-minute test trial, bilaterally. For the upper-extremity task, participants stood in front of a grid with eight targets arranged in a rectangular pattern. Participants had a maximum of 0.8 seconds to extinguish each target before the next target was illuminated. Participants completed two 30-second practice trials and three 1-minute test trials averaged for analysis. VMRT was calculated as the time in seconds between target hits using the manufacturer's tablet-based software, where higher VMRT represented slower reaction time. The independent variable was time (T1 and T2), and the dependent variable was VMRT. Descriptive statistics were summarized for all variables (mean±standard deviation). Separate Intraclass Correlation Coefficients (ICC) with corresponding 95% confidence intervals (CIs) were calculated to determine test-retest reliability for each task. The standard error of measure (SEM) and minimal detectable change (MDC) values were determined to examine clinical applicability.

Results: The average VMRT (seconds) for each task at each testing session can be found in Table 1. The right limb lower-extremity reliability was excellent (ICC_{2,1}=0.96(95%CI:0.89-0.98), SEM=0.02, MDC=0.05s). Both the left limb (ICC_{2,1}=0.89(95%CI:0.72-0.96), SEM=0.03, MDC=0.08s) and upper-extremity task (ICC_{2,1}=0.86(95%CI:0.65-0.95), SEM=0.02s, MDC=0.03s) had good reliability.

Conclusions: Both VMRT tasks have clinically acceptable reliability in a healthy, active population. These VMRT assessments provide reliable tests for the upper and lower-extremity that can be integrated into the evaluation for a range of sport-related injuries. Future research should explore further applications of this device as an outcome measure following rehabilitation for health conditions with known VMRT deficits.

Total Word Count: 446

[206952EB](#)

The Role of Hip Strength Deficits on Dynamic Function in Those With Chronic Ankle Instability

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Context: CAI occurs in 30% of individuals after a lateral ankle sprain (LAS) and is associated with diminished HRQL and functional deficiencies. LAS Copers are individuals who have a history of previous LAS but do not experience any lingering symptoms or functional deficiencies. It is hypothesized that hip muscle weakness is a contributor to the development of CAI and diminished HRQL associated with this pathology. However, no previous research has examined the connection between hip strength and HRQL in those with a LAS history. Examining hip strength and HRQL in CAI and LAS Coper cohorts may identify targets for future interventions to improve outcomes in these patients. The primary purpose of this study was to examine differences in isometric peak hip torque and HRQL outcomes between individuals with CAI, LAS Copers and healthy controls (HC). The secondary purpose was to examine the relationship between isometric hip peak torque and HRQL in participants with CAI.

Methods: Fifty-six individuals (39 women/17 men; age=24.86±4.54 years, height=170.06±10.16 cm, mass=71.85±14.11 kg) volunteered to participate in this case-control laboratory study. Participants were classified as HC (n=25), LAS Coper (n=12) or CAI (n=19) using previously established criteria by the International Ankle Consortium. HRQL was measured using the Foot and Ankle Disability Index (FADI), Fear Avoidance Beliefs Questionnaire (FABQ), and Disabling in Physically Active (DPA). Three, 5-second maximal volume isometric contractions evaluated peak force (N) for hip extension (H-EXT) and hip abduction (H-ABD) using a handheld dynamometer. Peak force was averaged, multiplied by the moment arm (m) and normalized to body weight (kg) to derive normalized peak torque (Nm/kg). Separate Kruskal Wallance with Mann-Whitney U post-hoc tests assessed between group differences in hip strength and HRQL outcomes. Spearman Rank correlations were used to examine associations between isometric hip peak torque (H-ABD and H-EXT) and each HRQL outcome measure (FADI-ADL, FADI-Sport, DPA, FABQ) within the CAI group only.

Results: Group means and standard deviations for all primary outcomes are listed in Table 1. No between group differences were observed for H-ABD or H-EXT (Table 1). Significant between group interactions were observed for all measures of HRQL (Table 1). Mann-Whitney U post hoc analysis determined the CAI group had worse scores on all HRQL measures compared to the LAS Coper ($p<0.05$) and HC groups ($p<0.05$). Additionally, LAS Copers had worse scores on the DPA ($p=0.032$) and FABQ ($p=0.025$) compared to the HC group. H-ABD nor H-EXT were not associated with any HRQL measure ($p>0.05$).

Conclusions: Isometric hip strength deficits were not identified in individuals with CAI and did not appear to influence HRQL. Research should examine other lower extremity impairments to better understand the underlying mechanisms contributing to worse HRQL outcomes in people with CAI.

Total Word Count: 441

204913MD

The Role of Task Demands on Decision Making in Dynamic Environments

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Context: Athletes must make challenging decisions about how to act with respect to contextual conditions (e.g., a closing gap between approaching opponents) when navigating towards strategic locations in the field of play. Accurate decisions are critical to guarantee a desired balance between efficiency and risk and thus identifying factors that affect these decisions can inform the development of injury prevention programs. The objective of this study was to assess the effect of navigation demand on decision making about a dynamic gap. We hypothesized that pressure to perform would increase the number of risky decisions.

Methods: Thirty undergraduate students performed a navigation task in a virtual sports environment, during which they had to decide to pass through or around a dynamic gap created by two virtual opponents (VO) moving diagonally in their direction. The VO's speed was varied to create 7 gap sizes at the point of convergence (some passable, some not). Participants performed the task with fixed stance and steered by rotating the trunk as their position in the virtual environment changed at a constant speed. Fifteen participants were told to move to a visible waypoint after making the decision to pass or go around the gap (low demand group). The other 15 participants were told to move to the waypoint as fast as possible (high demand group). Participants completed three blocks of 56 trials, 8 per gap size, with order randomized within blocks. To assess risk taking behavior, we computed the % of trials that they decided to go through a gap that was not passable, thus resulting in collision. A mixed effect analysis was used to test the effect of Group (1: low demand vs. 2: high demand) and Block (1, 2, and 3) on this decision error metric, with significance level of 0.05.

Results: Error reduced over blocks for both groups, $F(2, 84) = 11.73, p < 0.01$, but was generally higher for the high demand group ($M = .16, SD = .16$) compared to the low demand group ($M = .09, SD = .08$), $F(1,84) = 10.052, p < .001$. Block x group interaction was not significant.

Conclusions: Results indicate that when a person is under pressure to perform (the typical case for athletes), there is a greater likelihood that they will engage in risky behavior. Though there was a general decrease in decision error over blocks, the difference in error between groups remained relatively constant and, thus, simple feedback about their errors was not sufficient to mitigate the effect of pressure on decision making. Results suggest that collision prevention strategies should include interventions specifically designed to improve perceptual awareness of dynamic contextual conditions under demanding task conditions.

Total Word Count: 439

[205284ED](#)

Tibial Tubercle Avulsion Fracture in Two Different High School Athletes

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Background: Athlete #1 is a 14-year-old male participating in Football. The athlete was playing in a game during initial injury. He went to cut and pivot when his cleat got stuck in the turf. He stated that he felt a pop and tried to stand up, was not able to ambulate and Athletic Trainer was called onto the field at this time. Upon inspection, there was an obvious deformity on his left tibial tuberosity. The athlete's leg was then straightened, shoe and sock were removed and a dorsal pedal pulse was located. Athlete was then placed in a long leg vacuum splint and transported by EMS to the emergency department. Athlete #2 is a 15-year-old male participating in Football. The athlete was playing in a game during the initial injury. He jumped up to receive a pass in the end zone, landed on his right leg, twisted and fell backwards. Athlete stated that he felt a pop in his knee, but was not in a significant amount of pain, otherwise. Athletic Trainer was called onto the field at this time, athlete was able to be removed from the field and able to be evaluated on the sideline. Upon inspection there was an obvious deformity on his right tibial tuberosity. The athlete's shoe and sock were removed, dorsal pedal pulse was located, athlete was splinted and transported by EMS on site to the emergency department.

Differential Diagnosis: Tibial Tubercle Avulsion Fracture, Displaced Tibial Plateau Fracture.

Intervention & Treatment: Athlete #1 underwent open reduction with internal fixation of left tibial tubercle fracture. Surgeon performed a reduction maneuver intraoperatively, used fluoroscopy in AP and lateral planes to confirm reduction. Once anatomic reduction was achieved, two, 4.5mm partially threaded screws were placed in an anterior to posterior fashion to fixate the fracture. Athlete #2 underwent open reduction with internal fixation of right tibial tubercle avulsion fracture. The operative note stated that there was an extension of the fracture involving the lateral tibial plateau. Tibial tubercle fracture site was clamped and held in fixation by pointed reduction clamps and kirschner wires. Intraoperative fluoroscopic imaging was obtained in the AP, lateral and oblique views to ensure wire did not cross the proximal tibial physis. Once reduction was confirmed, three, 4.0 cannulated screws were placed in an anterior to posterior fashion to fixate the fracture.

Uniqueness: Tibial tubercle avulsion fractures are an uncommon injury occurring due to strong contraction of the quadriceps femoris muscle during leg extension, ultimately causing failure of the physis at the patellar tendon insertion (Agarwalla et al. 1). This particular injury has a reported incidence ranging from 0.4% to 2.7% (Frey et al. 470). Although uncommon, tibial tubercle avulsion fractures are clinically important injuries that, with early recognition and proper treatment, give good results. It is imperative for first responders and clinicians to recognize that compartment syndrome remains a significant concern post-injury and does require hospitalization with close monitoring and timely intervention.

Conclusions: Athlete #1 and Athlete #2 were both transported to a Level 1 Trauma Center, admitted overnight for observation, and scheduled for surgery the next morning. Athlete #1 is 9 weeks post op, full weight bearing and continuing outside physical therapy. Athlete #2 is 2 weeks post op, NWB and will have his first follow up with ortho this week.

Total Word Count: 540

209105ND

Toe Out Angle During Squatting is Associated With Lower Extremity Structural Alignment

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Context: Squatting is often used to rehabilitate lower extremity injury and is typically performed with the foot in transverse plane neutral. This foot alignment may not be appropriate for all individuals. The purpose of this study was to assess the potential individual and combined influence of passive hip internal rotation (HIR), thigh foot angle (TFA), weight-bearing dorsiflexion, and longitudinal arch angle (LAA) on toe-out angle (TOA) during a static stance, forward arm squat, and barbell back squat. We hypothesized that lesser HIR, greater TFA (external tibial torsion), lesser dorsiflexion, and lesser LAA would contribute to a greater TOA.

Methods: Thirty-seven college-age participants (18 females: 23.5±2.15yrs, 1.65±0.05m, 60.7±6.39kg; 19 males: 22.84±2.06yrs, 1.75±0.05m, 80.38±11.26kg) with no significant history of lower extremity injury participated in the study. Each participant scored a seven or greater on the Tegner activity scale and reported previous experience with squatting tasks. The following measurements were taken for each participant using standardized clinical methods: passive HIR, TFA, LAA, weight-bearing dorsiflexion, and TOA and stance width during static stance, forward arm squat, and barbell back squat. Measures were obtained with ImageJ software and analyzed offline. Multiple regression models were calculated to predict TOA for each activity from HIR, TFA, weight-bearing dorsiflexion, and LAA. Models of best fit were determined using R2 and Mallow's Cp.

Results: On average, participants exhibited a positive TOA (i.e. feet turned outward) in all activities. Average TOA and stance width increased from standing (9.6±5.0° and 19.9±4.5cm) to forward arm squat (14.7→+6.6° and 32.9±6.9cm) to barbell back squat (17.6±7.1° and 38.2→+7.4cm). During static stance, greater HIR was associated with lesser TOA, explaining 15% of the variance. During the forward arm squat, greater HIR was associated with lesser TOA, while greater TFA was associated with greater TOA and together explained 25% of the variance associated with TOA. During the barbell back squat, greater HIR and LAA were associated with lesser TOA, while greater TFA was associated with greater TOA and altogether explained 43% of the variance in TOA. Weight-bearing dorsiflexion was not included in any of the models.

Conclusions: HIR was the strongest stand-alone structural predictor of TOA for each activity, while TFA explained additional variance in TOA during forward arm and barbell back squats. LAA was only associated with TOA during the barbell back squat. Weight-bearing dorsiflexion does not appear to be related to TOA for static or dynamic activities. A positive TOA was widely preferred to a neutral transverse plane foot alignment, and this appeared to be influenced by the structural characteristics of passive HIR and TFA. Allowing patients to squat using a self-selected toe-out angle may be more appropriate than emphasizing neutral foot alignment.

Total Word Count: 435

207143FA

Torque Complexity of Maximal Knee Extensor Isometric Contraction in Individuals Following ACL Reconstruction

Bodkin, SG; Dooley, EA; Russel, SD; Hart, JM:

Context: Current rehabilitation goals following anterior cruciate ligament reconstruction (ACLR) are structured around the maximal force generating capabilities of the muscle and not necessarily the quality of the muscle contraction. Force fluctuations, an observable unsteadiness of motor output, have been observed in patients following ACLR. Quantifying force fluctuations through Approximate Entropy (ApEn) can describe the complexity of torque production to reflect the functional capacity of the neuromuscular system which would provide clinicians greater insight into the post-operative muscular recovery following ACLR. The purpose of this study was to assess the torque complexity of a sustained maximal voluntary quadriceps' contraction in relationship to clinical measures of strength, fatigue, and patient reported outcomes.

Methods: We collected data from 120 patients (65 Female, 21.0±8.3 years, 171.8±11.0 cm, 73.7±17.5 kg) during routine testing at approximately 6 months (5.96±0.48-mo.) post-primary, unilateral, uncomplicated ACLR. Patients completed the Knee Osteoarthritis Outcome Score (KOOS) subscales to quantify subjective function. Patients completed a 30-second knee extensor maximal voluntary isometric contraction (MVIC). Measures of Peak Torque and %Fatigue were extracted from the trial. The 30-second task was stratified into three 10-second bins, where the 3-seconds of lowest variation were used to calculate ApEn to quantify torque complexity for the Early (ApEn1), Middle (ApEn2), and Late (ApEn3) time bins. Torque complexity was compared across the trial within subjects using a repeated measures general linear model. Pearson's r correlations were performed between torque complexity to peak torque, %Fatigue, and subjective function. An a priori alpha was set at 0.05.

Results: Torque complexity was found to decrease throughout the 30-second trial ($P < .001$). Torque complexity at the end of the trial (ApEn3) was found to be negatively correlated with Peak Torque ($r = -.29$, $P = .004$) (Figure 1) and torque complexity at the beginning of the trial (ApEn1) was found to be negatively correlated with the %Fatigue ($r = -.23$, $P = .03$). Torque complexity at the end of the trial (ApEn3) was negatively related to the KOOS pain subscale ($r = -.21$, $P = .03$) and the KOOS sport subscale ($r = -.25$, $P = .01$).

Conclusions: A greater torque complexity in individuals following ACLR was related to lower quadriceps strength, lower subjective function, and quadriceps fatigue resistance. Torque complexity was also found to decrease throughout the 30-second MVIC trial. Force fluctuations during a maximal voluntary isometric contraction may provide clinical signs of quadriceps muscle function during the time of return to sport decision making.

Total Word Count: 382

205303FD

Trail Running Surface Does Not Affect Vertical Tibial Acceleration

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Context: Vertical tibial acceleration is associated with overuse running-related injuries, specifically tibial stress fractures. Greater peak tibial acceleration is associated with harder running surfaces, such as concrete. The purpose of this study was to investigate the differences in peak vertical tibial acceleration (PVTA), peak vertical head acceleration (PVHA), and acceleration attenuation (ATTEN) while running on dirt, gravel, and pavement surfaces. It was hypothesized the hardness of pavement will elicit greater PVTA and ATTEN than dirt and gravel surfaces.

Methods: This was a repeated measures study where participants ran on three surface types (dirt, gravel, and pavement) on a public trail. Fourteen healthy, adults who participated in distance running were recruited for the study (male=2, female=12, age=27.9±9.4 years, mass=64.9±13.0 kg, height=1.65±0.58 m). Participants ran in a standard shoe (Saucony Jazz) were instrumented with triaxial accelerometers on the forehead and bilateral medial distal tibias. Participants completed three, 30 m runs over pavement to determine self-selected running speed. To compare the effects of surface on PVTA and PVHA, participants ran over dirt, gravel, and pavement trails in the same environment. Participants were provided a 10 m run-up to reach self-selected running speed and then maintained the speed for 30 m. Trials were repeated until four runs on each surface were within ±5% of the self-selected running speed. Trials with running speeds greater than ±5% different from the self-selected running speed were excluded from analysis. To account for accelerating or decelerating, the first and last five steps were excluded for analysis. Left and right PVTAs were extracted separately and were not statistically different; therefore, the sides were averaged together for analysis. ATTEN was calculated by subtracting PVHA from the PVTA. One-way ANOVAs were performed to compare PVTA, PVHA, and ATTEN among the three running surfaces ($p \leq 0.05$).

Results: No significant differences were found among running surfaces for average PVTA (pavement=8.06±2.20 g, dirt=8.08±2.42 g, gravel=8.40±2.52 g, $p=0.916$), PVHA (pavement=2.17±0.36 g, dirt=2.09±0.33 g, gravel=2.13±0.32 g, $p=0.842$) or ATTEN (pavement=5.90±2.08 g, dirt=5.99±2.21 g, gravel=6.26±2.35 g, $p=0.901$).

Conclusions: Contrary to the hypotheses, there were no differences between average PVTA or ATTEN when running on different surfaces. Previous research reported that running on a grass surface reduced PVTA compared to pavement, but only when running at a speed slower than a runner's typical self-selected speed². Runners adjust leg stiffness within their first step on a new running surface³. It is possible individuals alter their running patterns in order to attenuate forces dependent on the surface⁴, though this may only be true during an unfatigued state⁵. While further study on trail running injury risk is necessary, the current study indicates trail running does not reduce PVTA, a measure associated with overuse running-related injuries.

Total Word Count: 438

206324ED

Transversus Abdominis Muscle Contractility Deficits of Individuals With Chronic Ankle Instability

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Context: Hip and trunk neuromuscular impairments are thought to perpetuate CAI through reduced lumbopelvic stability and resultant malpositioning of the lower body. However, no studies have compared lumbopelvic stability between individuals with and without CAI. While lumbopelvic stability is partially controlled by trunk musculature, morphological alterations of lumbar stabilizers have not been compared between these populations. Therefore, the purpose of this study was to compare lumbopelvic endurance and trunk muscle contractility between individuals with and without CAI and to examine relationships between these outcomes and self-reported function.

Methods: We separated 30 participants into CAI (F:5, M:5, 24.5±4.5yrs, 168.6±9.8cm, 81.5±19.1kg), COP (F:5, M:5, 23.0±3.0yrs, 173.0±6.5cm, 76.0±13.4kg), and CON (F:8, M:2, 23.2±3.3yrs, 166.6±6.1cm, 68.7±16.3kg) groups, based on criteria published by the International Ankle Consortium. In a single laboratory visit, we first conducted tests of transversus abdominis (TrA) and lumbar multifidus (LM) contractility via diagnostic ultrasound. Each muscle's thickness was averaged during 3 relaxed and 3 contracted trials. Contractility of each muscle was calculated as the percent increase in contraction thickness from rested to contracted conditions. Participants' lumbopelvic endurance was measured during single trials of the following tests conducted in random order: unilateral hip bridge, trunk flexion endurance, Beiring-Sorensen, and side plank. Lumbopelvic endurance scores were measured in seconds. Participants' self-reported function was measured via Foot and Ankle Ability Measure ADL (FAAM-ADL) and sport (FAAM-S) subscales. Separate one-way ANOVAs and Tukey post-hoc tests compared muscle contractility, lumbopelvic stability, and self-reported function between groups. Cohen's d effect sizes examined the magnitude of significant pairwise differences. Pearson product moment correlations analyzed associations between self-reported function and muscle contractility and lumbopelvic endurance. Significance was set at $P < 0.05$.

Results: COP had significantly higher TrA contractility compared to CAI (114.0 ± 37.6 vs 32.6 ± 17.9 , $P < 0.01$, $d = 2.65 [1.45, 3.85]$) and CON (114.0 ± 37.6 vs 67.4 ± 50.2 , $P = 0.03$, $d = 1.05 [0.08, 1.94]$). Although CAI and CON did not significantly differ, a large effect size suggests that CAI had lower TrA contractility ($P = 0.12$, $d = 0.92 [-0.03, 1.80]$). A significant group main effect was present for the unilateral hip bridge ($P = 0.04$), but there were no significant pairwise comparisons. No group differences existed for LM contractility or any other lumbopelvic stability test. Across all groups, Beiring-Sorensen scores were weakly correlated with TrA contractility ($r = 0.40$, $P = 0.03$) and FAAM-ADL score ($r = 0.37$, $P = 0.04$).

Conclusions: Individuals with CAI appear to have deficits in TrA contractility, which might arise as a result of CNS reorganization following ankle sprains. While the TrA is important for lumbopelvic stability, contractility was not influential to performance on the lumbopelvic endurance tests used in this study. Deficits in TrA contractility are potentially relevant to neuromuscular control of individuals with CAI and might need to be addressed on an individual basis.

Total Word Count: 431

206802ED

Traumatic Intramuscular Hematoma of the Vastus Medialis Oblique and Vastus Intermedius in a High School Softball Player

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Background: A 17-year-old (65kg, 165.1cm) Caucasian female high school softball player (second baseman) presented to the ATC with a mild effusion of her right knee. She reported during the game two-days prior that she attempted to stop another player from sliding into second base, and when the opposing player slid, she was kned in her right medial thigh and knee. She was able to continue to participate in the game. Discoloration was noted on the medial thigh and superior knee. Limited ROM with active knee flexion was apparent, and pain was noted with knee extension strength testing. The Certified Athletic Trainer's (ATC) examination revealed unremarkable indications of ligamentous laxity or meniscal pathology. Due to the presence of effusion, the athlete was referred by the ATC for further evaluation and diagnostic testing.

Differential Diagnosis: Medial thigh compartment syndrome, quadriceps contusion, quadriceps hematoma

Intervention & Treatment: The patient was evaluated by the physician three-days post-injury. The patient had visible soft tissue swelling of the vastus medialis oblique and diffuse tenderness to palpation along the medial joint line at anteromedial aspect of the knee. She had pain with active knee flexion noted at 90°, with passive knee flexion measured at 110°. Appreciable pain with resisted knee extension was also recognized. Full hip and ankle ROM was present, the neurovascular exam was unremarkable. All knee special testing was negative, and radiographs revealed no fracture, but mild soft tissue swelling of the inner thigh. At this time, the patient was diagnosed with a hematoma, placed partial weight-bearing on crutches with a compression sleeve, given anti-inflammatories, and told to begin ROM exercises with the ATC. Approximately 10 days post-injury, the follow-up evaluation revealed swelling but no pain with palpation. Her passive knee flexion improved to 125°, but active was limited to 90°. Mild quadriceps weakness was noted with pain in both extension and flexion. A diagnostic ultrasound was performed, revealing a 7cm x 3cm hematoma of the vastus medialis oblique and vastus intermedius muscles. The patient was instructed to weight-bear as tolerated, and continue with compression, exercises, and anti-inflammatories. At 17 days post-injury the patient had limited improvement, and further treatment options were discussed. An MRI of the femur was ordered to further define the hematoma (5.7 x 2.7 x 12.0cm), and the physician recommended aspiration. A total of 70 milliliters of fluid was collected from the vastus medialis oblique, as well as the medial margin of the vastus intermedius. After aspiration the patient was braced in 90° of knee flexion to allow healing of the muscle, continued rehabilitation with the ATC, and fully returned to sport 38 days post-injury.

Uniqueness: Blunt trauma to the thigh can lead to compartment syndrome which if left untreated can lead to muscle ischemia and death of the tissue. The literature suggests compartment syndrome of the thigh is often unrecognized due to the large size of the compartment and delayed presentation of symptoms. For this case specifically, if her symptoms were not followed closely, her hematoma could have progressed into compartment syndrome. Therefore, aspiration of the fluid was warranted. A case report found in the literature indicated evacuation of the fluid was warranted for hematomas with increased size, as even without neurological symptoms, the aspiration can decrease pressure and increase ROM.

Conclusions: A hematoma from blunt force trauma with lingering symptoms can progress to compartment syndrome and possibly tissue death. This Level IV case was a success, as the ATCs and physician worked collaboratively to monitor the patient's symptoms and progress throughout the initial phase of injury. This collaboration resulted in successful treatment of the hematoma and positive outcome for the patient.

Total Word Count: 594

[206492ED](#)

Traumatic Patellar Fracture in an Adolescent Football Player Following MPFL Reconstruction: A Case Study

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Background: Patellar dislocation with recurrent dislocation commonly affects young patients and can lead to significant disability, both in sport and daily activities. Recurrence rates following a first-time dislocation can be up to 60%, with 90% of these dislocations causing damage to the medial patellofemoral ligament (MPFL). Several surgical techniques have been reported as a course of treatment following failed conservative rehabilitation, including MPFL reconstruction involving patellar tunnels to secure an autogenous tendon graft. Complications associated with surgical intervention include persistent instability, restricted knee flexion and patellar fracture. The purpose of this Level 3 case study is to present and discuss the management of a 17-year-old offensive lineman who suffered a traumatic patellar fracture 10 months following MPFL reconstruction.

Patient: While playing offensive line during preseason practice and stepping back into his blocking position, a 17-year-old (190.5cm, 114kg) male, with a previous history of right patellar dislocation one year prior, felt his right knee cap slide out of place and immediately relocate. Following the second dislocation, the patient and his family decided to delay surgical intervention so he could participate. He successfully participated with the use of a brace during the season, then 3 months later underwent surgical reconstruction of his MPFL using a semitendinosus allograft with patellar tunnels. Four months post-surgery, the patient was cleared for full participation in all football activities as long as he was able to manage any reactive effusion. During preseason football the following season, he had one complaint of patellar pain following a direct hit to his involved patella. He had a mild joint effusion which resolved within 3 days with the use of GameReady and a compression sleeve. Over the next 4 weeks, the patient reported no complaints. However, he did exhibit mild joint effusions following games, all which resolved within 2 days following competition. One month later and 10 months after reconstruction surgery, the patient was blocking during a game when an opponent landed on the anterior aspect of his knee. He was unsure what happened but was able to bear weight through his affected limb. The ATC's knee evaluation revealed significant effusion, mild diffuse anterior knee tenderness upon palpation, limited knee flexion, yet full quadriceps strength and no laxity appreciated with ligamentous testing. X-ray revealed a displaced proximal transverse patellar fracture, likely through the site of previous MPFL reconstruction.

Intervention & Treatment: The patient underwent open reduction internal fixation using 4.0mm screws. The surgeon noted evidence of healing by the presence of fibrocartilaginous callus formation, indicating the fracture had been present prior to traumatic displacement. Following surgery, the patient was placed in a knee brace, locked in extension, and crutches.

Outcomes or Other Comparisons: A complication rate of 8-26% has been reported following MPFL reconstruction. Common complications include recurrent instability, patellofemoral pain and restricted knee flexion; however, patellar fracture has been reported in a number of cases. This case is unique because of the evidence of healing present during surgery. The patient most likely fractured at the site of the previous surgical tunnel during preseason but was still able to participate until the fracture worsened and displaced approximately one month later.

Conclusions: Patellar fracture occurs in approximately 3% of patients following MPFL surgery. Other complications can occur following MPFL reconstruction including recurrent instability, patellar pain and limited knee flexion.

Clinical Bottom Line: Although uncommon, it is important to be aware of the complications associated with MPFL reconstruction. Due to the high complication rate, it is critical for referral by the ATC if the patient complains of pain or other symptoms, especially in contact sports, where traumatic fracture is most likely to occur.

Total Word Count: 587

200111GD

Traumatic Thoracic Injury in a Ninja/Parkour Athlete: A Level 4 Rare Events Case Study

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Background: The patient was a 14-year-old male that sustained rib fractures with associated displacement on his left side (ribs 4-6), as well as a pulmonary contusion to the superior left lung. The patient was participating in an outdoor ninja course when he sustained the injury. He was jumping from varying levels of wooden pegs in the ground when he slipped and landed on his left side on the following peg. The patient immediately laid on his right side in a fetal position with labored breathing. Since the course was isolated from where the primary medical staff was located and inaccessible by cart or other mode of transportation, response time was approximately five minutes in which time the coach worked on calming the patient down. His coach mentioned it seemed like the patient had the breath “knocked out” of him. There was no obvious deformity on the left side and the only noticeable difference was a small abrasion and bruising forming on his left side distal to the arm pit. Lung sounds were normal and patient was not in respiratory distress, but he was unable to fully inhale and exhale. Vital signs were within normal limits throughout the examination, although at times he presented with tachypnea, as a result of being stressed out and emotional from the injury. The patient complained of a clicking feeling while breathing. An anterior/posterior compression was positive for pain. He was transferred to a local urgent care for further examination.

Differential Diagnosis: Lung contusion, rib fracture, contused ribs, costochondral sprain, and rib dislocation.

Intervention & Treatment: X-rays found rib fractures with displacement on his left side (ribs 4-6), as well as a pulmonary contusion to the superior left lung. He was then transferred to a local hospital that later transferred him by ambulance to a higher-level trauma center. He was given an incentive spirometer and asked to breathe in as best as he could each hour to help prevent pneumonia and further lung problems. His first few tries he measured approximately 500ml; the goal was to reach 1,000ml. The patient was monitored and discharged 72 hours later. The patient was given opioids for the pain and muscle relaxant medication. He was instructed to do activity as tolerated and continue using the incentive spirometer with a new goal of 2,000ml. Lastly, he was told to follow up with a primary care physician back home. He had no further implications and was cleared for return to activity after 6 weeks

Uniqueness: This case is unique because of the injury that was sustained as well as the sport being played at the time. Displaced ribs and/or pulmonary contusions are not very common in the sports world and little is documented about said injuries. Rib fractures are not common in children because their bones have yet to fully ossify. There have been four reported cases of pulmonary contusions for athletes- three football players and a diver. Ninja/parkour has minimal documentation of injuries since the sport is just starting to become popular and likely lacks consistent health coverage. A retrospective analysis of patients with blunt thoracic trauma found that thirty-nine (7.6%) of the 515 patients had trauma to the chest because of a fall.

Conclusions: Thoracic injury in children deserves special attention because, although it accounts for less than 10% of traumatic injuries in children, there is risk of death. Ninja and Parkour have become increasingly popular and athletic trainers should be aware of potential traumatic injuries. Interprofessional healthcare communication is a crucial component to reduce the incidence of negative transitions in the care of the injured athlete, which could complicate the care timeline and patient outcome.

Total Word Count: 598

204775ED

Treatment of a Collegiate Soccer Player Following Multi-Compartment Fasciotomies With Dry Needling: A Case Report

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Background: A 19-year-old female collegiate soccer player reported to the athletic training staff during physical examinations with bilateral multi-compartment fasciotomies for the treatment of exertional compartment syndrome in the lower legs. The patient stated that the fasciotomies had been performed over the course of the past two years, with the most recent taking place eight months prior to physical examinations. The patient reported that while her neurological and pressure symptoms had been alleviated by surgery, she still felt tightness and decreased range of motion in her ankles. Following clearance from her surgeon, the patient underwent treatment utilizing foam rolling, cupping, and instrument assisted soft tissue mobilization, but only received temporary relief.

Differential Diagnosis: Bilateral multi-compartment fasciotomies for the treatment of exertional compartment syndrome in the lower legs.

Intervention & Treatment: Throughout the patient's season, therapy sessions consisted of therapeutic exercises focusing on eccentric strengthening and improving range of motion of the subtalar and talocrural joints, along with cupping, instrument assisted soft tissue mobilization, and contrast bath. After a thorough explanation, the patient signed an informed consent document and began undergoing treatment. During her first dry needling session, one inch monofilament needles were inserted in the proximal aspect of the left anterior tibialis two inches apart. Alligator clips and a portable TENS unit were then used to apply motor TENS for five minutes. The most proximal needle was then removed and new needle was inserted two inches distal to the remaining needle. Following positive outcomes from the first two treatments, dry needling was incorporated into her treatment. With the new needle placed, the TENS treatment was repeated. After treatment, the patient noted that her left anterior compartment fasciotomy scar was causing restrictions to her movement. A two inch monofilament needle was used with a pistoning technique in an attempt to disrupt the scar tissue. At this time, the patient reported feeling an increase in perceived ankle range of motion with only minimal soreness at the needling sites. Two days after her first dry needling treatment, the patient underwent dry needling on her left triceps surae complex. Two inch needles were placed in the muscle bellies of the medial and lateral heads of the gastrocnemius, and a one inch needle was inserted into the musculotendinous junction of the gastrocnemius. Motor TENS was applied to each head of the gastroc with the circuit being completed using the distal needle for five minutes at each site. Following treatment, the patient performed a self-assessment using a BAPS board, and reported further improvements in stiffness and sensation of movement restriction. At this time, the patient began being dry needled once a week at the sites where the patient felt the most restriction. Throughout the remainder of the season, the patient experienced decreased soreness, fatigue and muscle stiffness following physical activity. Ultimately, the patient cited the magnitude of her symptom improvement as the reason for her preference for dry needling as her primary treatment.

Uniqueness: To the authors' knowledge, no previous studies have detailed the use of dry needling in the treatment of patients recovering from fasciotomies. The short amount of time needed to reduce the patient's symptoms may also be a noteworthy finding as many treatment techniques require several administrations before yielding results.

Conclusions: When caring for patients, it is paramount that the clinician explore all possible treatment options. Dry needling appears to be a safe and effective alternative treatment tool when treating an indicated condition. Prior to using dry needling, it is the responsibility of the clinician to review their state practice to determine their ability to perform dry needling.

Total Word Count: 587

[207902DD](#)

Two-stage Revision Anterior Cruciate Ligament Reconstruction in a Professional Football Player

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Background: Revision rates after primary ACL reconstruction (ACLR) vary between 1.5% and 10%. Surgeons have to choose whether to perform single-stage or two-stage revision ACL. The indications for two-stage revision are tunnel widening, loss of bone stock, and concomitant pathology. A level IV systematic review compared outcomes and failure rates of single-stage and two-stage ACL revisions. Findings of the review suggested that two-staged surgery has comparable clinical outcomes and lower re-revision rates compared to single-staged revision. This level 1 CASE report describes an elite football player who underwent a two-staged ACL revision with a 26-month follow-up. The case validates the findings of the currently reported outcomes.

Patient: 25-year-old male professional wide receiver, presented with acute right knee pain and instability 16-months status-post ACLR with ipsilateral bone-tendon-bone patellar autograft. Mechanism was described as a non-contact injury. Upon physical exam the patient had mild knee effusion, decreased ROM, positive Lachman's, and pivot shift tests. MRI revealed a proximal full-thickness tear of the ACL graft. CT scan revealed enlarged tibial tunnel from previous ACLR.

Intervention & Treatment: Patient consented to surgical intervention for treatment of the recurrent ACL tear. Intra-operative measurements of tibial and femoral tunnels taken during the first stage of the procedure, determined a two-stage revision was needed due to enlargement of the tibial tunnel. During the first-stage, previous hardware was removed and both tunnels were bone grafted using demineralized bone matrix and cancellous allograft bone chips. The second stage of the revision was performed 4 months later. Diagnostic arthroscopy of the right knee examined the sites of tunnel bone graft, which healed adequately. Bone-tendon-bone patellar autograft was harvested from the contralateral knee and the revision ACL was performed. After surgery the patient was placed in a knee immobilizer, restricted to toe-touch weight-bearing, and began rehabilitation. At 8-months later, the patient presented with acute right knee effusion due to new pathologies. MRI revealed a new oblique tear of the posterior horn of the lateral meniscus, and a full-thickness chondral defect on lateral femoral condyle. Patient was treated with right knee aspiration, viscosupplementation and corticosteroid injection initially, and with additional viscosupplementation and platelet-rich plasma 3 months later.

Outcomes or Other Comparisons: Physical examination 11-months revealed postoperatively negative Lachman's and pivot shift tests, indicating no clinical failure. At 26-months postop he had returned to unrestricted participation in football and had no further setbacks. The outcomes of the present case compare to that of the systematic review by Mathew et al. in that he is back to full play with no clinical instability. Revision rates at 2yr follow-up for two-stage ACL revisions were 3.1% compared to 6.8% in single-stage. Clinical failure rates were 5.1% in the two-stage patients compared to 13.8% in single-stage patients.

Conclusions: A challenge with this patient was that performing a two-stage revision ACL delayed recovery by 4 months compared to the time period of a single-stage revision. Professional football players that miss playing may have contract and salary consequences. Given the favorable outcomes shown in literature, the pros may outweigh the cons due to the long-term outcomes showing decrease in revision rates and better clinical outcomes with two-stage ACL revisions.

Clinical Bottom Line: Patients who undergo two-stage revision ACL have longer recoveries compared to single-stage, however, elite level athletes can return to high levels of sport participation with minimal risk of recurrence. This case provides clinical application of the findings from literature comparing clinical failure and revision rates in single-stage and two-stage revisions.

Total Word Count: 559

[207953JA](#)

Ultrasonographic Assessment of Acute Talar Cartilage Deformation Following Static and Dynamic Loading in Those With and Without Chronic Ankle Instability

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Context: The condition of chronic ankle instability (CAI) demonstrates early deleterious changes in cartilage composition, which may influence cartilage behavior in response to mechanical loads. Ultrasonography (US) has emerged as an alternative to magnetic resonance imaging (MRI) to assess cartilage thickness and deformation at the knee joint, but it is unknown if US is sensitive enough to detect talar cartilage deformation and behavior following acute loading in individuals with and without CAI. Therefore, the purpose of this study was to determine if talar cartilage deformation measured via US following standardized standing and hopping loading protocols differs between those with CAI and healthy controls.

Methods: Thirty CAI (11M, 19F; 21±2 years, 1.7±0.7m, 75.7±16.2kg) and thirty uninjured controls (7M, 23F; 20±4 years, 1.7±0.9m, 65.9±13.1kg) volunteered to participate. Inclusion criteria followed International Ankle Consortium guidelines. After a 60-minute off-loading period, US images of the talar cartilage were acquired using the Phillips Lumify tablet-based ultrasound unit with a 12-MHz linear probe before and after static (2-minute single-leg standing with approximately 45° of knee flexion) and dynamic (60 single-leg forward hops over 60cm distance) loading conditions on different days separated by at least 1 week. During the US assessment, participants were positioned supine with their knee at 90° of flexion and their ankle in a foot flat position. The US probe was placed transversely in line with the medial and lateral malleolus and rotated to maximize reflection of the articular cartilage surface. Talar cartilage images were manually segmented using ImageJ software to identify the medial, lateral, and overall cross-sectional area (mm²). The area was then normalized to the length of the cartilage-bone interface to obtain an average thickness (mm). Separate 2-way RMANOVAs were used to compare cartilage deformation between the groups and conditions. Weight differed between groups and was a covariate in all analyses. Minimal detectable change (MDC) scores were calculated using a control period at the end (last 15-minutes) of unloading.

Results: For the dynamic loading condition, those with CAI had greater deformation in the medial (CAI:-0.050±0.054 vs Control:-0.017±0.036, p=0.043) and overall (CAI:-0.050±0.054 vs Control:-0.018±0.021, p=0.038) talar cartilage. This difference exceeded the MDC. Lateral (p=0.031) cartilage deformed similarly between groups. For the static loading protocol, those with CAI had greater deformation in the medial (CAI:-0.066±0.046 vs Control:-0.031±0.043, p=0.006) and overall (CAI:-0.054±0.038 vs Control:-0.033±0.032, p=0.032) and talar cartilage. This difference also exceeded the calculated MDC. No effects were observed for the lateral talar cartilage (p>0.05).

Conclusions: A greater magnitude of talar cartilage deformation occurred following static and dynamic loading in those with CAI compared to healthy individuals. US is capable of detecting differences in cartilage behavior between those with CAI and uninjured controls following standardized physiologic loads.

Total Word Count: 438

[205393BD](#)

Upper Body Strength-Endurance and Power Norms in Healthy Collegiate Dancers: A 10-year Prospective Study

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Context: Dance is physically demanding and requires dancers to have adequate upper body, core, and lower body fitness to perform successfully. Researchers note that 50-85% of dancers suffer injury during a performance season. While a large number of dancer's injuries are to the lower body, several dance genres (e.g. modern, hip hop, salsa) utilize upper body (UB) motions such as partner lifts and holds, which result in higher risk for UB injury. Athletic Trainers (ATs) often use baseline physical performance normative values to determine their patients' fitness levels and when planning training programs to prevent or rehabilitate injury. While ATs working with performing artists and dancers can use baseline norms that exist for lower body fitness in collegiate dancers, little information exists regarding UB fitness norms among collegiate dancers. Thus, our purpose was to determine UB strength-endurance and power norms in collegiate dancers.

Methods: We recorded UB muscular fitness in 214 healthy collegiate dancers (males:n=26 females:n=188, 164.7+7.2cm, 60.9+8.2kg) prospectively over a 10-year period (2008-2018) in a dance program that emphasizes modern and ballet dance . For UB strength-endurance, we recorded the number of push-ups a dancer was able to perform without forcibly straining or losing form for 2 consecutive repetitions. For UB power, dancers sat with legs outstretched, backs flat against a wall, and threw a 3-kg ball horizontally from their chest as far as possible (distance thrown normalized to body height, %Body Height-BH). The best attempt of 3 trials was used for statistical analyses. We calculated descriptive statistics, percentiles, and inter-quartile ranges (IQRs) for both outcome measures.

Results: Dancers performed 20.4+10.6 (Range:2-70, IQR:12-24) push-ups and threw the medicine ball 1.8+.5%BH (Range:.45-3.9, IQR:1.4-2.1).

Conclusions: Overall, dancers' UB muscular fitness is lower than previous reports among traditional athletes. These observations are understandable given the differing demands of dance compared to other sports. Dancers' UB fitness levels may not necessarily be problematic, as our dancers were all healthy collegiate-level dancers. Rather, our findings reinforce the need to develop dance-specific norms so that AT practitioners can use these values to assess dancers' UB fitness and devise interventions appropriately. Our findings provide baseline UB muscular fitness norms among collegiate modern and ballet dancers. Future researchers should similarly develop norms across different dance genres, for pre-professional and professional dancers, and also examine whether these norms can predict dancers' injury risk or performance.

Total Word Count: 383

[209633GA](#)

Upper Extremity Muscle Activation and Perceived Fatigue During Simulated Baseball Game Pitching

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Context: Ulnar collateral ligament (UCL) injuries remain increasingly common among collegiate baseball pitchers. The torque experienced by the medial elbow during pitching far exceeds what the UCL can withstand on its own. This highlights the functional importance of the wrist flexor-pronator mass and biceps brachii musculature surrounding the joint, which are considered to provide additional stabilization to the medial elbow by minimizing valgus stress during dynamic movements. However, there is limited evidence with respect to the change in activation of these muscles during a simulated baseball game when fatigue develops, which may decrease performance and increase risk of elbow injury. Therefore, our objectives were to assess the change in muscle activation of the wrist flexor-pronator muscles and biceps brachii, pitch velocity as a measure of performance, and perceived fatigue during simulated baseball game pitching.

Methods: Nine healthy currently active, or previously experienced baseball pitchers (age: 21.1 ± 1.3 years, height: 183.8 ± 9.3 cm, mass: 81.1 ± 11.7 kg) volunteered. Those with current upper extremity injury or with a history of surgery to the throwing elbow or shoulder were excluded. Independent variable included inning. Each participant performed 15 pitches per inning with 10 minutes of rest between innings up to 120 pitches, unless the participant decided to discontinue. We recorded activation of the flexor carpi ulnaris (FCU), flexor carpi radialis (FCR) and biceps brachii muscles of the pitching arm using wireless surface EMG. We recorded fast-ball velocities, and self-reported fatigue using visual analog scale in the end of each inning. EMG values were normalized to the maximum voluntary isometric contraction (%MVIC) EMG for each muscle and averaged in each inning for statistical analysis. Repeated measures ANOVA was used to compare mean EMG amplitude, pitch velocity, and perceived fatigue from the first to eighth inning.

Results: Pitch velocity (mean: 42.4 ± 7.7 mph), and EMG activity of the FCU (mean: $100.9 \pm 107.4\%$) and FCR (mean: $65.8 \pm 41.1\%$) did not differ by inning ($p > 0.05$). Biceps brachii EMG activity decreased from the second to sixth inning ($16.6 \pm 14.0\%$ vs. $13.4 \pm 13.0\%$, $p=0.02$), and second to seventh inning ($16.6 \pm 14.0\%$ vs. $8.4 \pm 6.7\%$, $p=0.04$). Perceived fatigue increased from the second to eighth inning (1.3 ± 0.5 cm vs. 6.2 ± 2.1 cm, $p < 0.05$).

Conclusions: Flexor-pronator muscle activation remained unchanged, while biceps brachii muscle activation decreased during simulated baseball game pitching. Constant activation of the flexor-pronator muscles might be responsible for maintaining stability to the medial elbow during baseball pitching. Increased perception of fatigue might be associated more with decreased activation of the biceps brachii muscle than flexor-pronator muscle activation. While decreased biceps brachii activation may result in compensatory activation of other muscles to maintain pitch velocity, our findings suggests fatigue in baseball pitchers does not pose a threat to flexor-pronator muscle activation.

Total Word Count: 440

[206363GD](#)

Using A Pre-Season Movement Examination to Analyze Scapular Movement Patterns in NCAA Division I Swimmers

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Context: Shoulder pain is the most common musculoskeletal complaint in competitive swimmers. Scapular dyskinesis is considered a contributing factor to developing pain, though an understanding of how assessment techniques are related is unknown. Therefore, the objective of this study was to examine the extent to which components of a pre-season scapular movement examination are associated.

Methods: Twenty-nine NCAA Division I swimmers (15 females, BMI: 23.21 ± 1.93 , 14 males, BMI: 23.98 ± 1.96) participated in this cross-sectional study occurring in an athletic training facility. A single rater performed an initial movement examination evaluating the presence or absence of scapular dyskinesis during weighted active humeral abduction and flexion. Assessment of scapular dyskinesis during the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) was also performed. The number of touches on the CKCUEST was normalized by each participant's height. Fisher's exact tests were used to evaluate the relationship between the presence of pain and the presence of scapular dyskinesis during; 1) abduction, 2) flexion, and 3) during the CKCUEST. Fisher's exact tests were also used to examine the relationship between the presence of scapular dyskinesis between; 4) abduction and flexion, 5) the CKCUEST and abduction, and 6) the CKCUEST and flexion. Additionally, independent t-tests were used to evaluate performance on the CKCUEST based on; 1) presence of scapular dyskinesis during the CKCUEST, 2) presence of scapular dyskinesis during abduction, 3) flexion, and 4) shoulder pain in the past two weeks. Alpha was set a priori at $p \leq 0.05$.

Results: A significant association was found between the presence of scapular dyskinesis during the CKCUEST and shoulder pain in the past two weeks ($p=0.04$). There was no association between scapular dyskinesis with abduction and flexion ($p=1$), or with pain and abduction ($p=0.31$) or pain and flexion ($p=0.20$). There was no association between the presence of scapular dyskinesis during the CKCUEST and abduction ($p=1$) or with flexion ($p=0.70$). Participants with scapular dyskinesis during flexion had increased CKCUEST performance scores compared to those without although there were no other significant performance differences on the CKCUEST in the other groups examined. (Table 1)

Conclusions: Scapular dyskinesis is a multi-planar movement condition that can affect athletic performance. The results of this study suggest that the presence of scapular dyskinesis is likely related to multiple factors including pain and the conditions under which the shoulder is assessed. The results also suggest the presence of scapular dyskinesis in one task is not associated with presence during another. In conjunction with consideration of previous pain history, clinicians should utilize a thorough movement examination of both open and closed kinetic chain tasks to evaluate for scapular dyskinesis.

Total Word Count: 431

209845FD

Utilization of the Landing Error Scoring System-Real Time (LESS-RT) to Detect Kinematic Changes Following Three Different Functional Exercise-Induced Muscle Damage Protocols

Goins JM, Kopec TJ, Hibberd EE

Context: The purpose of this study was to compare the effects of 3 practical exercise-induced muscle damage (EIMD) protocols on LESS-RT performance. Each of the 3 EIMD protocols were used to target a specific muscle fiber type; Type IIa, Type IIx, and Type I.

Methods: Twelve healthy participants, 7 males and 5 females (22 ± 1.76 years, 170 ± 11.8 cm, 76.6 ± 17.0 kg), participated in the repeated measures study. Participants did not have a current or previous lower extremity injury within the previous 3 months. The exercise protocol sequence for each participant was randomly assigned and each session was separated by at least 6 days. After each session, participants returned 24 hours later for a retest. The 3 protocols included an agility-based protocol targeting Type IIa fibers, a sprint-based protocol targeting Type IIx fibers, and a squat protocol targeting Type I fibers. The LESS-RT was performed before, immediately after, and 24h after each EIMD protocol. Differences between pre- and post-scores were calculated using paired samples t-tests, and differences in scores immediately after and 24 hours after the 3 fatigue protocols were assessed using a repeated measures ANOVA.

Results: Average LESS-RT scores before the agility-based protocol (3.17 ± 2.79) were significantly different than average scores immediately after the protocol (4.17 ± 1.80 , $p = 0.046$) and 24 hours after (4.18 ± 1.72 , $p = 0.020$). Average LESS-RT scores before the sprint protocol (3.50 ± 2.77) were significantly different immediately after the protocol (4.33 ± 1.88 , $p = 0.025$), but not 24 hours later (4.42 ± 2.39 , $p = 0.067$). Average scores before the squat protocol (2.83 ± 2.21) were significantly different than immediately after (4.00 ± 2.37 , $p < .001$), but not 24 hours later (3.75 ± 2.96 , $p = 0.183$). No significant differences were noted between scores among the 3 protocols immediately after the fatigue protocols ($p = 0.720$), nor at 24-hour follow-up ($p = 0.149$). No significant differences were noted between the changes in LESS scores from before the respective exercise to immediately after ($p = 0.978$), nor between before exercise to 24-hour follow-up among all of the protocols ($p = 0.199$).

Conclusions: This study evaluated the efficacy of three different exercise protocols to elicit changes in jump landing kinematics as evaluated using the LESS-RT. This is a novel application for the LESS-RT, as it was developed for clinical adoption, where EIMD is produced from exhaustive bouts of exercise. The agility-based protocol produced the greatest changes in LESS-RT scores. Although there was no statistically significant differences in the protocols, previous literature explained that a 1-unit change in LESS scores may relate to moderate-to-large differences in certain biomechanical variables.

Total Word Count: 437

205511LB

Visual Reweighting Using Stroboscopic Vision in Healthy Individuals

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Context: The sensory organization test (SOT) is a balance protocol that helps clinicians and researchers assess trade-offs in balance as a result of manipulating visual and somatosensory information. Testing how individuals use visual information to maintain balance has been traditionally limited to two extreme conditions: eyes closed and eyes open. Stroboscopic glasses allow clinicians to control the amount of visual information that influences balance, varying between eyes opened and closed.

Methods: Participants (8 males and 7 females, 24.59 ± 3.97 years, 71.39 ± 14.89 kg, 172.35 ± 10.64 cm) completed the SOT under three visual conditions: 100% vision, 50% vision, 20% vision. In the 50% and 20% vision SOTs, the eyes-open trials (conditions 1 and 4) used Senaptec Strobe goggles for a stroboscopic vision (SV) effect. The 50% vision SOT used 5Hz SV (100ms transparent, 100ms opaque) and 20% vision SOT used 2Hz SV (100ms transparent, 400ms opaque). All trials were randomized and completed during double-limb stance. Equilibrium scores were calculated from the Neurocom Balance Master system and the three-trial average from each condition and SOT was used for analysis. Data from conditions 1, 2, 4, and 5 were used for analysis. A two-way repeated-measures ANOVA was used to evaluate the interaction between and within factors of vision (100%, 50%, 20%, 0%) and support surface (firm and sway-referenced).

Results: A significant interaction effect between vision and support were observed, $F(3, 48)=10.338$, $P<.001$, $\eta^2=.39$. Significant main effects were found in vision (100%, 50%, 20%, 0%), $F(3, 48)=16.135$, $P<.001$, $\eta^2=.50$ and support (firm and sway), $F(1, 16)=69.116$, $P<.001$, $\eta^2=.81$. Data from each condition can be seen in Table 1. Follow up one-way repeated measures ANOVA indicated that vision between 100% and 0%, 50% and 0%, and 20% and 0% were significantly different on the fixed support at $P<.001$. On the sway-reference support, 100% and 20%, 100% and 0%, 50% and 20%, 50% and 0Rk% were significantly different at $P<.05$.

Conclusions: Decreasing the visual sampling rate has a significant effect on standing balance. It negatively impacts balance on a firm surface, and is amplified when somatosensory cues are unreliable. This shows the importance of somatosensation as a guiding sensory modality for balance, especially when visual conditions are limited. Recent evidence suggests that neuroplastic changes occur within injured populations such as concussion, CAI, and ACL-R. These changes reflect a decreased use of somatosensory cues and increased reliance on visual cues. The steep trade-offs observed in our study suggests that such manipulating vision and support surface may be beneficial at overcoming the neuroplastic changes after injury. Future research is warranted to examine these effects in injured populations.

Total Word Count: 428

[206935JD](#)

Vitamin D3 Supplementation May Spare Bone Mineral Density In Athletes During Periods of Intense Training

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Context: Inadequate bone mineral density (BMD) can lead to an increased likelihood of fractures. Those with insufficient vitamin D levels are thought to be at greater risk of developing a lower BMD due to the role vitamin D plays in transporting calcium into the bone. Supplementation of vitamin D is used to increase serum levels of 25-hydroxy-vitamin D (25(OH)D). However, it is currently unknown what role vitamin D supplementation plays in maintaining BMD in an athletic population. The primary purpose of this study was to determine if supplementation with vitamin D3 resulted in an increased BMD over a 12-week period.

Methods: Seventeen NCAA Division I athletes (10 females, mean age – 20.8 + 1.1 years) participating in outdoor sports (baseball, softball, track & field) in the southeastern United States were recruited to participate in this controlled laboratory study. Participants had height, weight, body composition, serum 25(OH)D levels, and BMD measured. Serum 25(OH)D was measured by liquid chromatography/tandem mass spectrometry following intravenous blood draw. Bone mineral density and body composition were measured using a dual-energy X-ray absorptiometry (GE Lunar-Prodigy; software version 7.51.008). Subjects with baseline 25(OH)D below 30 ng/mL (n = 7) were supplemented with 50,000 IU of vitamin D3 once weekly for 12-weeks. Data were analyzed using SPSS software (version 24.0). Paired sample t-tests were used to exam pre- and post-data while a one-way ANOVA was used to examine differences between intervention groups on outcome variables.

Results: No significant differences were found between pre- and post-BMD for any body region. A significant increase was seen in serum 25(OH)D levels for individuals who supplemented with vitamin D3 (28.5 + 5.9 ng/mL; 75.3 + 19.0 ng/mL, p < .001). A significant decrease was seen in body composition for all participants (25.1 + 9.2%; 22.8 + 9.9%, p = .009). Pre-serum 25(OH)D levels were significantly different between intervention groups (41.2 + 11.4 ng/mL; 28.5 + 5.9 ng/mL, p = .019). While post-intervention total BMD was not significant (p = .058), the differences could be clinically meaningful between the non-supplement and supplemented groups (1.32 + .09 g/cm²; 1.45 + .15 g/cm²).

Conclusions: While both groups saw a decrease in total BMD during the 12-week intervention period, the group that supplemented with vitamin D3 appears to have retained BMD better than those who had normal serum 25(OH)D at baseline. Longitudinal studies in athletes need to be completed to see how yearly intense training effects BMD. Even though BMD was still in the normal range during post-intervention measurement, decreases in BMD during heavy training periods may increase the risk of fractures. While not confirmed, this may warrant all athletes supplementing with vitamin D3 to help spare BMD during periods of intense training.

Total Word Count: 442

206851JD

Vocal Cord Dysfunction in Women's Soccer

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Background: Vocal cord dysfunction (VCD) is the medical term for the adduction of the vocal cords during respiration. Depending on the severity of it, it can affect people differently specifically how long the onset and recovery of the symptoms are which would include their breathing respiration. It closely mimics asthma through its symptoms however, they have distinct differences. Unlike asthma, it cannot be treated through an inhaler but through improved breathing techniques.

Patient: An 18-year-old female collegiate soccer athlete had issues during full exertion last summer. She was not cleared on her physical and was sent to a cardiologist to eliminate any heart issues. The rapidness of her symptoms of tightness in the throat, high-pitched grating and struggle during inhalation while breathing led to the suspicion of VCD.

Intervention & Treatment: She was sent to an ENT physician to get a nasal endoscopy to look at the vocal cords function during exercise and it was found that she had a mild case of VCD. To treat this the athlete was instructed to learn to control her breathing, inhaling through the nose and exhaling through the mouth and filling her stomach with the air instead of her chest. In addition, a speech pathologist was suggested but at this time not being used.

Outcomes or Other Comparisons: VCD often goes unnoticed or misdiagnosed as asthma due to the symptoms that are presented. People with exercise-induced asthma share similar symptoms to those who suffer from VCD such as improper respiration and tightness of chest/throat while breathing. Asthma is described as the constriction of the airways in the lungs brought on by exercise and causes tightness in the chest, wheezing, trouble in exhalation and is brought on gradually. However, with VCD breathing is high pitched and grating, tightness is experienced within the throat and can be brought on rapidly. By changing the way she breathes during exercise she has had an easier time getting through activities without having to stop and relax.

Conclusions: Although the effects of both seem similar, they are uniquely different but do not get properly recognized and should be treated different. To measure the athlete's improvement subjective notes will be noted on her endurance levels to see if she is able to exercise longer than the previous time. Along with this, listening to her breathing will be noted to see if she is able to regulate her respirations better.

Clinical Bottom Line: The signs and symptoms that are presented with VCD should be recognized by medical personnel because it can disrupt a person's ability to exercise. There are differences between asthma and VCD that can help differentiate the two, if someone gets mistreated for it as asthma then they will not find and improvement. This can cause anxiety with the thought of not knowing what is wrong with them and why they are not getting better which can further disrupt respiration through panic.

Total Word Count: 470

200514FD

Wearable Sensors Identify Interlimb Asymmetries During Return-to-Sport Tests in a Collegiate Downhill Skier After Unilateral ACL Reconstruction

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Background: Improving the return-to-sport (RTS) decision-making process is an area of growing research, particularly assessing interlimb symmetry after injury. Wearable sensors can provide affordable and objective information on how the body moves, thus providing more detailed information to clinicians; however, previous research using wearable sensors has only identified interlimb asymmetries when completing unilateral limb tasks. The purpose of this level 1 CASE Study is to use inexpensive wearable sensors to identify interlimb asymmetries during bilateral tasks typically used during RTS.

Patient: A former competitive downhill skier (Female, 27 years old, 1.57 m, 49.6 kg, 4 years collegiate experience) ruptured her left ACL while skiing. The patient underwent ACL reconstruction (hamstring graft) and medial meniscus repair (October 2016) and returned to full activity in August 2017. Presently, the patient averages 180 minutes of moderate to vigorous activity per week and complains of no limitations to activity with intermittent weakness, swelling, and soreness post-activity to the affected knee.

Intervention & Treatment: The patient completed RTS tasks aimed to test jumping and agility skills while utilizing both limbs (counter movement jump, broad jump, vertical jump, pro-agility test, agility t-test cutting left, agility t-test cutting right, and forty-yard dash). Accelerometers (MetaMotionR, Mbientlab) were attached at the pelvis via custom clip attached to the posterior waistband and to each shank via adhesive wrap. The sensors were placed to ensure axes of the accelerometer were in line with vertical, mediolateral, and anteroposterior motion of the pelvis and shanks, respectively. Sensors streamed triaxial accelerations at 100 Hz during all RTS tasks. Gait events (such as take-off and initial contact) were identified by peak vertical accelerations at the pelvic and shank sensors. Peak accelerations of the pelvic sensor were assigned to the corresponding limb from ipsilateral mediolateral accelerations (pelvic acceleration to the right corresponded with right limb stance). A symmetry index was used to compare peak vertical accelerations between limbs.

Outcomes or Other Comparisons: During jumping tasks, shank asymmetries could be identified for both take-off and landing events. During the forty-yard dash and pro-agility test, peak vertical accelerations of the pelvic sensor could be assigned to each limb and an interlimb asymmetry could be calculated. During the agility t-test, the initial cut could be identified by the peak mediolateral acceleration at the pelvic sensor. The pelvic sensor captured reduced peak acceleration to the right when cutting with the affected (left) limb compared with the healthy limb, suggesting the patient was unable to change the velocity of the body as quickly with the ACL reconstructed limb. Interlimb asymmetries of peak vertical accelerations were identified for all tasks (Table 1). Previous research has identified asymmetries utilizing unilateral limb tasks (i.e., single leg hop); however, asymmetries during bilateral tasks within a RTS protocol have not previously been collected with wearable sensors.

Conclusions: Wearable sensors can provide additional information to the clinician utilizing tasks often incorporated into a RTS protocol. Although prior studies have utilized symmetry indices in injured athletes and the RTS decision-making process, the ability to collect clear and objective interlimb asymmetries during dynamic tasks has been limited to the laboratory. Further, the sensors used presently were chosen because of their relatively low cost to demonstrate direct clinical application, compared with the costly systems in previous research. Clinicians will still be challenged with interpreting the acceleration data provided by these sensors; however, there is a growing body of literature to assist with clinical biomechanical analyses. Future research should validate the clinical significance of these findings in a larger sample.

Clinical Bottom Line: Inexpensive wearable sensors can identify interlimb asymmetries during dynamic bilateral tasks used during return to sport testing.

Total Word Count: 586

207151CA

Whole-Body Reactive Agility Testing Reveals Modifiable Impairments Among Elite Athletes With Self-Reported History of Sport-Related Concussion

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Context: A strong association between history of sport-related concussion (HxSRC) and whole-body reactive agility (WBRA) asymmetry has previously been reported. A plausible explanation is impairment of functional connectivity within and between brain networks, which may be a modifiable factor that elevates risk for subsequent injury.

Methods: A cohort of 16 elite athletes (25.3 \pm 5.8 years; 10 males: 69.0 \pm 3.8 cm, 160.7 \pm 27.4 kg; 6 females: 63.8 \pm 2.0 cm, 144.47 \pm 28.7 kg) representing 5 Olympic sports participated in 12 WBRA training sessions over 26 \pm 9 days. A virtual reality motion analysis system (TRAZER™, Westlake, OH) measured 8 lateral WBRA responses within a 3-m X 3-m area to targets presented on either the right or left side of a large monitor. A second dual-task (DT-WBRA) trial simultaneously presented targets on both sides of the monitor, with correct direction of movement responses indicated by the center arrow of 4 possible flanker test displays (<<<<<, >>>>>, <<><<, >><>>) that were equally presented in random order. Measurements included total distance required to deactivate all targets, reaction time, speed, acceleration, and deceleration. Performance in right versus left directions was calculated for the latter 4 measurements, as well as directional asymmetries, and an average of asymmetries for each participant (WBRA Asym). Performance values for the 12 training sessions were combined to create 3 training phases that each included 4 sessions. The discriminatory value of averaged phase 1 measurements for identification of HxSRC cases was assessed through receiver operating characteristic and cross-tabulation analyses. Averaged values for phases 1 and 3 were compared to assess performance improvement using repeated measures analysis of variance.

Results: Self-reported HxSRC at 3.0 \pm 2.2 years prior to testing (range: 0.3 – 8.0 years) represented 56% of the cohort (9/16; 5 males, 4 females). Total distance \geq 27.3 m for DT-WBRA demonstrated good discrimination between no SRC (NoSRC) and HxSRC cases (AUC=.714; OR=7.5). A significant DT-WBRA group X phase interaction effect was evident (P=.038) for total distance, with greater improvement for HxSRC (28.6 \pm 4.0 to 24.4 \pm 2.5; SRM=2.06) than NoSRC (25.9 \pm 1.5 to 24.2 \pm 1.1; SRM=0.93). Single-task (ST) WBRA Asym \geq 13.4% demonstrated good discrimination (AUC=.698; OR=5.0), and thresholds of \geq 10% and \geq 15% demonstrated remarkable similarity to discrimination observed in our previous studies (Table). Significant ST-WBRA Asym reduction was observed (P=.049; SRM=0.57), but the magnitude was similar for HxSRC (15.7 \pm 4.7% to 12.6 \pm 2.4%) and NoSRC (12.9 \pm 3.7% to 10.2 \pm 2.5%).

Conclusions: Our findings support previous evidence that ST-WBRA Asym represents a potentially valuable clinical indicator of disrupted brain connectivity. The DT-WBRA training protocol appeared to induce a visual-spatial calibration improvement (decreased total distance) that was greater among HxSRC athletes, which may reduce risk for future injury.

Total Word Count: 436

207853QA

Work-Family Conflict Among Athletic Trainers Who are Parents in the Collegiate and Secondary School Settings

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Context: The National Athletic Trainers' Association (NATA) recently released a position statement on work-life balance, as it has become a primary concern in the Athletic Training profession, with time/hours worked as a primary inhibitor. Work-family conflict (WFC) can negatively impact the care provided by the athletic trainer, while social support can help improve work-life balance. Previous literature has not compared two of the most common practice settings in the same study nor has social support's potential impact on WFC been investigated in the same sample.

Methods: Using a cross sectional observational survey, the purpose of this study was to compare WFC and social support among athletic trainers employed in the two most common practice settings. Recruitment emails were sent to 1474 collegiate athletic trainers and 2219 secondary school athletic trainers. A total of 474 (231=females, 243=males) athletic trainers employed in the college (43.2%) and secondary school settings (56.8%) completed the study. Data were collected through a web-based survey. The social provisions scale (24-item scale) was used to quantify our participants' social support. The WFC scale (18-item scale) was used to measure facets of conflict including time, strain, and behavior-based conflict. Likert responses were summed, and demographic information was analyzed for frequency and distribution. Independent t-tests and Mann-Whitney U were run to determine group differences. Linear regression was used to determine if social support was predictive of WFC.

Results: The social provisions scale (α .91) and WFC scale (α .89), both previously validated and found to be reliable, had high internal consistency in our sample. No significant WFC differences ($p=.778$) were found between collegiate and high school athletic trainers despite collegiate athletic trainers ($63\pm.76$) working significantly more hours during their busiest seasons compared to high school athletic trainers ($54\pm.81$) ($p<.001$). Similarly, no significant differences in WFC ($p=.969$) were found between males (46.9 ± 11.1) and females (46.8 ± 10.9). Males ($61\pm.83$) worked significantly more hours than females ($55\pm.82$) during their busiest times ($p<.001$). Males ($37\pm.77$) also worked significant more hours than females ($33\pm.67$) during their least busy times ($p<.001$). Our participants scored highest on time-based WFC items. A statistically significant moderate negative correlation was found between social provisions and WFC ($r=-.496$, $p<.001$); social provisions score was found to be predictive of WFC ($F(1,472)=143.485$, $p<.001$, $R^2=.233$) with participant's predicted total WFC equal to $94.430-.566$ (social provisions total score).

Conclusions: WFC is experienced in the two most common employment settings and among both sexes; indicating no sex or setting differences. Social support plays an important role in helping decrease conflict faced by athletic trainers and may improve work performance, mentality, and patient care. The presence of WFC and a lack of social support can have negative implications on work-life balance. Future research should further explore the work-time construct of WFC.

Total Word Count: 446

[207713JD](#)

Work-Family Conflict Experienced by Collegiate Certified Strength and Conditioning Specialists

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Context: Long working hours and the expectation to win in collegiate athletics creates an optimal environment for work-family conflict (WFC). Prior research has indicated athletic trainers (ATs) and collegiate coaches experience WFC. Lack of control and inflexible work schedules can facilitate WFC. ATs may experience WFC when coaches set practice and competition schedules. Certified strength and conditioning specialists (CSCS) have yet to be studied within sports culture and the WFC paradigm. They, like the AT, work according to schedules set by the coach. As researchers continue to understand the role of the work setting on WFC, it is important to understand WFC from all perspectives.

Methods: Using a cross-sectional survey, the purpose of this study was to examine WFC among collegiate CSCSs. An online survey including demographic questions and the WFC Scale ($\alpha=.78-.87$) was used. An email was sent to Division I CSCSs requesting participation. Reminder emails were sent at one and three weeks. Mean WFC scores included: gender, marital status, and parental status. Independent t-tests and an ANOVA were used to determine group differences. Pearson's correlation was used to determine if there was statistical significance between hours worked and gender.

Results: The survey was sent to 1695 participants. A total of 213 (12.6%, 56=females, 153=males) respondents with an average of 9.6 years of experience were included in analyses. Responses were excluded if respondents were only a sport coach or if less than 50% of their job duties included working as a CSCS. No significant WFC difference ($p=.984$) occurred between males (48.9 ± 11) and females (44 ± 11). Although, males ($n=136$) worked more hours (61 ± 22) during their busiest time of year compared to females ($n=42$, 54 ± 27) there was not a significant difference in hours ($p>.01$). Men ($n=145$, 37.5 ± 17) also worked more during their least busy time of year compared to females ($n=45$, 35.9 ± 18) but the finding was not statistically significant ($p>.01$). Parental status (children 47.6 ± 12 , no children 48 ± 11) had no statistically significant difference ($p=.443$) on WFC. No statistically significant difference was found between different groups based on marital status $F(47, 136) = 1.08$, $p = .35$. The WFC scale has been previously considered a reliable and valid measure and was such in our study ($\alpha=.87$).

Conclusions: Similar to ATs and coaches, CSCSs experience WFC in the collegiate setting. Consistent with ATs, there are no gender differences in WFC. Neither marital nor parental status correlate to WFC. An important role of the CSCS is to physically prepare athletes for competition, supporting the ATs' main goal of injury prevention. As ATs, it is our role to assure the organization is providing a safe space for sport participation which starts with prevention. Future studies should examine ways to mitigate WFC among people employed in the collegiate sport setting.

Total Word Count: 449

200325ED

Y-Balance Test as a Predictor of Lower Extremity Injuries in Division I Collegiate Football Players

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Context: Dynamic balance deficiencies have been implicated as a risk factor in lower extremity (LE) injuries. Many current trends examine constructs of balance as a forecaster of injuries. The purpose of this study was to analyze the ability of the Y-Balance Test to predict LE injuries in Division I collegiate football players.

Methods: This prospective clinical trial design used Y-Balance Test score data from Division I collegiate football participants that were recorded before the start of a fall football season. LE injuries were recorded throughout the same season and defined as hip and below, not including the sacroiliac joint, that caused the participant to miss the next scheduled game and/or practice. Participants were excluded if they had sustained a LE injury or concussion in the past 3 months or had acute head cold and/or vestibular dysfunction. Eighty-seven male football players (Age: 19.89 ± 1.33 years, Height: 186.91 ± 7.18 cm, Weight: 103.75 ± 20.88 kg) met the inclusion criteria and participated in this study. LE anterior, posteromedial, and posterolateral reach balance scores from the Y-Balance Test were assessed and calculated into composite scores to examine the relationship to any LE injuries sustained. A multiple linear regression analysis was conducted to determine how well the Y-Balance Test predicted LE injuries.

Results: Twenty-three LE injuries were documented over the fall season. Ordered multiple linear regression results indicated that right composite balance scores (304.18 ± 31.85 cm) were not significant in predicting LE injuries [$R^2 = 0.019$, $F(4,82) = 0.387$, $P = 0.817$]. The sample multiple correlation coefficients indicated that only 0.66% of the variance for sustaining a LE injury was accounted for by the right composite balance scores and 1.35% by the specific right anterior reach direction scores (58.2 ± 6.92 cm), 0.58% by the right posteromedial reach direction scores (124.46 ± 12.35 cm), and 0.19% by the right posterolateral reach direction scores (121.52 ± 12.58 cm). Ordered multiple linear regression results indicated that left composite balance scores (302.21 ± 31.39 cm) were not significant in predicting LE injuries [$R^2 = 0.050$, $F(4, 82) = 1.072$, $P = 0.376$]. The sample multiple correlation coefficients indicated that only 1.19% of the variance for sustaining a LE injury was accounted for by the left composite balance scores and 0.11% by the specific left anterior reach direction scores (58.58 ± 6.42 cm), 2.53% by the left posteromedial reach direction scores (122.96 ± 12.07 cm), and 0.29% by the left posterolateral reach direction scores (120.67 ± 12.90 cm).

Conclusions: The Y-Balance Test may be a good device for dynamic balance assessment but found to be a poor predictor of lower extremity injuries in the Division I collegiate football population.

Total Word Count: 436