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Dear NATA Members and Friends:

We are pleased to present the annual *Supplement* to the *Journal of Athletic Training*. This Supplement contains abstracts presented during the 2024 NATA Clinical Symposia & AT Expo as part of the NATA Foundation Free Communications Program.

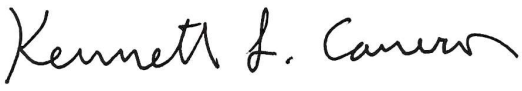
The Free Communications Program provides certified athletic trainers, students and other healthcare providers an opportunity to present and learn about the latest in athletic training research. Research is presented in oral and poster formats and includes general research, NATA Foundation-funded research and clinical case reports. Abstracts of the research are printed here by day of presentation at the 2024 NATA Convention for your convenience. Free Communications presentations represent a wide range of research and clinical interests. In addition, the Clinical Case Reports sessions allow you to test your clinical assessment skills. We encourage you to view these presentations.

We also urge you to view the sessions featuring research funded by the NATA Foundation. The NATA Foundation funds research and a variety of educational programs, including summits on issues critical to athletic training, as well as annual scholarships to professional and post professional students of athletic training.

Support from NATA members, corporations, and other affiliated groups make this supplement and all of our programs possible. Please note projects funded by the NATA Foundation and by the generous contributions of our donors are specified in this Supplement. To make an investment in the future of the profession, please contact us today[fndnstaff@nata.org](mailto:fndnstaff@nata.org) or visit https://natafoundation.org/support/ways-to-give/donate/.

The NATA Foundation and NATA are pleased to offer this supplement as a service to NATA members. We hope that it provides theoretical and practical information you can use to improve your effectiveness as a certified athletic trainer. Thank you for your support!

Sincerely,



Kenneth Cameron PhD, MPH, ATC, CSCS, FNATA
President, NATA Research & Education Foundation

Kathy Dieringer, EdD, LAT, ATC
President, NATA

Dear Colleagues:

On behalf of the National Athletic Trainers' Association Research & Education Foundation and the Free Communications Committee, I would like to thank all the authors who submitted abstracts to the Free Communications Program. We received and conducted peer-reviews on 345 submissions this year. This year's Program is exciting as it contains fantastic mix of high caliber research reports and clinical case studies that will be delivered in both rapid fire oral and poster presentation formats. We appreciate the presenters' time and commitment to offering amazing content to attendees and the efforts to advance the science of the Athletic Training profession.

I would also like to take this opportunity to extend a special thanks to all of the NATA and NATA Foundation staff and especially Velma Meza, who works tirelessly behind the scenes and whose attention to detail and dedication makes the Free Communications Program possible. Additionally, many individuals have worked very hard to review submissions, schedule presentations and produce this *Supplement to the Journal of Athletic Training.* Therefore, I would like to thank and recognize the efforts of the Free Communications Committee for their long hours of abstract reviews and creativity in developing this year's Free Communications program. The Free Communications committee members are

David Berry, PhD, ATC

Cathy Brown Crowell, PhD, ATC, FNATA

Johanna Hoch, PhD, ATC

Tamerah Hunt, PhD, ATC

Christopher Kuenze, PhD, ATC

Kevin Laudner, PhD, ATC

Brian Pietrosimone, PhD, ATC

Riana Pryor, PhD, ATC

Jacob Resch, PhD, ATC

Justin Rigby, PhD, ATC

Adam Rosen, PhD, ATC

Melissa Snyder, PhD, ATC

Stephen Thomas, PhD, ATC

I also acknowledge the unwavering support and guidance from Kenneth Cameron, PhD, ATC, FNATA and the rest of the NATA Foundation Board and staff. Lastly, I wish to thank Leslie Neistadt and the staff of the editorial office of the *Journal of Athletic Training* for making the *Supplement* possible.

As we move forward, we continually try to improve and make the review process more transparent. Our goal is to be as inclusive as possible while maintaining the high level of scholarship that readers expect of the *Journal of Athletic Training.* To further improve the process, we appreciate the feedback from authors and suggestions are always welcomed and discussed in committee meetings.

Our Committee looks forward to seeing you in New Orleans. Please take the opportunity to view the posters and attend the Free Communications Rapid Fire Oral presentations. Please note that projects funded by the NATA Research & Education Foundation and our award winners are specified in this *Supplement*. Finally, please offer your thanks to those recognized above if you have the opportunity.

Sincerely,

Erik Wikstrom, PhD, ATC, FNATA
Chair, NATA Research & Education Foundation, Free Communications Committee

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Thursday, June 27, 2024

Authors present 9:00 AM-9:55 AM



Authors present 10:25 AM-11:20 AM

# Medal for Distinguished Athletic Training Research


## J. Troy Blackburn, PhD, ATC
## The University of North Carolina at Chapel Hill


Troy Blackburn's first foray into the world of athletic training is, he admits, a common story. While playing football, basketball, baseball, and golf in high school, he consulted a physical therapist for any injuries, as his rural North Carolina school did not employ an athletic trainer. Seeing the kind of work his physical therapist did, he wanted to pursue the profession to help athletes like himself; however, once he entered college and began volunteer hours for physical therapy, Blackburn realized this was not where he belonged. All it took was a suggestion to try sports medicine, which turned out to be everything he had originally envisioned physical therapy would be—an engaged clinical setting working with a specifically athletic population as part of a team, interacting with patients on a daily basis, and helping them with injury prevention, injury treatment, nutrition, and rehabilitation.

Now, Blackburn chairs the Exercise and Sport Science Department at the University of North Carolina at mChapel Hill and is the associate director of the MOTION Science Institute after recently stepping down as the 2016–2023 Associate Dean for Undergraduate Research in the College of Arts & Sciences. As an athletic training student, anterior cruciate ligament (ACL) injury and rehabilitation immediately piqued his interest because of the injury's potential for vast long-term complications. One of these complications, osteoarthritis, can be difficult to study and manage—Blackburn remarks that it is often seen as a disease strictly affecting older adults, but, for example, a 16-year-old female athlete could tear her ACL in high school, be diagnosed with osteoarthritis at age 36, and require a total knee replacement in her 40s. By treating patients from the time they first tear their ACL, Blackburn hopes that it will become possible to identify the cause of osteoarthritis and improve ways to treat the disease, which will enhance outcomes not only for student-athletes with ACL injuries but also for millions of others diagnosed with osteoarthritis, both in athletic and nonathletic populations.

When it comes to being an athletic trainer, Blackburn stresses that failure is the recipe. To be successful in the field, he encourages students to accept failure and learn from it. The world's problems won't be solved in a day, he says, and the same is true of athletic training—it can be a slow-moving career, with incremental gains in research, so he recommends students settle in and find something they are passionate about in the field. For himself, Blackburn  ask for more; he gets to do a job he can "geek out" about, and as a bonus, it might incidentally help people.

Blackburn thanks Kevin Guskiewicz, PhD, ATC, who assisted him in becoming a better clinician and scientist and inspired him to pursue administration. He admits they are an odd pairing, with Blackburn doing ACL and rehabilitation research and Guskiewicz doing concussion research; though they may speak different "languages," Guskiewicz still took Blackburn on as a PhD student and let him do what he wanted…as long as he "didn't kill himself or burn down the lab, that is." Blackburn also recognizes Darin Padua, PhD, ATC, who showed him how to build a line of research and strategize long-term studies in sequence, and Brian Pietrosimone, PhD, ATC, with whom he built a partnership over the last 10 years, figuring out how to share the "unicorns" (ie, the ideal candidates for ACL research) between the 2 of them, as they have similar research interests.

Among Blackburn's many accomplishments is receiving the National Athletic Trainers' Association's own version of the EGOT (that is, a person who has won an Emmy, Grammy, Oscar, and Tony award) by being awarded the David H. Perrin Outstanding Dissertation Award in 2007, the Dr. Freddie & Mrs. Hilda Pang Fu New Investigator Award in 2009, and now, the Medal for Distinguished Athletic Training Research in 2024. He owes these achievements to his mentors, master's students, PhD students, postdoctoral students, and, to some extent (at least, according to him), a bit of luck as well.

He is forever thankful for his wife, Sarah, and son, Campbell, for their understanding and flexibility as he navigates his career in athletic training. They have afforded him ample opportunity to succeed, and in turn, he helps them to succeed in whatever they wish to do, as they are all just one part of "this thing" called life.

# The Dr. Freddie & Mrs. Hilda Pang Fu New Investigator Award


## Shelby Baez, PhD, ATC
## The University of North Carolina at Chapel Hill


Shelby Baez did not always intend to be an athletic trainer. She first studied journalism, then English, and finally landed on sports medicine. The idea of an athletic trainer was not new to her, however, as, unlike many high schools at the time, hers employed an athletic trainer, which led to her to become acquainted with the profession. After completing her observation hours in the athletic training program at the University of North Carolina at Chapel Hill, she felt confident that this was the place she should be and ended up obtaining her BA in exercise and sport science with a concentration in athletic training. She went on to earn her MS in athletic training and PhD in rehabilitation sciences with a concentration in sport and exercise psychology at the University of Kentucky via a Lyman T. Johnson Fellowship.

Baez currently works as an assistant professor in the Department of Exercise and Sport Science at the University of North Carolina at Chapel Hill and is the director of the patient-centered and clinician-focused Psychology of Sport Injury Laboratory. She believes she is in a unique position as an athletic trainer, as she has the rare opportunity to truly know patients before they actually become patients—a luxury not available to all health care professionals. She's drawn to this type of work because she genuinely wants to help patients and student-athletes succeed. She is interested in a psychologically informed approach to patient care and stresses the importance of a whole-person approach to practice in which the focus is not solely on biology, strength, range of motion, etc, as psychological responses may affect outcomes during recovery and return to activity for anterior cruciate ligament injuries. Baez cites the COVID-19 pandemic as a catalyst for this more mental health–focused approach to injury.

As a queer person of color in the athletic training profession, Baez certainly recognizes the need for diversity, equity, inclusion, and accessibility to be integrated throughout the practice because athletic trainers are always working with athletes of different backgrounds (race, ethnicity, sex, gender identity, gender expression, etc). She believes athletic trainers must feel confident in their ability to recognize these differences and to tailor care accordingly.

Baez's advice for athletic training students is simple: step out of your comfort zone. Be okay with being uncomfortable, and don't be afraid to ask for help. For athletic training students of color, Baez advises leaning on your mentors—knowing you are "other" or different may make you less likely to ask for help, but it should be emphasized that athletic trainers (Baez especially!) want to support you and provide resources specifically for you as you navigate athletic training spaces.

Among Baez's ongoing projects is a study that incorporates virtual reality and mindfulness techniques after anterior cruciate ligament reconstruction. Using virtual reality, Baez hopes to reduce barriers to psychologically informed practice and focus patients' attention to help them truly engage in mindfulness.

Baez says she would not be in the position she is today without the tremendous support of her mentors, including Kevin Guskiewicz, PhD, ATC, FNATA who was her undergraduate anatomy professor and advocated for her at every step of the way, Darin Padua, PhD, ATC, FNATA and Meredith Petschauer, PhD, ATC. Jennifer Howard, PhD, ATC, urged Baez to engage in research (something Baez wasn't thrilled about at first, but now has a passion for) while she was studying for her master's, allowing her to grow and teaching her how to create robust research projects and submit grants for National Athletic Trainers' Association (NATA) funding. Her PhD advisor was Johanna Hoch, PhD, ATC, who encouraged Baez to delve deeper into the psychological aspects of injury, resulting in Baez being at the forefront of and a trailblazer for psychologically informed practice. She is grateful for her colleagues and friends: Christopher Kuenze, PhD, ATC, FNATA; Emily Hunt, PhD, ATC; Katie Perry, PA-C, ATC; Samantha Pexa, PT, DPT, ATC; Alex Cobo, PA-C, ATC; and Breton Asken, PhD, ATC. She is also thankful for her current and former doctoral students, Francesca Genoese, PhD, ATC; Elaine Reiche, MS, ATC, CSCS; and Caitlin Brinkman, MS, ATC. She thanks the NATA Research & Education Foundation for its continuous support throughout her master's, doctoral, and current research. Finally, she appreciates the endless support of her parents, Linda and Claude, especially during the difficult years as a busy graduate student.

# The Dr. Freddie & Mrs. Hilda Pang Fu New Investigator Award

Dr. Fu was a pioneer and authority in sports medicine and recognized as a preeminent leader in orthopaedic surgery and sports medicine across the globe. He earned his MD from the University of Pittsburgh, spending more than 3 decades as the head team physician for the University of Pittsburgh's Department of Athletics, including secondary appointments at Pitt as Professor of Mechanical and Material Sciences, Physical Therapy, and Health and Physical Activity. Dr. Fu founded the University of Pittsburgh School of Medicine's sports medicine program in 1986. In 1998, he was named the David Silver Professor and Chairman of the Department of Orthopaedic Surgery at the University of Pittsburgh Medical Center (UPMC). In 2018, the University of Pittsburgh sports complex medical building was renamed the UPMC Freddie Fu Sports Medicine Center. As a leader in sports medicine, Dr. Fu was a proponent for athletic trainers and an ardent supporter of the athletic training profession.

Dr. Fu was also a pioneer in sports medicine and ACL research. In 1996, he was the recipient of the American Academy of Orthopaedic Surgeons Kappa Delta Award. He published more articles concerning the ACL than any other author and more of the top 100 cited papers on ACL research than anyone else in the world. His published work has been collectively cited more than 60,000 times by other authors. In total, Dr. Fu published 705 peer-reviewed articles, 200 non-peer-reviewed articles, 145 book chapters, and 33 major textbooks on sports medicine. He gave 1315 national or international presentations. Dr. Fu was always passionate about supporting and recognizing excellence in sports medicine research.

Dr. Fu passed away on September 24, 2021, at the age of 70. Dr. Fu is survived by his wife of 47 years, Hilda Pang Fu; his daughter, Joyce Lok-See Fu; his son, Gordon Ka-Hong Fu; 5 grandchildren, Ludvine Ling-Yun Fu Martin, Alexander Zee-Yun Fu Martin, Axel Wei-Yun Fu Martin; Kendrick Kai Cheng Fu, and Kasen Kai Sheng Fu; his mother, Mabel Foo; 2 brothers, Frank Fu and Nigel Fu; and 2 sisters, Susan Lam and Jeanette Maeba.

Mrs. Hilda Pang Fu is a graduate of St. Stephen's Girls' School and Hong Kong University, and holds a Master of Library Science degree from the University of Pittsburgh and a Master of Public Management degree from Carnegie Mellon University. She is the founder and president of Luminari, a Pittsburgh-based non-profit formed to broaden minds and inspire innovation.

Mrs. Fu has also served as Director of External Relations of Health Sciences at the University of Pittsburgh, Executive Director of Summer Programs at Point Park University, founding Director of the Pittsburgh Regional Champions. She was the creator of the Pittsburgh Regional Brag Book and was former Chairwoman of the Board of Women and Girls Foundation of Southwestern Pennsylvania. She was also a founding board member of ToonSeum.

# The Doctoral Dissertation Award Presented in Honor of David H. Perrin, PhD, AT Ret, FNATA, FACSM Sponsored by Friends of Dr. Perrin


## Mayrena Hernandez, PhD, MPH, ATC
## Sam Houston State University




Mayrena Hernandez happened into athletic training accidentally during a college scavenger hunt. A fierce competitor, she needed to win, so when the last item on the list was to take a picture with a professor on campus, Hernandez sought out a tall gentleman in a suit—surely, he must be a professor? He was, in fact, a kinesiology professor and the associate dean of the College of Education.

This fated meeting changed Hernandez's life, sparking her interest in athletic training. While she swam in high school, she did not interact with the school's athletic trainer, so, before college, she had not heard of athletic training and so focused on physical therapy. As a first-generation Mexican-American, Hernandez initially experienced difficulties in convincing her parents that athletic training was the way to go, but after a lunch with the tall gentleman—John Buckwalter, PhD, who happened to speak fluent Spanish—they were thoroughly persuaded.

Hernandez went on to obtain a BS in athletic training from the University of Texas-Arlington, an master's in public health from Kansas State University, and a PhD in kinesiology from the University of Wisconsin-Madison. She seeks to marry the athletic training and public health professions, stating that athletic training can be the answer to many public health concerns; for example, Hernandez suggests that athletic trainers could potentially work alongside school nurses to provide treatment for an entire community that may be underinsured or uninsured.

In the same vein, Hernandez's research focuses on how social determinants of health (specifically low socioeconomic status) affect student-athletes. Her parents saw the injury rates in more traditional sports such as soccer and basketball and worried for her health and safety—although swimming had lower injury rates, the risk was still there, and without health insurance, a sport-related injury could be costly. Having to navigate the potential high cost of sport while also acknowledging the benefits it provides (physical activity, discipline) is challenging, especially for those with low socioeconomic status.

Hernandez is currently an assistant professor in the Department of Kinesiology at Sam Houston State University and the director of the Healthy Activity Toward Promoting Injury Reduction (HAPIR) lab. The lab is working on a number of projects, including a survey on a health-needs assessment at a Hispanic-serving institution, conducting preparticipation examinations for a local high school and gathering data on students' perceptions of

the process, and collaborating with Lagree Fitness, who provided Lagree Mini Pro machines, to determine how these machines might benefit posture, balance, and core endurance.

She loves involving both undergraduate and master's students in the HAPIR lab so that they can see firsthand how athletic trainers work alongside other clinicians. She hopes to share her love of research with students and to open their eyes to the profession—this is athletic training. To succeed as an athletic trainer, Hernandez says that you must be curious. Question everything you are taught, realize that earning your degree doesn't mean you're done learning, and stay up to date on the latest research. She highlights that athletic trainers must provide care that is in the best interests of their patients, to advocate for them when no one else will.

Hernandez thanks Cynthia Trowbridge, PhD, ATC, who first introduced her to research and now collaborates with her on the Lagree study. David Bell, PhD, ATC, helped to make her time at the University of Wisconsin-Madison the best 4 years of her life. He kept her on track and focused and let her know that her dissertation shouldn't be a scary thing—she would absolutely do even greater things afterward. She also thanks her colleague, Andrew Winterstein, PhD, ATC; her parents, Sara and Oscar; her younger sister, Sarys; and her husband, Thomas Swain, a fellow athletic trainer, for their support. Hernandez credits Swain as the inspiration behind her dissertation: he was a high school athletic trainer for a primarily Hispanic population, whose insurance barriers and knowledge deficits concerning the health care system led to difficulties in providing care to student-athletes.

**David H. Perrin, PhD, AT Ret**

David H. Perrin, PhD, AT Ret, FNATA, FACSM, is a respected researcher, educator, mentor and friend of athletic training. This 2003 NATA Hall of Fame inductee is a noted pioneer of terminal degrees in sports medicine, and his dedication to athletic training is making an impact on the profession's development even today.

Serving as editor-in-chief of the *Journal of Athletic Training* and founding editor of the *Journal of Sport Rehabilitation* are only two of Dr. Perrin's significant achievements. Others include being awarded NATA's Sayers "Bud" Miller Distinguished Educator Award in 1996, Most Distinguished Athletic Trainer Award in 1998, and All-University Outstanding Teaching Awards from the University of Virginia in 1997 and 1998.

Dr. Perrin has built research education programs at the undergraduate, master's, and doctoral levels and has fully dedicated himself to mentoring and developing future scholars. Dr. Perrin makes every effort to maximize his students' potential by offering sound advice and helping them make the most of their educational programs. Many of his students have gone on to bright careers in the profession, as researchers, program directors, clinical supervisors, and award-winning scholars.

Dr. Perrin was the dean of the College of Health from 2014 through 2022 and is a professor of physical therapy and athletic training and exercise and sport science at the University of Utah.

The NATA Foundation Doctoral Dissertation Award, presented in honor of David H. Perrin, recognizes outstanding doctoral student research and is a fitting tribute to a man who has dedicated the duration of his career to mentoring and developing future scholars.

# Free Communications, Rapid Fire Presentations: Fostering Harmony: Navigating Behavioral Health and Boosting Job Satisfaction

Wednesday, June 26, 2024; 11:25 AM-12:20 PM; Room 260-262
Moderator: Zachary Winkelmann, PhD, ATC

### Burnout and Intent to Leave the Profession Among Athletic Trainers Working in NCAA Power-5 Settings

Eason CM, Abdenour TE, DiSanti JS, Hoffman MA, Post EG, Root HJ: Korey Stringer Institute, University of Connecticut, Storrs, CT; Retired, San Diego State University, San Diego, CA; Duquesne University, Pittsburgh, PA; Oregon State University, Corvallis, OR; Indiana State University, Terre Haute, IN; Northern Arizona University, Phoenix, AZ

**Context:** Burnout is a psychological syndrome that has classically been defined as encompassing emotional exhaustion, depersonalization, and decreased perceptions of personal accomplishment. While burnout rates among athletic trainers are comparable to other health professionals, the impact of the COVID-19 pandemic within the athletic training profession is not fully understood. The objective of this study was to quantify burnout among athletic trainers working at institutions in "NCAA Power 5" athletic conferences following the COVID-19 pandemic, and then examine if burnout is impacting intention to leave the athletic training profession.
**Methods:** This study utilized a cross-sectional online survey of athletic trainers working within the "Power 5" (PAC-12, Big Ten, Big 12, SEC, or ACC) institutions. Participants had to be currently employed as an athletic trainer at a "Power 5" institution and be involved directly in patient care. The online survey, delivered through Qualtrics, consisted of the following sections: 1) participant demographics, 2) participant burnout and intent-to-leave profession, and 3) qualitative questions regarding burnout and intent-to-leave the profession. The Copenhagen Burnout Inventory (CBI) was used to assess the degree of burnout, which is a validated 19-item inventory that measures burnout on a scale of 0-100; (<50=no/low, 50-74=moderate, 75-99=high, 100=severe burnout). The 3 CBI subscales measure personal, work-related, and patient-related burnout and each is measured on a 0-100 scale. Intent to leave the profession was measured using the Intention to Leave survey (ITLS), a validated 7-item inventory that generates a score between 7-28. Higher scores indicate a greater intention to leave the profession. Data were summarized as frequencies with proportions (%) and means with standard deviations (SD).
**Results:** The survey was emailed to 1179 athletic trainers listed on the websites of "Power 5" institutions. Complete data was returned by 302 athletic trainers (mean age 34.3±9.5 years old, 55% female, 25.6% response rate). Participants demonstrated low levels of burnout as per the CBI overall score (43.6±23.2), and CBI subscales identified moderate levels of work-related burnout (50.3±24.7), with low levels of personal (42.2±24.8) and patient-related burnout (37.1±19.8). Similarly, results of the ITLS indicated a low overall level of intent to leave the profession (10.7±3.6). The majority (66%) of participants indicated the COVID-19 pandemic had increased their burnout level "somewhat" (39%) or "to a great extent" (27%), and 39% of participants indicated the pandemic had "somewhat" (30%) or "to a great extent" (9%) increased their intention to leave the athletic training profession.
**Conclusions:** Overall levels of burnout and intentions to leave the athletic training profession were low among athletic trainers within NCAA "Power 5" athletic conferences. Burnout was highest related to work-related factors as opposed to personal or patient factors. The COVID-19 pandemic appears to have increased burnout and intent to leave the profession overall.

Mark Hoffman, PhD, ATC, EMT, FNATA is a professor of Athletic Training at Oregon State University, a member institution of the PAC-12 Conference which is the funding source.

## Impact of Collegiate Student-Athletes Mental Health Status on Daytime Sleepiness

Pazik M, LaMonica T, Farmer KW, Roach RP, Chrabaszcz S, Altman J, Tipper N, Horodyski MB: Department of Orthopaedic Surgery and Sports Medicine, University of Florida, Gainesville, FL

**Context:** Previous research has found that collegiate student-athletes receive less than 7 hours of sleep per night.1,5 Lack of sleep may lead to decreased performance and longer injury recovery time.2,3,6 Additionally, recent research has found a link between decreased mental health and poor sleep habits in collegiate student-athletes.4 The objective of the current study was to investigate the relationship between mental health scores measured via the General Anxiety Disorder 7 Scale (GAD-7) and daytime sleep scores measured via the Epworth Sleepiness Scale (ESS). It was hypothesized that student-athletes with poor mental health scores will also have poor daytime sleepiness as indicated on the ESS.

**Methods:** This was a retrospective review of a prospective database of collegiate student-athletes at an NJCAA institution. Subjects between the ages of 17-30 and who participated on at least one school-sponsored athletic team were enrolled in the database during their initial Pre-Participation Exam (PPE). All student-athletes at the institution complete the GAD-7 and ESS questionnaires as standard practice during their PPE. GAD-7 scores were categorized into 4 levels based on the severity of anxiety: minimal, mild, moderate, or severe. ESS scores were categorized into 4 levels of daytime sleepiness: unlikely to be sleepy, average daytime sleepiness, excessive daytime sleepiness, or extreme excessive daytime sleepiness. To assess differences in GAD-7 scores and ESS Scores based on sex, Mann-Whitney U Tests were utilized for non-parametric data. To assess differences between categories of GAD-7 scores and raw ESS scores analysis of variance (ANOVA) was performed.

**Results:** A total of 204 athletes were included, 115 females and 89 males. The mean age was 19.2 ± .81 years. GAD-7 scores ranged from 0 to 20 (mean=1.04 ± 2.65, 95% CI [.68-1.42]). ESS Scores ranged from 0-23 (mean=6.04 ± 3.51, 95% CI [5.6-6.5]). There was a significant difference between males and females for GAD-7 scores ($p<.001$) but no difference between sexes for ESS scores ($p=.67$). A significant difference was found ($p=.049$) for raw ESS scores based on level of anxiety on GAD-7 questionnaire. Additionally, based on level of anxiety, student-athletes with minimal anxiety (mean = 5.6 ± 3.5) had lower average scores on the ESS questionnaire than student-athletes in the mild (mean = 8.6 ± 3.4), moderate (mean = 7.7 ± 2.5), or severe (mean = 8.5 ± 0.71) anxiety groupings.

**Conclusions:** Student-athletes with mild, moderate, or severe anxiety had higher ESS scores than student-athletes with minimal levels of anxiety. Similar to previously reported literature, there is a difference between sexes for GAD-7 scores, with females reporting higher levels of anxiety than males. Future research should examine how sleep scores may affect mental health decline in student-athletes, specifically females.

## Relationship Between Mental Health Characteristics and Disordered Eating Behaviors Among Collegiate Wrestlers

Franklin T, Runyon M, Severance M, Williams J: Franklin College, Franklin, IN

**Context:** Wrestlers often adopt behaviors to make or maintain body weight without proper guidance and in short amounts of time. Such behaviors may be related to challenges in bio-, psycho-, and social-domains of the athlete's life. Examining relationships between mental health challenges and disordered eating behaviors in male collegiate wrestlers has received relatively little attention in the current literature. Therefore, the purpose of this study was to examine relationships between mental health characteristics and disordered eating behaviors in male collegiate wrestlers.

**Methods:** This study used a cross-sectional survey design. The survey was web-based and consisted of scales from the Depression Anxiety Stress Survey-21 (DASS-21); and the Eating Pathology Symptoms Inventory (EPSI). A purposive sample of male collegiate wrestlers (n=20, age=19.80±1.3) rostered on National Collegiate Athletic Association (NCAA) Division II, III, or National Association of Intercollegiate Athletics (NAIA) affiliated teams during the time of the study were used. The average number of collegiate wrestling experience among the sample was 1.80±1.1 years. Participants identified as White (n=17); Black/African American (n=2); and Hispanic/Latino/x or Spanish Origin (n=1). Wrestling weight classes represented in the sample included 125lbs(n=2); 133lbs(n=1); 141lbs(n=2); 149lbs(n=5); 157lbs(n= 5); 174lbs(n=1); 184lbs(n=1); 197lbs(n=2); 285lbs(n=1). Internal consistency was examined for the DASS-21-Depression, DASS-21-Anxiety, DASS-21-Stress, DASS-21-Composite, as well as the EPSI-Binging, EPSI-Purging, and EPSI-Restriction sub-scales by computing Cronbach alpha coefficients for each scale prior to analysis. Spearman rho correlation analysis was used to explore relationships between disordered eating behaviors and mental health characteristics. Alpha level was set a priori at $p < .05$ for all analyses.

**Results:** The survey instruments demonstrated good internal consistency among this sample of respondents where Cronbach alpha coefficients for the DASS-21-Depression, DASS-21-Anxiety, DASS-21-Stress, DASS-21-Composite, as well as the EPSI-Binging, EPSI-Purging, and EPSI-Restriction, were .86, .74, .90, .93, .88, .90, and .90, respectively. Spearman rho correlation analyses demonstrated statistically significant, positive relationships between EPSI-Binging and DASS-21-Depression (rs=.71, P<.001), EPSI-Binging and DASS-21-Anxiety (rs=.45, P=.05), EPSI-Binging and DASS-21-Stress (rs=.63, P=.003), EPSI-Binging and DASS-21-Composite (rs=.66, P=.002), EPSI-Purging and DASS-21-Depression (rs=.53, P=.018), EPSI-Restriction and DASS-21-Depression (rs=.55, P=.013), as well as EPSI-Restriction and DASS-21-Composite (rs=.49, P=.029).

**Conclusions:** Findings demonstrated a pattern of mental health characteristics among the sample of collegiate wrestlers. Unlike the other mental health characteristics, depression was uniquely related to each of the disordered eating behaviors demonstrating a moderate-high, positive, and statistically significant relationship with binging, purging, and restriction dieting. Clinicians should consider using the DASS-21 to expand their meaningful use of patient reported outcomes that drive more informed, evidence-based management of behavioral health issues among patients. We suggest clinicians use the DASS-21 as a proxy measure to detect wrestlers who may be at risk for engaging in potentially dangerous disordered eating behaviors.

## Moral Distress and Ethical Preparedness in Athletic Training Students

Drescher MJ, Eberman LE: North Dakota State University, Fargo, ND, and Indiana State University, Terre Haute, IN

**Context:** Moral distress is a negative emotional state that arises when someone knows the right thing to do but feels powerless to do it. This occurs in healthcare providers, including athletic trainers, and can lead to burnout and professional attrition. It's unclear if athletic training students feel the same moral distress. Ethics education can mitigate moral distress, but limited data exists on its implementation in athletic training education. Further, it is unknown if students believe that current athletic training education is sufficiently preparing them for ethical ambiguity in clinical practice. This study aims to examine moral distress in athletic training students (ATSs) and whether their education prepares them for ethical ambiguity in clinical practice.

**Methods:** This study used a concurrent mixed-methods design to explore moral distress experiences and perceptions among ATSs, as well as the effectiveness of ethics education curricula. Multiple criterion sampling methods were employed to recruit students in CAATE-accredited athletic training programs who had undergone a clinical immersion experience lasting at least four weeks within the last six months. Semi-structured online interviews were used to capture their experiences. The Measure of Moral Distress in Athletic Trainers (MMD-AT) was used to examine experiences and perceptions of moral distress in ATSs, and these data were used to contextualize the lived experiences of students gathered from the interviews. Data were analyzed using a combination of descriptive statistics and consensual qualitative research (CQR) methods to analyze the MMD-AT and the semi-structured interview data, respectively. Due to the design of the project, participant data were only included in the study if they completed both the MMD-AT and the semi-structured interview.

**Results:** Overall, 20 students completed the survey and a semi-structured interview, with an average age of 24.5±4.0 years and the majority identifying as women (n = 17) and Caucasian (n = 16). The average total score on the MMD-AT was 23.8±24.5 (range: 0-73), indicating a present but low level of moral distress. Composite scores from the MMD-AT were also analyzed and indicated that students felt the highest level of moral distress from unclear, inconsistent treatment plans and pressure from external stakeholders, while they felt the least moral distress from pressure to avoid reporting a colleague who makes a medical error. Three domains and eleven categories related to student experience with moral distress and their perceptions of their preparation were identified from the qualitative data (Table 1). Typically, students accurately described morally distressing situations, but some ATSs inaccurately reflected true moral distress and indicated a lack of understanding of the difference between moral distress and general distress. Students also described methods to deal with distress, including acceptance, withdrawal, and engaging in moral disengagement, with debriefing being the typical response. Educational preparation for dealing with ethical ambiguity in ATSs included field-specific ethical training and problem-based learning with students indicating that they typically viewed morally distressing events as growth opportunities. Generally, ATSs identified experiential learning as an effective method for their preparation. However, students also identified a general belief that they were insufficiently prepared to deal with ethical ambiguity in clinical practice, indicating that their current ethics education was ineffective.

**Conclusions:** Athletic training students experience moral distress from clinical practice and generally feel unprepared by their education to deal with the ethical ambiguity of clinical practice, exposing them to the long-term development of moral distress and potential burnout in the profession. Athletic training educators must focus on integrating effective ethics education practices, such as experiential learning, field-specific ethics, and problem-based learning strategies into athletic training curricula to ensure students learn the skills required to manage ethical ambiguity and moral distress in clinical practice.

Domain and Category Frequency Chart

| Domain, Category | Count | CQR Commonality Characterization |
|---|---|---|
| Moral Distress Definition | | |
| Accurately Described | 12 | Typical |
| Inaccurately Described | 8 | Variant |
| Dealing with Distress | | |
| Withdrawal | 8 | Variant |
| Moral Disengagement | 8 | Variant |
| Acceptance | 5 | Variant |
| Debriefing | 17 | Typical |
| Educational Preparation | | |
| Field-Specific Ethics | 15 | Typical |
| Problem-based Learning | 8 | Variant |
| Experiential Learning | 20 | General |
| Growth Opportunities | 15 | Typical |
| Insufficient Preparation | 19 | General |

*Note.* General=19–20 Cases, Typical=10–18 cases, Variant=4–9 cases, Rare=2–3 cases

## Factors That Influence the Intent to Leave the Athletic Training Workplace

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**Context:** The vitality of the athletic training profession, the profession's capacity to live and grow, has been waning within the last several years with rising job vacancies and declining entry of new athletic trainers (ATs) into practice. Yet, this issue is multi-factorial and several researchers have aimed to identify the primary culprit (e.g. compensation, workplace inclusion, work-life integration). We aimed to explore how workplace expectations, a factor of role congruence, influence ATs intent to leave their current employer.
**Methods:** We used a mixed-methods design with online survey and semi-structured interviews. We recruited ATs using the NATA's Research Survey Service, but only included those who participated in both the survey and interview (n=20; 13 men, 7 women; 40±11 years old, 17±11 years of experience), consistent with explanatory sequential mixed-methods. The survey (Qualtrics, Provo, UT) consisted of 21 demographic questions and 16 questions adapted from the validated Turnover Intention Scale (TIS) (5-point Likert scale, variable indicators with 3 reverse scored items). The range of scores is 5 to 30 (sum) and a score above 18 indicates an intent to leave. The instrument was content validated by four experts in athletic training research and survey design. A Context Validity Index (CVI) was used to assess the demographic questions and TIS items (S-CVI/Ave = 1.00). We developed the interview protocol with 14 primary questions, which was also content validated by the same four experts. All interviews were audio recorded and transcribed verbatim through (Zoom, San Jose, CA) transcription services. Member checking was completed to ensure the trustworthiness of the data. Data were analyzed via a multiphase process and a 3-member coding team that followed the consensual qualitative research tradition. The coding team analyzed the transcripts for core ideas. The final consensus codebook and coded transcripts were externally audited to ensure credibility and trustworthiness.
**Results:** Participants indicated a low intention to leave their current employer (16.7±4.5) when completing the survey. Three main domains characterize the ATs workplace expectations relative to their feelings about leaving their current employer (Table 1): (1) affirming tactics, (2) deterring tactics, (3) and organizational commitment. Within the affirming tactics domain, participants described actions their employer took that helped affirm their commitment to their employer. These tactics included prolonged onboarding processes, regular and clear communication, and mentorship, which accounted for peer-to-peer mentoring. Within the deterring tactics domain, participants described actions their employer took that discouraged them from committing to their employer. Deterring tactics included role incongruence, having to advocate for themselves and the athletic training profession, lacking clarity on what roles and responsibilities are expected within their position, mismanagement of workload, and compensation. The final domain represented how the participants described their commitment to the organization and the factors important to them as individuals. Specifically, participants described that autonomy and control over work, their comfort level within the position and the organization, and the geographical location of the position all influenced commitment to their employer.
**Conclusions:** Overall, participants scored below threshold on the TIS indicating a lower intent to leave for their current employer. Similar to previous literature, this explanatory mixed-methods approach revealed that intent to leave an employer is multi-factorial and participants shared both affirming and deterring tactics from their employers. Participants also acknowledged factors they felt were important to their commitment to the organization. Organizations should be aware of deterring tactics and invest in affirming tactics to help retain ATs.

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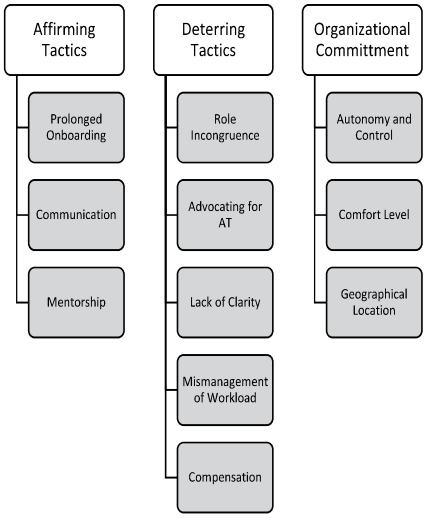
Figure 1: Domains and Core Ideas



## Current Perspectives From Secondary School Athletic Trainers in Managing Mental Health Cases

Jang SH, Drescher MD, Armstrong TA, Neil ER, Eberman LE: Indiana State University, Terre Haute, IN; North Dakota State University, Fargo, ND; Drake University, Des Moines, IA; Temple University, Philadelphia, PA

**Context:** Mental health (MH) conditions are rising among adolescent populations. Specifically, secondary school student-athletes are reportedly experiencing higher depression levels, low-stress management, and emotional difficulties. Secondary school athletic trainers (SSAT) could provide MH management for student-athletes; however, SSAT preparation for MH situations is unknown. This study aimed to investigate SSATs' current preparedness and confidence in managing MH situations.

**Methods:** We use a cross-sectional study with an online survey among SSATs recruited through the NATA Research Survey Service (n=263/3083, 8.5% access rate; n=171/263, 65.0% completion rate; 41±12 years old; 17±11 years of experience). The survey included 47 items for school demographics (11 items), presence of policies, procedures or guidelines (policies) developed from NATA Guidelines and Interassociation Recommendations (16 items), confidence for MH situation management (15 items), and previous MH management experience (5 items). The survey demonstrated high content validity (S-CVI/Ave=0.96) by 3 content experts. The survey was distributed for 4 weeks each time in April/May and October 2023. Survey results were analyzed using descriptive statistics, Mann-Whitney U and chi-square tests to identify differences on the existence of policies between employment structures (school-based, hospital-based) and employment characteristics (full-time with school, full-time split with health care unit, full-time split with academic unit, part-time with school) (SPSS statistical software, Version 28).

**Results:** Most respondents indicated they do not have (49.7%) or were unsure about (21.1%) having policies on preventing, recognizing, and managing MH situations for minor patients participating in secondary school athletics. The existence of specific policies varied between 14.7% (legal implications) and 80.5% (mandatory reporting relative to abuse or neglect) (Table 1). Levels of confidence varied between 46.6% (legal implications) and 81.7% (mandatory reporting relative to abuse or neglect). We identified significant differences between employment structures, but not for employment characteristics for the presence of recommended policies: referral (p=.033), recognizing specific indicators of mental health special considerations (p=.009), monitoring strategies (p=.001), stakeholder education (p=.040), resource availability (p=.006), mandatory reporting relative to county, state, and federal regulations (p<.001), mandatory reporting for potential self-harm or harm of others (p=.002), mandatory reporting for potential abuse and neglect (p=.003), activating chain of command for campus crisis (p<.001), training of stakeholders in recognizing stressors that may lead violence (p=.015), referral for potential violence to mental healthcare providers (p=.005), and a MH emergency action plan (p=.021). School-based employment structures were more likely to have policies.

**Conclusions:** Overall, most SSATs reported they do not have or do not know if they have policies for MH management. However, SSATs rated moderate to high confidence in managing MH situations, suggesting a disconnect between organizational and personal preparedness. SSATs, specifically hospital-based SSATs, should work to incorporate the NATA Guidelines and Interassociation Recommendations about MH management into existing policies.

I received funding from the Indiana State University Graduate Research Fund.

**Table 1**
Presence and Percent Confidence of Implementation of Recommendations.

| Policy, Procedures, or Guidelines<br>Do you have a policy, procedure, or guideline related to: | Presence (mode) | Confidence (mean±SD) |
|---|---|---|
| 1. Referring student-athletes to appropriately credentialed mental health care providers | Yes, 40.9% | 73.0±25.1 |
| 2. Reviewing mental illness in student-athletes to recognize potential psychological concerns | No, 54.7% | 54.1±25.4 |
| 3. Considering unique stressors and triggers with student-athletes to recognize potential mechanisms or events that may create a mental illness or exacerbate an existing mental illness | No, 58.5% | 57.1±26.6 |
| 4. For stakeholders, monitoring strategies to recognize concerning behavior changes that could be related to mental health special considerations (Ex. changes in eating and sleeping habits, unexplained weight loss or weight gain) | No, 51.5% | 60.5±24.7 |
| 5. For stakeholders, monitoring strategies related to student-athletes with mental health special considerations or circumstances (Ex. psychological response to injury, concussions, substance and alcohol abuse, attention-deficit hyperactivity disorder (ADHD) diagnosis, eating disorders, bullying and hazing consideration) | No, 49.4% | 58.4±24.9 |
| 6. The legal implications in developing a plan to deal with the psychological concerns of student-athletes, particularly minors | No, 45.3% | 46.3±26.1 |
| 7. The education of stakeholders on the importance of psychological health | No, 47.6% | 59.3±26.8 |
| 8. The education of stakeholders on the importance of having resources available to promote psychological health (Ex. stress-management strategies, youth mental health services, or resources within the community) | No, 45.6% | 61.2±27.3 |
| 9. The collaboration between stakeholders in developing a plan to address student-athlete psychological concerns effectively | No, 47.4% | 63.2±26.8 |
| 10. Whether those are considered county, state, and federal laws and regulations regarding mandatory reporting | Yes, 67.3% | 77.5±25.5 |
| 11. Mandatory reporting in cases in which an individual poses a risk to themselves or others in any way | Yes, 71.9% | 80.5±22.1 |
| 12. Mandatory reporting in cases in which an individual is being abused or neglected in any way | Yes, 80.5% | 81.7±20.6 |
| 13. Including parental/guardian rights and notification practices regarding student-athlete mental health considerations | Yes, 34.9% | 60.6±28.3 |
| 14. The chain of command and contact protocol for the campus crisis intervention team regarding student-athlete mental health considerations | Yes, 56.9% | 70.3±26.8 |
| 15. Regarding the training of stakeholders in recognizing a variety of potential traumatic stressors that may cause a traumatic stress reaction or violence in student-athletes | No, 39.5% | 59.0±27.4 |
| 16. Regarding the referral of student-athletes who exhibit potential traumatic stressors that may cause a traumatic stress reaction or violence to credential mental health care providers | Yes, 38.6% | 65.3±28.6 |
| 17. A recognition and referral pathway for mental health emergencies that serves as your action plan when an emergency occurs | Yes, 48.7% | 68.6±27.0 |

## A 5-Year Update to Collegiate Athletic Trainers' Preparedness and Confidence in Addressing Mental Health Concerns

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**Context:** In 2020, the COVID-19 pandemic shutdown created isolation for many student-athletes. Since then, rates of mental health (MH) conditions in this population have risen 2 to 3 times. The purpose of this study was to provide a 5-year follow-up to an assessment of collegiate athletic trainers' (AT) preparedness and confidence in addressing MH concerns.
**Methods:** We used a cross-sectional, web-based survey: institutional demographics (5 items), MH policy creation and incident rates (4 items), participant demographics (6 items), contemporary expertise and professional development (4 items), presence of NCAA recommended policies/procedures (23 items), confidence in screening, preventative patient education, recognizing and referring routine and emergency MH situations (6 items; 5-point Likert scale: 1=not at all confident, 5=very confident). The survey was developed from prior research and validated using a content validity index for relevance by 3 content and methods experts (Scale-CVI/AVE=0.92). We used a multi-pronged recruitment approach including the NATA Research Survey Service with 3082 e-mails (236 accessed [7.65%], 208 completed [88.14%], 105 viable [50.48%]). We posted 9 times to "X" (6 viable responses). We also used snowball sampling through NCAA athletic training supervisors via e-mail (38 viable responses). A true response rate is not calculable; however, the distribution between collegiate divisions and representativeness of the sample is consistent with the reported characteristics of the population (149 respondents; age=37±11y, years of experience=14±10y; NCAA Division I=59, 39.6%, NCAA Division II=39, 26.2%, NCAA Division III=34, 22.8%, NCJAA=11, 7.4%, NAIA=6, 4.0%). Data were analyzed using descriptive statistics.
**Results:** ATs report high levels of confidence for screening (mean=3.7±0.9; mode=4, 43.0%, n=64), preventive patient education (3.8±0.9; mode=4, 43.6%, n=65), recognition of routine MH situations (4.1±.7; mode=4, 56.4%, n=84), referral of routine MH situations (4.3±0.7; mode=5, 46.3%, n=69), recognition of emergency MH situations (4.3±0.7; mode=4, 46.3%, n=69), and referral of emergency MH situations (4.3±0.8; mode=5, 47.7%, n=71), which was similar to data from 5 years ago. The ATs report having developed contemporary expertise in the prevention, recognition, and collaborative care of MH situations through personal experience (n=89, 59.7%), family/friend experience (n=70, 47.0%), clinical experience (n=102, 68.5%), professional development (n=113, 75.8%), and scholarship experience (n=12, 8.1%). Substantial structural changes have occurred in the 5-year update relative to the proliferation of policies for MH situations (Table 1); however, the lack of policy for re-entry into sport (n=64, 43.0%) and the distribution of MH emergency action and management plans to stakeholders (n=45, 30.2%) is still concerning.
**Conclusions:** ATs are generally confident and knowledgeable about recognizing and referring patients with MH situations comparable to 5 years ago. While more policies have been developed, the continued proliferation of policies and procedures as well as the regular refinement of these policies is necessary to match the rise of MH concerns in collegiate student-athletes.

Received funding from Indiana State University Graduate Research Fund.

**Table 1.** Chart Review of Mental Health Policies Inclusion (n = 149)

| Prompt | Yes | No | Unknown |
|---|---|---|---|
| Formal mental health evaluation or treatment by qualified practitioners | 127, 85.2% | 17, 11.4% | 5, 3.4% |
| Identifies behaviors related to mental health emergencies | 123, 82.6% | 17, 11.4% | 9, 6.0% |
| Written procedure for management of suicidal/homicidal ideation | 113, 75.8% | 20, 13.4% | 16, 10.7% |
| Written procedure for management of sexual assault | 97, 65.1% | 26, 17.4% | 26, 17.4% |
| Written procedure for management of acute psychosis or paranoia | 83, 55.7% | 34, 22.8% | 56, 35.6% |
| Written procedure for management of acute delirium/confusional state | 41, 27.5% | 55, 36.9% | 53, 35.6% |
| Written procedure for management of acute intoxication/ drug overdose | 64, 43.0% | 29, 80.6% | 28, 18.8% |
| Immediately identifies medical services | 134, 89.9% | 5, 3.4% | 10, 6.7% |
| Identifies local protocol for involuntary retention | 88, 59.1% | 31, 20.8% | 30, 20.1% |
| Management expectations of each stakeholder during a crisis situation | 104, 69.8% | 25, 16.8% | 20, 13.4% |
| Steps following an emergency situation has resolved for patient support | 56, 37.6% | 64, 43.0% | 29, 19.5% |
| Formal policy for contacting family for a mental health emergency | 61, 40.9% | 48, 32.2% | 40, 26.8% |
| Policies are provided to stakeholders specifying management roles | 76, 51.0% | 45, 30.2% | 28, 1838% |
| Identifies symptoms/behaviors of non-emergent mental health concern | 105, 70.5% | 23, 15.4% | 21, 14.1% |
| Specifies referral to a licensed mental health professional | 118, 79.5% | 21, 14.1% | 10, 6.7% |
| Specifies who should be responsible for making the referral | 104, 69.8% | 29, 19.5% | 16, 10.7% |
| Provides written instructions for referral of non-emergent situations | 110, 73.8% | 27, 18.1% | 12, 8.1% |
| Pre-participation exam includes screening for mental health disorders | 79, 53% | 27, 18.1% | 5, 3.4% |
| Procedure for when/where symptomatic or at-risk SA will be referred | 99, 66.4% | 34, 22.8% | 16, 10.7% |
| Annual meetings to develop strategies of education and management | 64, 43% | 45, 30.2% | 40, 26.8% |
| SAAC representatives and SA receive annual information | 61, 40.9% | 31, 20.8% | 57, 38.3% |
| SAAC representatives and SA receive annual information on prevention and response | 85, 57.0% | 22, 14.8% | 42, 28.2% |

**Legend:** SA=Student-Athlete, SAAC=Student-Athlete Advisory Committee

### The Validity of Low-Cost Handheld Dynamometers for Assessing Quadriceps Strength in Individuals With ACL Reconstructed Knees

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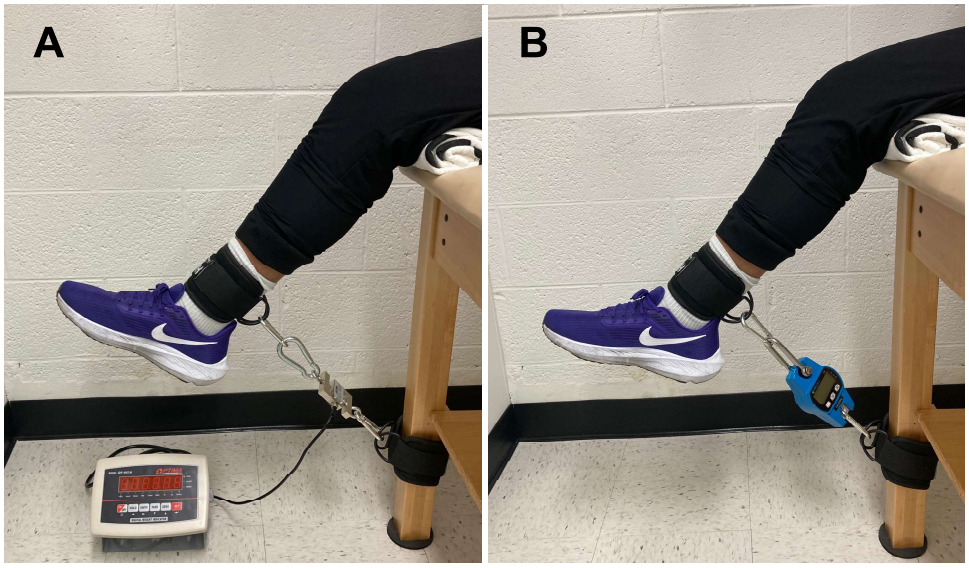
**Context:** Objective measures of quadriceps strength are a key outcome in patients recovering from anterior cruciate ligament reconstruction (ACLR) surgery. Handheld dynamometers (HHDs) may provide an affordable alternative tool for measuring quadriceps strength compared to the "gold-standard", but expensive ($40-50k USD), isokinetic dynamometers (IKDs). The purpose of our study was to explore the ability of two low-cost HHDs to perform valid measures of unilateral quadriceps strength and limb symmetry index (LSI) in individuals with ACLR knees when compared to an IKD.
**Methods:** We used a descriptive laboratory design and data were collected in a laboratory setting. Our sample included N=24 participants with a history of primary, unilateral, ACLR greater than 4-months prior to testing (4 males/20 females; 21.1±3.1 years old; 37.6±31.9 months post-surgery). We measured bilateral, maximum isometric knee extension torque at 60-degrees knee flexion on all participants using three different dynamometers in a randomized order. Our three dynamometers included a Biodex IKD with standard knee testing setup and two low-cost HHDs, HHD A ($50) and HHD B ($390). For each HHD dynamometer, participants were seated on a standard treatment with the HHDs secured to the participants' ankle and the treatment-table leg using two padded ankle cuffs and metal carabiners (Figure 1). Testing procedures were the same for all three dynamometers. Participants were seated upright with arms across their chest, a waist belt, and knee flexed to 60-degrees. On each limb, participants completed practice trials followed by 3 maximal isometric contraction trials. HHD force measures were converted to torque using each participant's knee extension moment arm (=joint line to ankle cuff). We calculated average peak isometric torque on each limb (Nm) and the LSI between limbs (%). We compared the HHD and IKD measures using Pearson's-r correlation coefficients and one-way ANOVAs.
**Results:** Both HHDs demonstrated "excellent validity" for unilateral strength measures in the ACLR (HHD A: r=0.80, HHD B: r=0.83) and contralateral (HHD A: r=0.84, HHD B: r=0.81) limbs compared to IKD. Average unilateral strength measures were lower with both HHDs compared the IKD on both the ACLR (IKD: 133.4±31.1 Nm, HHD A: 115.6±33.4 Nm, HHD B: 113.5±33.9 Nm) and contralateral limb (IKD: 158.6±40.8 Nm, HHD A: 122.3±36.2 Nm, HHD B: 120.6 ± 38.0 Nm). Both HHDs demonstrated "moderate-to-good" validity for LSI measures compared to the IKD (HHD A: r=0.50-0.55); however, both HHDs overestimated LSI measures compared to the IKD (IKD: 85.4±11.2%, HHD A: 95.4±10.6%, HHD B: 95.5±13.0%).
**Conclusions:** The two low-cost HHDs demonstrated "excellent validity" performing unilateral measures of quadriceps strength. Both HHDs demonstrated "moderate-to-good validity" performing measures of quadriceps strength LSI; however, both HHDs overestimated LSI by an average of 10% compared the IKD. Clinicians adopting similar HHD quadriceps strength testing methods may need to use a more conservative LSI criterion.

The project was funded by a research grant from the Virginia Athletic Trainers Association (VATA).



**The Relationship Between Patient-Reported Outcome Measures and Return-to-Sport Assessments in Patients Post-Anterior Cruciate Ligament Surgical Reconstruction**

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**Context:** Psychosocial health effects on post-operative recovery is of interest, with perceived poor health thought to negatively impact recovery trajectories. Understanding the relationship between patient-perceived health mid-rehabilitation and objective outcomes at return-to-sport (RTS) will help clinicians ensure rehabilitation meets the specific needs of patients. The purpose of this study was to determine the relationship between mid-rehabilitation patient-report of health and RTS assessments in anterior cruciate ligament reconstruction (ACL-R) patients.

**Methods:** A retrospective chart review of patients who presented to a pediatric hospital for ACL-R between March 2020-March 2022 was conducted. Patients were identified using CPT codes 27429 and 29888. Patients were included if they were age 11-21 at time of surgery and completed mid-rehabilitation and RTS assessments. Patients completed the ACL-Return-to-Sport Index Short Form (ACL-RSI SF) and Pediatric International Knee Documentation Committee (Pedi-IKDC) form during mid-rehabilitation evaluation (average 5.7±.73 months post-surgery) and performed strength and functional testing during the RTS evaluation (average 9.1±1.6 months post-surgery). Outcome variables included absolute peak torque knee extension, absolute peak torque knee flexion, limb symmetry index (LSI), single leg hop for distance, and 30-second side hop tests. Pearson correlations (r) were used to estimate the strength of association between patient-reported scores at mid-rehabilitation with strength and function outcome variables during RTS evaluation. Significance was set at $p<.05$. Correlations were interpreted as little-to-no (0.0-.25), fair degree (.26-.50), moderate-to-good (.51-.75), and good-to-excellent (>.75) relationship.

**Results:** 44 patients were included in analysis. Patients were male (50%, n=22) and female (50%, n=22), averaged 15.5±1.48 years old, and most received a patellar bone-tendon-bone autograft (77.3%, n=34). Higher Pedi-IKDC scores at mid-rehabilitation were predictive of higher peak torque during knee extension on the operative leg ($r=.37$, $p<0.05$) and better knee extension LSI ($r=.38$, $p<0.05$) at RTS testing. Higher Pedi-IKDC scores mid-rehabilitation were predictive of a lower hamstring-to-quadriceps ratio on the operative leg ($r=-0.37$, $p<0.05$) at RTS testing. Higher ACL-RSI SF scores mid-rehabilitation were predictive of lower 30-second side hop repetitions on the operative ($r=-0.48$, $p<0.05$) and non-operative ($r=0.46$, $p<0.05$) legs. All correlations are presented in Table 1.

**Conclusions:** These correlations suggest that patient self-report of health, function, and readiness to return-to-sport midway through rehabilitation help anticipate strength and functional outcomes at return-to-sport. However, there are inconsistencies between patient self-report and performance measures that warrant consideration. Using patient self-report and strength and function testing along the care trajectory is important to identify patients who may self-report a readiness to participate, but, objectively, may return to sport prematurely. Conversely, patients may fail to participate in rehabilitation because they believe they have fully recovered. Interventions to support patients with lower self-reported health and function may help promote positive outcomes. The unexpected finding that readiness to return-to-sport predicts lower repetitive jumping performance needs further study.

| RTS Outcomes | n | ACL-RSI SF | Pedi-IKDC |
|---|---|---|---|
| Operative Leg | | | |
| Peak Torque Knee Extension | 43 | -0.100 | 0.369* |
| Peak Torque Knee Flexion | 43 | -0.127 | 0.151 |
| Hamstring:Quadriceps Ratio | 43 | -0.102 | -0.373* |
| Single Leg Hop For Distance | 15 | -0.253 | 0.297 |
| 30-Second Side Hop Reps | 24 | -0.480* | 0.215 |
| Non-Operative Leg | | | |
| Peak Torque Knee Extension | 22 | -0.260 | 0.134 |
| Peak Torque Knee Flexion | 22 | -0.147 | 0.111 |
| Hamstring:Quadriceps Ratio | 22 | 0.137 | -0.043 |
| Single Leg Hop For Distance | 15 | -0.272 | 0.269 |
| 30-Second Side Hop For Reps | 14 | -0.456* | 0.237 |
| Limb Symmetry Indices | | | |
| Knee Flexion | 43 | 0.054 | 0.114 |
| Knee Extension | 43 | 0.208 | 0.381* |
| Single Leg Hop For Distance | 15 | -0.253 | 0.297 |
| Sing Leg Side Hop For Reps | 14 | -0.054 | -0.115 |

Anterior Cruciate Ligament Return-to-Sport Index, Short-Form = ACL-RSI SF
Pediatric International Knee Documentation Committee Form = Pedi-IKDC
* $p<0.05$

## Impaired Explosive and Peak Quadriceps Strength Are Associated With Arthrogenic Muscle Inhibition in ACL-Reconstructed Females

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**Context:** Individuals who have undergone ACL reconstruction (ACLR) often exhibit reduced peak and explosive quadriceps strength, quantified by maximal voluntary isometric contraction (MVIC) and rate of torque development (RTD), respectively. These neuromuscular deficits, potentially linked to arthrogenic muscle inhibition (AMI), elevate the risk of a subsequent ACL injury and should be addressed in rehabilitation. However, limited research has explored the underlying factors contributing to quadricep deficits post-ACLR, particularly RTD. Therefore, this study aimed to examine the association between quadriceps AMI and neuromuscular function, specifically RTD and MVIC, in females with ACLR.
**Methods:** Twenty-nine ACLR females (Age: 25.52±5.17 years, Height: 162.02±6.01cm, Mass: 62.10±10.99 kg, Time after surgery: 23.97±27.65 months, Tegner Activity Scale score: 6.10±1.50) were participated in this cross-sectional study. Isometric quadriceps torque-time curves were recorded in the reconstructed limb using a Biodex System 4 dynamometer during three RTD and MVIC trials. Peak torque was identified and defined as the MVIC during each MVIC trial, while RTD was calculated by fitting a line of best fit to the recorded torque-time curve between torque onset and 100 milliseconds after onset during each RTD trials, both of which were normalized by body mass. The selected timeframe is based on the contribution of neural drive excitation to the early phase of RTD. A superimposed burst (SIB) was given and torque productions during three SIB trials were collected and AMI, quantified by central activation ratio (CAR) was calculated. Quadriceps CAR, RTD, and MVIC were averaged across three trials for statistical analysis. Separate Pearson product moment correlations (r) were used to determine the strength of association between CAR, RTD, and MVIC.
**Results:** The mean and standard deviation of quadriceps CAR, RTD, and MVIC were 76.36±15.99%, 7.87±3.53 Nm/s/kg, and 1.15±0.44 Nm/kg, respectively. In the primary analysis, no significant association was found between CAR and RTD (r=.17, p=.39), nor between CAR and MVIC (r=.28, p=.14). To further investigate this relationship, we implemented a 90% CAR cutoff to identify 20 ACLR females with more pronounced AMI. This secondary analysis uncovered noteworthy findings, showing statistically significant correlations indicating that lower CAR is associated with reduced RTD (r=.53, p=.02), as well as decreased MVIC (r=.62, p=.003).
**Conclusions:** The study reveals that lower quadriceps CAR is associated with RTD and MVIC reduction, particularly in ACLR females with more severe AMI (CAR<90%). Notably, Quadriceps CAR accounts for a substantial portion of the variance in both RTD (28.52%) and MVIC (38.93%). These findings emphasize the potential benefits of incorporating disinhibiting interventions, especially within explosive and peak quadriceps muscle strengthening programs, to effectively restore muscle function when ACLR patients exhibit significant quadriceps AMI.

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## A Single-Bout Transcranial Direct Current Stimulation (tDCS) With Proprioceptive Training Can Enhance Knee Joint Position Sense After ACL Reconstruction

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**Context:** Numerous patients who have undergone anterior cruciate ligament reconstruction (ACLR) procedures experience ongoing proprioceptive deficits, even after mechanical stability has been re-established. The diminished proprioception could be attributed to deafferentation between the central nervous system (CNS) and mechanoreceptors in the knee joint. Proprioception plays a crucial role in maintaining functional knee stability and achieving a successful return to pre-injury level for ACLR patients. A novel approach that could potentially optimize neuroadaptation within the CNS to enhance proprioception is transcranial direct current stimulation (tDCS). The purpose of the current study was to explore the therapeutic effects of tDCS on knee proprioception in ACLR population. We hypothesized that a single-bout tDCS combined with proprioceptive training intervention would improve knee proprioception in ACLR patients.

**Methods:** This study employed a randomized cross-over design and was conducted in a research laboratory. Fifteen patients with a history of unilateral ACLR (ACLR: 20.60±1.59yrs, 71.72±13.51kg, 169.02±9.21cm, M/F: 7 / 8) along with 15 healthy individuals (CONT: 21.13±3.18yrs, 65.36±9.98kg, 166.97±10.35cmM/F: 7 / 8) who had no history of lower extremity injury were included. Each participant completed three sessions: pre-intervention, sham-tDCS (S-tDCS), and anode-tDCS (A-tDCS) sessions. The order of S-tDCS and A-tDCS was randomized. During each session, participants underwent 20 minutes of stimulation, combined with proprioceptive training on a wobble-board with perturbations. Stimulation was targeted at the primary motor (M1) and somatosensory cortices (S1). Participants completed one session per week, with a one-week interval between each session. Joint position sense (JPS) was evaluated using an isokinetic dynamometer during at each visit. The absolute JPS error (JPSAE) calculated as |45□-acquired angle| was used to quantify JPS and compared across groups (ACLR and CONT) and three sessions (Pre-intervention, S-tDCS, A-tDCS) using repeated measures ANOVAs.

**Results:** A significant main intervention effect (p=.009) was revealed. Multiple pairwise comparisons indicated that A-tDCS (4.75±0.45) had significantly lower JPSAE than pre-intervention (6.12±0.44, p=0.012). However, there was no significant difference between pre-intervention and S-tDCS (4.71±0.53, p=0.065) nor between A-tDCS and S-tDCS (p=1.00).

**Conclusions:** Our results highlight the possibility of a single-bout tDCS intervention on M1/S1 combined with proprioceptive training that might benefit individuals with proprioceptive deficits after ACLR to enhance their proprioceptive recovery. However, our ACLR did not show a deficit in proprioception measured by JPS test compared to healthy CONT. Our results may indicate that ACLR can recover proprioception after six months post-ACLR procedure and have a similar JPS ability to healthy individuals. Furthermore, it is still unknown whether tDCS enhanced brain function during the proprioceptive rehabilitation program. Future studies need to explore the tDCS therapeutic effects on brain function in ACLR patients with a neuroimaging tool such as EEG.

**Limb Loading and Quadriceps Strength Recovery After ACL Reconstruction**

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**Context:** Common rehabilitation goals following anterior cruciate ligament reconstruction (ACLR) include restoring movement quality and regaining lower extremity strength to reduce reinjury risk. It is unclear if movement quality (limb loading during bilateral body weight squats) and strength convalesce in concert from early to late-stage recovery. This study was designed to describe how limb loading and strength changed from early to late-stage recovery and quantify the relationship between the change in limb loading symmetry and the change in strength symmetry.

**Methods:** Patients' (32 females / 28 males, 22.5±9.35yrs) limb loading and strength were assessed at Session 1 (4.9±1.44 months) and 2 (8.0±1.90 months) following ACLR. Patients completed three sets of three body weight squats, to a metronome set at 40 beats per minute, while standing on an instrumented pressure mat (Tekscan SBmat, Norwood MA). Limb loading peak force (N) was recorded bilaterally during the squatting task. Quadriceps isometric peak torque (Nm) values were collected bilaterally during a 30-second maximal effort trial using an isokinetic dynamometer (Biodex System IV, Shirley NY) set at 90 and 85-degrees of knee and hip flexion respectively. Limb symmetry index (LSI; operative / non-operative x 100%) was calculated for limb loading peak force and isometric peak torque across sessions. Change scores were calculated from the difference in LSI measures from Session 1 and 2 for limb loading and strength metrics. Analyses of variance were conducted comparing limb loading peak force and strength peak torque across limbs and time. A Pearson's correlation coefficient (r) correlation was calculated to determine if there were any relationships between limb loading and strength LSI change scores. All analyses were performed using SPSS Version 28 (IMB Corp, Chicago IL) with $\alpha \leq 0.05$.

**Results:** A limb-by-time interaction ($F(1,59)=5.71$, $p=0.02$) was observed for limb loading peak force (N) where the ACLR limb was underloaded at Session 1 compared to the contralateral limb ($t=2.42$, $p < 0.01$, $d=0.31$ [Table 1]). However, patients loaded the ACLR limb more over time ($t=1.83$, $p=0.04$, $d=0.24$). Additionally, a limb-by-time interaction ($F(1,59)=36.40$, $p < 0.001$) for quadriceps peak torque (Nm) was observed. The ACLR limb had increased peak torque across sessions ($t=9.69$, $p < 0.001$, $d=1.25$, [Table 1]), however strength deficits persisted at both sessions (Session 1: $t=14.69$, $p < 0.001$, $d=1.90$; Session 2: $t=11.23$, $p < 0.001$, $d=1.45$). No significant relationships were observed between change scores for limb loading and strength LSI ($p > 0.05$).

**Conclusions:** Throughout recovery, limb loading generally increased on the ACLR limb and decreased on the contralateral limb during the squatting task. Quadriceps peak torque also increased across sessions. No relationship was observed between change scores of limb loading and strength symmetry. This could indicate strength and motor control, determined via limb loading, recover independently.

This study was supported by funding from the Innovative, Development Exploratory Award (IDEA) research and development fund from the School of Education and Human Development at the University of Virginia. This study was also supported by funding from the graduate student summer research fellowship from the American College of Sports Medicine (ACSM) Biomechanics Interest Group (BIG).

**Table 1.** Limb Loading and Strength Metrics Across Time (Mean±SD)

| Variable | Session 1 | Session 2 |
|---|---|---|
| ACLR Limb Loading Peak Force (N) | 502.79±142.64* | 527.02±159.41† |
| Contralateral Limb Loading Peak Force (N) | 560.32±149.58 | 547.30±152.56 |
| LSI Limb Loading Peak Force (%) | 94.95±32.79 | 99.92±29.11 |
| ACLR Limb Quadriceps Peak Torque (Nm) | 99.24±37.80* | 123.36±43.46*† |
| Contralateral Limb Quadriceps Peak Torque (Nm) | 169.38±47.29 | 173.29±48.84 |
| LSI Quadriceps Peak Torque (%) | 59.12±18.94 | 71.49±17.30 |

LSI, Limb Symmetry Index; *Difference between limbs, $p<0.05$; †Difference between Session 1 and Session 2, $p<0.05$

**Change of Direction Performance Does Not Improve From 6 to 9 Months Post-ACLR**

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**Context:** Change of direction (COD) is a common sport-related maneuver and a leading cause of ACL injury; yet it is rarely evaluated following ACL reconstruction (ACLR). The increased injury risk during COD is partially due to high-risk biomechanics like small knee flexion angle (KFA), large knee abduction angle (KAA), and high vertical ground reaction force (vGRF). Generally, individuals with ACLR are medically cleared to initiate COD activities 6 months post-surgical and resume unrestricted sport participation at 9 months post-ACLR. However, there is limited evidence to suggest COD performance or knee biomechanics improve during this time. The purpose of this study was to assess changes in pro-agility (ProA) and agility T-test (ATT) completion time; and changes in knee biomechanics during an unplanned crossover drop jump (uXDJ) from 6 to 9 months post-ACLR. We hypothesized that individuals with ACLR will display significantly faster ProA and ATT completion times and greater KFA, lesser KAA, and lesser vGRF in the ACLR limb during the uXDJ at 9 months compared to 6 months post-ACLR. As an exploratory aim, we compared the uXDJ KFA between limbs at 9 months post-ACLR.

**Methods:** Seventeen participants (Female=53%; age=20.9±4.2 years; months post-ACLR at enrollment=6.8±0.6) completed the study. The ProA involves three sprints (4.57-9.54 m) and two 180° COD. The ATT involves four sprints (4.57-9.54 m), one 9.14 m back pedal, and four COD (90°-180°). Three left and three right trials of the ProA and ATT were collected. Completion time (s) was recorded using a motion-sensitive timing system. Biomechanical data were collected using 3D motion capture and force plate. During the uXDJ, participants stood on the ACLR limb, and jumped from a 30-cm box positioned 40 cm from the force plate then hopped at a 45° angle either away from or toward one of two light-emitting sensors, activated by a motion-sensitive trigger. Trials in which the participant hopped in the direction opposite the ACLR limb were reported. Separate one-way repeated measures ANOVA with partial eta-squared effect size were used to assess differences in completion time and knee biomechanics between 6 and 9 months. Between limb differences in KFA were compared using a one-way ANOVA. The a priori alpha level was set at 0.05.

**Results:** We observed no significant improvement in ProA (p= 0.07) or ATT completion time (p= 0.06), or in knee biomechanics (p=0.28-0.95) from 6 to 9 months post-ACLR, Table 1. The uninvolved limb KFA (54.7±7.92°, p=0.045) was significantly greater at 9 months compared to the ACLR limb (47.6±10.87°).

**Conclusions:** COD performance and knee biomechanics did not improve from 6 to 9 months post-ACLR, which is a potential barrier to sport participation. Furthermore, deficits in ACLR limb KFA is a risk factor for secondary ACL injury that requires targeted training before returning to sport.

This project was supported the NATA Research and Education Foundation Doctoral Student Grant (Award#1920DGP06).

Table 1. Change in Completion Time and uXDJ Knee Biomechanics 6 to 9 Months Post-ACLR

| | 6 months | 9 months | SS | MS | F | *p* | $\eta^2_p$ |
|---|---|---|---|---|---|---|---|
| Pro-agility (s) | 6.35±0.96 | 6.12±0.99 | 0.42 | 0.42 | 3.87 | 0.07 | 0.20 |
| Agility T-test (s) | 12.90±1.70 | 12.10±1.68 | 2.70 | 2.70 | 4.34 | 0.06 | 0.24 |
| uXDJ | | | | | | | |
| Flexion (°) | 43.10±10.20 | 47.60±10.90 | 54.60 | 54.60 | 1.29 | 0.28 | 0.08 |
| vGRF (xBW) | 3.74±0.52 | 3.71±0.56 | 0.0004 | 0.0004 | 0.004 | 0.95 | 0.00 |
| Abduction (°) | 4.09±4.75 | 3.93±6.67 | 0.20 | 0.20 | 0.01 | 0.93 | 0.00 |

vGRF=vertical ground reaction force; SS = sum of square; MS = Mean Square; uXDJ=unplanned crossover drop jump; xBW=normalized to body weight in Newtons

## Time of Return to Sport Testing Following ACL Reconstruction

Pales Taylor ML, Ihn H, Cushman DM, Bodkin SG: University of Utah, Salt Lake City, UT

**Context:** Approximately 1 in 4 individuals following Anterior Cruciate Ligament Reconstruction (ACLR) will have a subsequent ACL injury. There is strong evidence to support greater risk of reinjury when individuals return to sport (RTS) prior to 9 months post-surgery. Early administration of RTS testing, aimed to identify functional deficits, may promote sport or activity clearance before this time. Therefore, the purpose of this study was to systematically review the literature to identify when RTS testing is administered in patients following ACLR.

**Methods:** A systematic review, following Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, was conducted (Figure 1). Our search was performed utilizing Pubmed, EMBASE, SPORTDiscus, CINAHL, and Cochrane Library, within the dates of January 2008 to October 2023. Inclusion criteria did not limit participant age, country of origin, primary or recurrent reconstruction, graft type, testing battery, or level of sport or activity. Studies were included if functional batteries were administered following ACLR with the purpose of informing RTS decisions. Studies were excluded from the review if testing was administered after full clearance for sport or activity participation. Abstract and full text reviews were performed by 2 independent reviewers, with all conflicts resolved by a third reviewer. Studies with descriptive (mean ± standard deviation) timepoints were included for a pooled analysis. Articles with stratified study samples were included as multiple, separate cohorts. A pooled mean and 95% confidence interval were calculated for the average time of RTS testing from all extracted samples.

**Results:** After duplicate studies were removed, a total of 1,086 articles were identified for screening. Following abstract (n studies = 354) and full text review (n studies = 162) we identified 94 studies that met the inclusion and exclusion criteria as well as reported descriptive timepoints of RTS testing (Figure 1). A total of 94 studies with 133 separate cohorts resulted in 9,344 individuals for a pooled analysis. The average time of RTS test administration was 7.30 (7.23, 7.33) months post-ACLR.

**Conclusions:** Within the literature, RTS testing is administered approximately 7 months following ACLR. Conducting RTS assessments at this timepoint may promote sport clearance before evidence-based recommendations. Healthcare teams should collectively discuss the appropriate time to administer assessments with the goal of making RTS decisions.

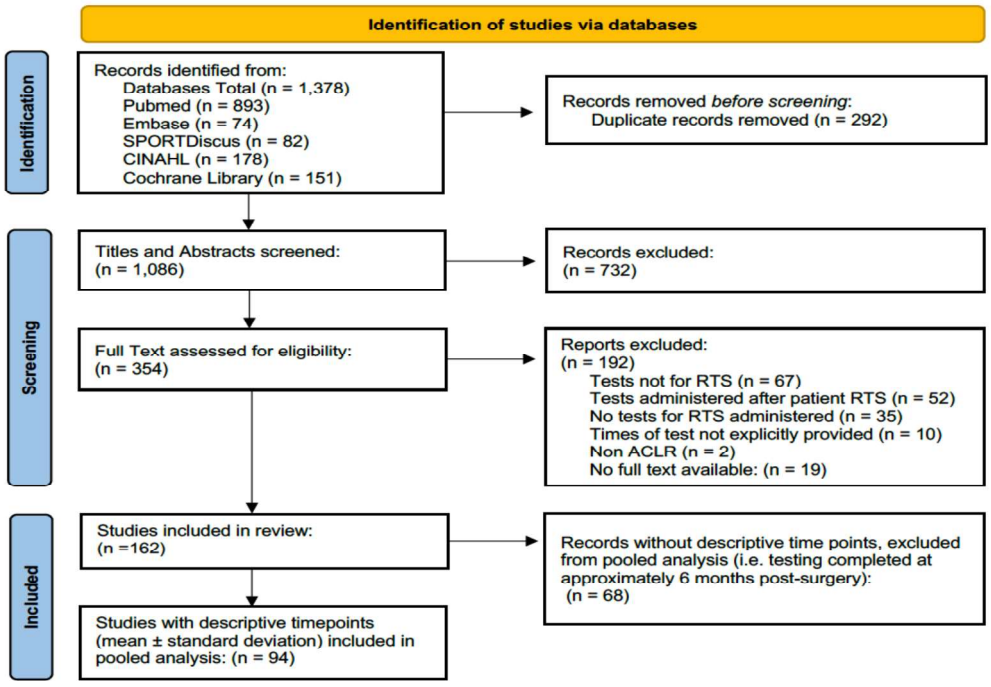


Figure 1. PRISMA flow diagram of study selection process.

### Football Helmet Characteristics and Maintenance Processes Among Arizona Secondary School Athletic Programs

Peterson B, Hayward D, Valovich McLeod TC: Palo Verde Magnet High School, Tucson, AZ; Highland High School, Gilbert, AZ; A.T. Still University, Mesa, AZ

**Context:** The proper fit and maintenance of football helmets is an important risk reduction tactic for athlete safety. Recent initiatives by the National Football League and Virginia Tech University have aimed to classify football helmets by the results of laboratory and field impact testing and make recommendations for use. It is unknown how secondary schools routinely fit and maintain helmets and whether the helmets used are of sufficient ratings. Our purpose was to evaluate the helmet characteristics and maintenance processes among secondary school football programs.

**Methods:** Participants with knowledge about football operations were solicited via email by the state interscholastic athletic association to complete an online survey developed by the sports medicine advisory committee and validated for content validity by sports medicine experts and athletic directors. The survey consisted of 5 sections that included Likert, multiple choice, select all that apply, and open-ended questions related to demographics, athletic trainer (AT) access, football helmets, helmet fitting and maintenance, and risk reduction. Descriptive statistics (percentages, frequencies) were reported. Independent samples Kruskal-Wallis tests were used to assess differences in dependent variables across football divisions ($p<.05$).

**Results:** The survey was completed by 177/242 respondents (response rate=73%). Respondents included athletic directors (53.1%), athletic trainers (26.6%), football coaches (10.2%), and equipment managers (6.2%) from all six football divisions. ATs were accessible at 79.1% of schools. The most commonly used helmet was the Riddell Speed Flex (77.7%), followed by the Riddell Speed Classic Icon (40.0%), Schutt F7 (26.3%), and Schutt Vengeance (25.1%), with only the Riddell Speed Flex recommended by the NFL and all but the Schutt Vengeance rated as 5 by the Virginia Tech ratings. The majority of schools (79.7%) recertify helmets annually, with a smaller proportion recertifying every other year (14.7%) or every three years (2.3%). Most schools make replacement decisions based on the results of the helmet recertification process (55.1%) or have a budget line to replace those that are aging out or do not pass the recertification process (42%). The majority of schools (68.9%) noted they have formal training for those engaged in helmet fitting with 11.9% noting this training is annual. Individuals responsible for helmet processes are provided in the table. The most commonly used risk reduction strategies include appropriate fitting helmets (96.6%), having an on-site athletic trainer (81.1%), tackling technique training for players (75.5%), and limiting contact practices (67.3%). Differences between football divisions were noted for AT access ($p<.001$), frequency of recertification ($p<.001$), and in-season helmet checks ($p=.004$).

**Conclusions:** Most secondary schools have processes in place for helmet purchase, fitting, and maintenance, with higher divisions schools having greater access to athletic trainers, annual helmet recertification, and regular helmet checks. Efforts to educate schools regarding football helmet best practices should continue.

**Table.** Helmet Fitting and Maintenance Personnel. Percentage (frequency) of schools responding. Schools could select more than one response.

| | Helmet Fitting | Helmet Maintenance | Air in Helmet | Checking and Refitting During Games |
|---|---|---|---|---|
| Football coach | 53.3 (89) | 52.1 (86) | 47.3 (78) | 23.2 (39) |
| Athletic director | 5.4 (9) | 7.3 (12) | 3.6 (6) | 1.2 (2) |
| Athletic trainer | 60.5 (101) | 43.0 (71) | 65.5 (108) | 51.5 (85) |
| Equipment manager | 38.3 (64) | 52.7 (87) | 46.7 (77) | 27.3 (45) |
| Parent | 0.6 (1) | 1.2 (2) | 0.6 (1) | 0 (0) |
| Other | 3.6 (6) | 3.0 (5) | 1.8(3) | 1.2 (2) |
| Other open-ended | Helmet representative Vendor | Helmet representative Vendor Student managers | Athletic trainer interns Student managers Student aides | Assistant coaches Athletic trainer interns |

## Potential Protective Effects of Jugular Vein Compression Devices on Brain Microstructure Integrity: A Critically Appraised Topic

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**Context:** Increasing concerns about the consequences of sub-concussive head impacts has led to the development of tools for mitigating injury risk. Many of these devices (e.g., helmets, mouth guards) have been studied extensively providing minimal protections.1 Continued investigation of protective equipment has led to the development of jugular vein compression (JVC) devices. These devices are proposed to increase intracranial blood volume through external compression of the jugular vein creating a protective fluid barrier.2 As the popularity of these devices increases, it is important to better understand the role of these devices in mitigating injury risk. Therefore, the purpose of this study is to investigate if jugular vein compression devices (JVC) are an effective tool for mitigating head impact risk in athletes.

**Methods:** A systematic search was conducted using PubMed/Medline, CINAHL, and PsycINFO databases in October of 2023. The search terms for each database were as follows: [P]–athletes/ concussion/ head injury/ head impact/ mild traumatic brain injury/ slosh; [I/C]–jugular vein compression device/ neck compression collar/ neuro shield /q-collar; [O]–concussion prevalence/ concussion risk/ white matter integrity/ diffusion tensor imaging. Eligible studies included Centre for Evidence Based Medicine (CEBM) level 2 or higher prospective studies published within the past five years. Studies which did not include an adequate control group, conference abstracts, and pilot studies were excluded.

**Results:** Four relevant studies met all inclusion criteria. Critical appraisal of included articles was conducted using the PEDro scale (mean score = 7). Diekfuss et al.,3 found that wearing a JVC provided some protection from diffusion tensor imaging (DTI)-derived changes in brain white matter (WM) and moderated the relationship between head-impact exposure and WM changes from pre- to post-season in male high school (HS) football athletes. Dudley et al.,4 reported similar findings with significantly greater changes in resting-state functional MRI and DTI for HS female soccer athletes after a single competitive season. Myer et al.,5 reported that significant pre- to post-season changes in brain WM were observed in mean diffusivity (2.83±2.46%), axial diffusivity (2.58±2.34%), and radial diffusivity (3.52±2.60%) for the non-collar group with no significant changes for the collar group in HS female soccer athletes. Yuan et al.,6 identified similar degradation in behavioral and cognitive outcomes (i.e., King Devick test, Near Point Convergence test, the Trail Making Test, and the Flanker test) for athletes not wearing a JVC collar compared to those who wore collars across 488 HS athletes with no between-group differences in concussion rates across groups.

**Conclusions:** Based upon consistent findings among the studies included in this critically appraised topic, there is Grade B evidence to support the use of a JVC collar to protect against alterations in brain WM structure associated with participation in sports.

## Guardian Cap Soft-Shell Padding Efficacy in American Football Throughout a Competitive Season

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**Context:** Aftermarket soft-shell padding is purported to augment the protection provided by standard football helmets by reducing head impact severity from impacts sustained during practices. We aimed to determine the effects of soft-shell padding on reducing head impact kinematics while controlling for position group, play type, and head impact location.
**Methods:** In total, ten Division I college football players from the fall 2022 season were analyzed, including those who wore Guardian Cap soft-shell padding (SHELL; n = 5; 4 defensive linemen and 1 tight end) or chose not to wear soft-shell padding (CONTROL; n = 5; 2 offensive linemen, 2 defensive linemen, and 1 tight end). Helmets were equipped with Head Impact Telemetry (HIT) System instrumentation to quantify peak linear acceleration (PLA; g) and peak rotational accelerations (PRA; rad/s2). Linear mixed models with random intercepts were conducted to account for between-subject differences in Log-transformed PLA and PRA outcomes whilst controlling for impact location [front (referent), side, top/crown, and back], position group [offense linemen (including tight ends), and defense linemen], and play-type [individual drills (referent), pass, rush, inside run, and 1v1 drills].
**Results:** In total, 1901 video-confirmed head impacts (SHELL: 651, CONTROL: 1250) were sustained during practices across the season. After controlling for position group, play-type, and impact location, soft-shell padding did not reduce PLA ($F_{1,1882} = 1.69$, $p = 0.190$) or PRA ($F_{1,1882} = 1.39$, $p = 0.240$). Impacts to the front of the helmet resulted in greater PLA than side ($F_{1,1882} = 48.54$, $p < 0.0001$) and back ($F_{1,1882} = 16.26$, $p < 0.0001$) impacts, and greater PRA compared to side ($F_{1,1882} = 33.74$, $p < 0.0001$), top/crown ($F_{1,1882} = 119.11$ $p < 0.0001$) and back ($F_{1,1882} = 37.30$, $p < 0.0001$) impacts. Between position groups, offensive linemen incurred greater PRA than defense linemen ($F_{1,1882} = 4.22$, $p = 0.04$). Compared to individual drills, there was greater PLA during rush ($F_{1,1882} = 5.17$, $p = 0.020$), inside run ($F_{1,1882} = 19.20$, $p < 0.0001$), and 1v1 ($F_{1,1882} = 5.09$, $p = 0.02$) play types, and greater PRA during rush ($F_{1,1882} = 8.28$, $p = 0.004$), inside run ($F_{1,1882} = 26.15$, $p < 0.0001$) and 1v1 ($F_{1,1882} = 10.82$, $p < 0.001$) play-types.
**Conclusions:** Guardian Cap protective soft-shell padding did not reduce linear or rotational accelerations among a subset of college football players across a competitive season. Head impact severity was greater during team-based activities and 1v1 drills compared to individual drills and was greater among impacts to the helmet's front when compared to all other locations. Contextual factors including position, play type, and location of sustained head impacts contribute to head impact burden to a greater extent than soft-shell padding.

This study was partially funded (Guardian Caps) by Football Research Inc. (Award# A22- 0340-001). They were not involved in the study conceptualization, statistical analysis, interpretation, or drafting of the abstract.

**Sport Season Timing of Concussion Occurrence and Diagnosis and Recovery Milestones in Collegiate Athletes**

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**Context:** Collegiate sports have distinct season segments that differ in competition and training style, intensity, and frequency. Additionally, the degree of access to sports medicine healthcare providers may vary throughout the year based upon the nature of team activities allowable by the NCAA during different season segments. Due to this, the diagnosis and initiation of care of acute injuries may be delayed depending upon the season segment in which the injury was sustained. It is currently unknown how the timing of concussion occurrence influences injury identification and recovery outcomes. Therefore, the purpose of this study was to determine the association between the sport season timing of concussion occurrence and diagnosis and recovery milestones in collegiate athletes.
**Methods:** This multi-site retrospective cohort study included medical chart reviews of diagnosed concussions sustained by NCAA collision and contact sport athletes from July 2015 through February 2020. Injury information was extracted by 11 LIMBIC Military and Tactical Athlete Research Study consortium institutions and aggregated to form a master data file. There were 774 concussion cases sustained by collision and contact sport athletes included in this investigation (Table 1). Date of injury was used to categorize each case into independent variable season segment groups based upon the NCAA handbook guidelines for each sport. Concussions that occurred during the championship season segment were categorized into the pre-season (n=119 15.4%), regular season (n=320; 41.3%), or playoff season (n=28; 3.6%) groups. The off-season group (n=307; 39.7%) was comprised of concussions occurring outside of the championship season. The diagnosis and recovery milestone dependent variables were days from injury to diagnosis (Dx), symptom resolution (SR), and return to sport (RTS). Additional dependent variables included the days from Dx to SR and RTS. We conducted Kruskal-Wallis analyses to investigate diagnosis and recovery milestone differences between concussions occurring within the different season segments. Alpha was set a priori at $P < 0.05$.
**Results:** Descriptive information and diagnosis and recovery milestone outcomes by timing of injury are presented in Table 1. There were no significant differences by season segment for any of the concussion diagnosis and recovery milestone outcomes (Date of injury to Dx (H=4.15, P=0.24), SR (H=1.02, P=0.79), RTS (H=1.34, P=0.72); Date of Dx to SR (H=2.56 P=0.46), RTS (H=3.87, P=0.28).
**Conclusions:** Concussion diagnosis and recovery timelines were similar for all included cases regardless of when the injury was sustained. These findings are favorable and suggest that the standard of concussion identification and care in the collegiate sport setting are held constant throughout the various season segments. This may be a byproduct of the consistent access to an athletic trainer and the NCAA concussion management plan and safety protocol requirements. Future research should expand on these findings to investigate different sport populations and potential confounding factors.

**Table 1. Concussion Case Demographics and Diagnosis and Recovery Milestone Outcomes by Sport Season Timing of Injury**

| | Pre-season n=119 | In-Season n=320 | Post-Season n=28 | Off-Season n=307 | Total n=774 |
|---|---|---|---|---|---|
| Age (Years; M, SD) | 19.6±1.4 | 19.9±1.5 | 20.0±1.4 | 20.0±1.8 | 19.8±1.6 |
| Sex (n, %) | | | | | |
| *Female* | 37 (31.1%) | 91 (28.5%) | 5 (17.9%) | 130 (42.0%) | 263 (34.0%) |
| *Male* | 82 (68.9%) | 229 (71.5%) | 23 (82.1%) | 177 (58.0%) | 511 (66.0%) |
| Sport Type (n, %) | | | | | |
| *Contact* | 29 (24.4%) | 51 (15.9%) | 2 (6.1%) | 74 (24.1%) | 156 (20.2%) |
| *Collision* | 90 (75.6%) | 269 (84.1%) | 26 (93.9%) | 233 (75.9%) | 618 (79.8%) |
| Division (n, %) | | | | | |
| *I (Power 5)* | 62 (52.1%) | 164 (51.4%) | 19 (68.0%) | 135 (44.0%) | 380 (49.1%) |
| *I (Non-Power 5)* | 23 (19.3%) | 86 (26.9%) | 7 (25.0%) | 123 (40.0%) | 239 (30.9%) |
| *II* | 22 (18.5%) | 36 (11.1%) | 1 (3.5%) | 35 (11.4%) | 94 (12.1%) |
| *III* | 12 (10.1%) | 34 (10.6%) | 1 (3.5%) | 14 (4.6%) | 61 (7.9%) |
| Milestones (Days; Md, IQR) | | | | | |
| *Injury to diagnosis* | 0 (0, 2) | 0 (0, 1) | 0 (0, 1) | 0 (0, 2) | 0 (0,2) |
| *Injury to symptom resolution* | 6.5 (4, 12) | 7 (4, 12) | 9 (4, 14) | 7 (4, 12) | 7 (4, 12) |
| *Injury to return to sport* | 11 (8, 17.5) | 13 (8, 21) | 12 (9, 27) | 12 (8, 18) | 12 (8, 20) |
| *Diagnosis to symptom resolution* | 5 (3, 10) | 6 (3, 12) | 8.5 (3, 14.5) | 6 (3, 10) | 6 (3, 11) |
| *Diagnosis to return to sport* | 9 (7, 16) | 12 (9, 27) | 12 (9, 27) | 11 (7, 16) | 11 (7, 18) |

*Note.* Percentages were calculated by column.

## Playing By the Rules: Concussion Frequency and Head Impact Mitigation Rule Changes - A LIMBIC MATARS Investigation

Furey CE, Rosenblum DJ, Munce TA, Bowman TG, Beidler E, Campbell TR, Cifu DX, Resch JE: University of Virginia, Charlottesville, VA; Sanford Research, Sioux Falls, SD; University of Lynchburg, Lynchburg, VA; Duquesne University, Pittsburgh, PA; Old Dominion University, Norfolk, VA; Virginia Commonwealth University, Richmond, VA

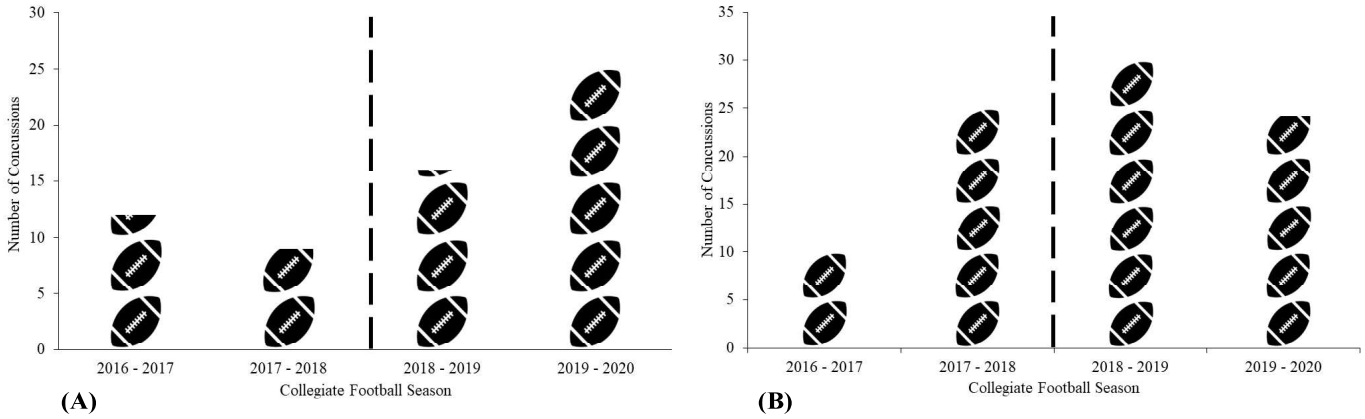
**Context:** The National Collegiate Athletic Association (NCAA) implemented three rules between 2018 and 2020 aimed at reducing the number of concussions in football competitions and practices. These rule changes were intended to reduce high-speed collisions, limit crown-of-the helmet contact, and prevent injuries experienced by athletes who were unprepared for contact. Limited research has examined the efficacy of these NCAA rule changes on reducing the number of concussions in collegiate football. The purpose of this multi-site study was to evaluate the number of concussions documented during competitions and practices before and after implementation of the three rule changes. We hypothesized that the NCAA rules, created to mitigate concussion incidence rates, would result in fewer concussions during football competitions and practices.

**Methods:** This retrospective chart review used data collected between 2015 - 2016 and 2019 - 2020 football seasons as a part of the LIMBIC Military and Tactical Athlete Research Study (MATARS) across seven public universities. A total of 158 concussions were recorded during football competitions (n=65) and practices (n=93). The number of documented competition and practice concussions during the two years before and after 2018 were compared using independent t-tests. Cohen's d effect sizes and 95% confidence intervals were also calculated. All analyses were performed with $\alpha$=0.05.

**Results:** There were no statistical differences observed for number of concussions during competitions (t(2)=-1.93, p=0.10, d=-1.93[-4.46,0.80]) or practices (t(2)=-2.49, p=0.07, d=-2.49[-5.39,0.57]) between the two time periods. However, the actual number of diagnosed concussions that occurred before 2018 during either competition (n=22) or practice (n=37) nearly doubled after 2018 (n=43 and n=56, respectively [Figure 1]).

**Conclusions:** The number of recorded concussions increased substantially following the implementation of three new NCAA rules that were designed to mitigate the risk of injury. While these findings are contrary to our hypothesis, they may reflect enhanced concussion recognition by healthcare professionals and improved care-seeking behaviors by collegiate athletes. Additional research, incorporating athlete exposures and specific football positions, is needed to more fully explore the influence of collegiate football rule changes designed to reduce the risk of concussion.

**A Comparison of Concussion Frequency Prior to and Following Head Impact Mitigation Rule Changes in Collegiate Football**



**Designing Effective Parent Concussion Education: The Role of Parent Knowledge in Athlete Symptom Disclosure**

Warmath D, Winterstein AP: University of Georgia, Athens, GA, and University of Wisconsin-Madison, Madison, WI

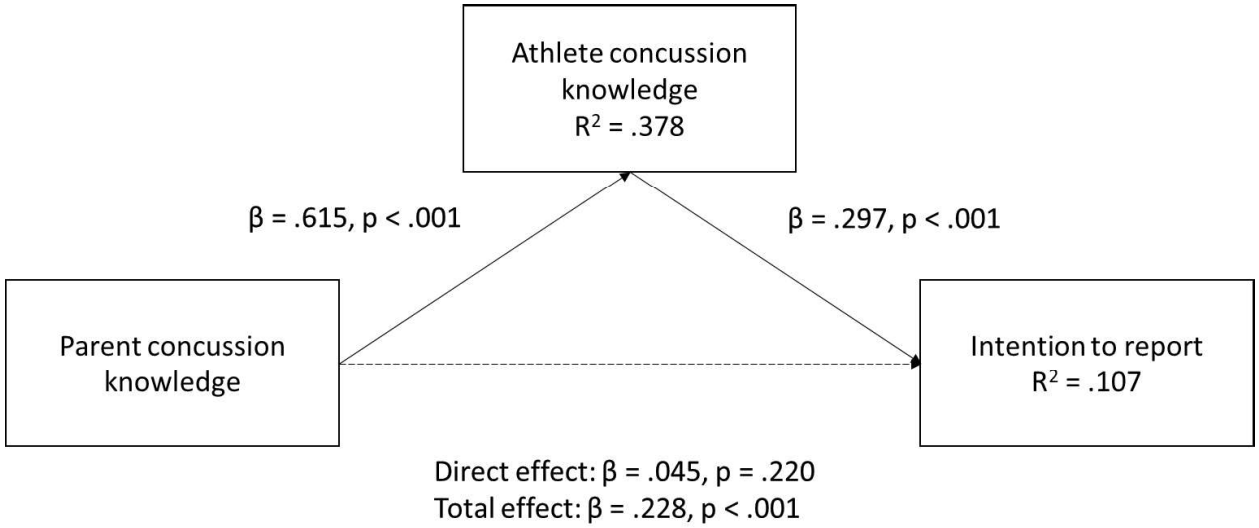
**Context:** Mandated concussion education includes the parents of athletes. While studies examine the education parents receive, little attention has been paid to the effect of parent education or concussion knowledge on athlete outcomes including intention to disclose symptoms. The study reported here examines whether and how parent concussion knowledge is associated with their high school athlete's intention to report concussion-like symptoms. Our hypothesis is that the parent's concussion knowledge is associated with the high school athlete's willingness to disclose symptoms directly and indirectly through the association between the concussion knowledge of the parent and athlete.

**Methods:** A total of 1,070 parents and their high-school athletes (i.e., dyads) completed an online survey with Survey Sampling International. Parents (75% mothers/25% fathers; average age 47.1) responded first. Their high-school athletes (51% female/49% male; average age 16.7) completed a separate survey. The dependent variable was a published scenario-based question asking the high school athlete how likely they would be to report symptoms. Independent variables of primary interest were the concussion knowledge of the parent and the athlete. Descriptive statistics assessed the level of concussion knowledge for parents and athletes. T-tests and correlations examined the relationship between parent and athlete knowledge. Hayes PROCESS Macro Model 4 (Mediation) was used to examine the direct and indirect associations between parent concussion knowledge and their athlete's intention to report.

**Results:** As a group, parents tended to have higher levels of concussion knowledge than athletes (mean: 10.01 versus 8.95, $t=10.800$, $p<.001$). At a household level, there was a significant correlation between the parent's and their athlete's concussion knowledge ($R=.615$, $p<.001$). While there was a total effect of parent concussion knowledge on athlete intentions to report ($\beta=.228$, $p=.001$), this effect was fully mediated by athlete concussion knowledge (direct effect of parent knowledge on athlete intentions: $\beta=.045$, $p=.220$). Athlete concussion knowledge was significantly associated with reporting intentions ($\beta=.297$, $p=.001$). Figure 1 illustrates these results.

**Conclusions:** Parent concussion knowledge plays a largely supporting role in the athlete's willingness to disclose symptoms through its association with their high school athlete's concussion knowledge. These findings indicate that parent knowledge cannot replace the need to build concussion knowledge in high school athletes but can play a supporting role in athlete knowledge and intentions to disclose symptoms. The design of strategic and tailored parent concussion education should recognize this role. Programs to educate parents on concussions and their symptoms should encourage parents to use that knowledge to help build their high school athlete's concussion knowledge. Thus, the parent can play a supporting role in encouraging athlete symptom disclosure.

NCAA Mind Matters Challenge Grant



## Applying Topic Modeling to Assess Concussion Education Through the Athlete's Lens

Winterstein AP, Warmath DE, Peng Y: University of Wisconsin-Madison, Madison, WI, and University of Georgia, Athens, GA

**Context:** Education as a primary intervention to encourage concussion reporting behavior has fallen short of this desired outcome. Rather than move beyond education, there is a need for innovation in the design and assessment of concussion education. Novel approaches are needed to inspire such innovation. This study examines whether a "letter to my future self" analyzed using structured topic modeling (STM) represents a useful technique in revealing what the athletes take away from their education and the impact of those takeaways on their future behavioral intentions. Topic modeling is neither quantitative nor qualitative and can be thought of as the statistical identification of themes in unstructured text.

**Methods:** Four hundred and fifty-nine collegiate club-sports athletes (ages 18-25, 61% female, 49% male) participating in a larger concussion education randomized control study (three treatment conditions: traditional, revised symptom, and consequence-based education) were asked to write a two-paragraph letter to their future self-describing what they hoped to remember from the education. STM was used to discover the dominant topics embedded in the letters and independent sample t-test were used to examine differences in topic prevalence by educational treatment.

**Results:** The STM revealed a six-topic solution (much like a cluster analysis of cases) that reflected what was learned (i.e., Symptom Knowledge + Action; Concussion Literacy; and Tell/Don't Tell Consequences) after the intervention and implications of that knowledge (i.e., Awareness; Concussion Seriousness; and Brain Health). Table 1 contains results of the comparison of outcome topics by intervention. The Consequence-based education was more likely to generate the Concussion Seriousness (23%) topic while Traditional (24%) and Consequence-based (20%) interventions were more likely to generate the Importance of Responsibility for Brain Health topic. Traditional (21%) and Revised-symptom (17%) interventions were more likely to generate the Awareness and Action topics. While each of the concussion education interventions delivered their intended message with 40-50% of participants referencing the content in their letters, the interventions fell short in generating behavioral intentions with only 15-25% of participants mentioning these topics.

**Conclusions:** This study demonstrates that the letters to my future self and STM add athlete-generated insight extracted from unstructured data to guide assessment and evolution of concussion education programs. For example, from the results presented here, it appears that athletic trainers as designers and implementers of concussion education should consider an increased emphasis on the intended takeaways from the educational content. Thus, letters to the future self and STM have the potential to inspire innovation that addresses gaps in the design and delivery of concussion education and the impact of that education on the thought process of the athlete. It is through the impact on the thought process that education can influence behavioral change to promote brain health.

A portion of this study was funded through the Mind Matters Challenge Grant from the National Collegiate Athletic Association/US Department of Defense.

**Table 1.** Independent t-tests examining differences in outcome topic prevalence by educational intervention.

| | Educational Intervention | | | T-test Results | |
|---|---|---|---|---|---|
| Outcome Topic | Traditional Concussion | Revised Symptom | Consequence-based | TC vs RS | TC vs CB |
| Awareness and Action | 21% | 17% | 8% | t=-1.484, p = .138 | t = -4.805, p < .001 |
| Concussion Seriousness | 13% | 12% | 23% | t = .370, p = .771 | t = 3.654, p <.001 |
| Importance of Brain Health | 16% | 11% | 20% | t = 1.548, p = .122 | t = 1.950, p = .052 |

# Free Communications, Rapid Fire Presentations: Understanding and Treating the Consequences of Chronic Ankle Instability

Wednesday, June 26, 2024; 1:15 AM-2:10 PM; Room 265-268

Moderator: Phillip Gribble, PhD, ATC

### Effects of Blood Flow Restriction on Performance During Balance Exercises in Individuals With Chronic Ankle Instability

Clark K, Trickett J, Donovan LT, Dawson J, Goetschius J: James Madison University, Harrisonburg, VA, and University of North Carolina at Charlotte, Charlotte, NC

**Context:** Clinicians commonly introduce constraints to traditional balance exercises (ex. closing eyes, unstable surface) to challenge the sensorimotor system during chronic ankle instability (CAI) rehabilitation. Blood flow restriction (BFR) is a rehabilitation tool which may introduce a constraint, similar to muscle fatigue, to challenge patients during traditional balance exercises. The purpose of our study was to determine whether individuals with CAI demonstrated a decline in balance performance during dynamic balance exercises with BFR compared to exercises without BFR.

**Methods:** We used a cross-over design with counterbalanced conditions in a laboratory setting. Our sample included N=25 young-adults with a history of CAI based on International Ankle Consortium criterion. Participants completed two laboratory visits 24-hours apart. At each visit, participants completed 4-sets (30x-15x-15x-15x) of dynamic balance exercises with either BFR or control (no BFR) conditions. Condition order was randomized between visits. Dynamic balance exercised were performed similar to the modified star excursion balance test (SEBT). Participants balanced on their CAI limb and cycled through maximal reaches with the contralateral limb along a tape measure in the anterior, posteromedial, and posterolateral directions. Each reach counted as 1-repetition. To assess balance performance, we measured SEBT reach distances in each direction (3x reaches per direction) at baseline (before exercise) and during the final repetitions of each of the 4-sets of balance exercises. We calculated a composite SEBT score by averaging the reach distances from all three directions and normalized by leg length. We compared composite SEBT scores between the conditions (BFR, Control) and across time (baseline, set 1, set 2, set 3, set 4) using a 2x5 repeated measures ANOVA with Bonferroni post-hoc tests. We calculated Cohens d effect-sizes with 95% confidence intervals between the BFR and control conditions at each time-point.

**Results:** Composite SEBT means ± standard deviations and effect-sizes (95% confidence intervals) are in Table 1. At baseline, we observed no significant difference in SEBT scores between conditions (P=0.34); however, SEBT scores were significantly lower during the BFR condition compared to the Control during set 1 (P=0.02), set 2 (P < 0.001), set 3 (P < 0.001), and set 4 (P < 0.001). Between-condition effect sizes changed from “trivial” (baseline), to “small” (set 1), to “moderate” (set 2), to “large” (sets 3-4) across the exercises. During the BFR condition, SEBT scores were significantly lower during all balance exercise sets compared to baseline (all P < 0.001). During the Control condition, SEBT scores did not change between baseline and each balance exercise set (all P=1.00).

**Conclusions:** Individuals with CAI demonstrated a decrease in balance performance during dynamic balance exercises performed with BFR compared to balance exercises without BFR. BFR may be useful for introducing a novel form of constraint during traditional dynamic balance exercises during CAI rehabilitation.

This project was funded by a research grant from the Virginia Athletic Trainers’ Association (VATA).

**Cross-Education Effects of Balance Training in Individuals With Chronic Ankle Instability**

McCann RS, Reyes MC, Chung S, Gruskiewicz VM, Johnson KR, Foreman NN, Suttmiller AMB: Old Dominion University, Norfolk, VA; Children's Hospital of the King's Daughters, Norfolk, VA; Medical University of South Carolina, Charleston, SC; Norfolk Christian Academy, Norfolk, VA; Atlantic Orthopedic Specialists, Virginia Beach, VA

**Context:** Chronic ankle instability (CAI) results in bilateral neuromuscular impairments related to balance performance, hip strength, and lumbopelvic stability. Previous studies have shown that balance training and hip strengthening are effective methods for improving balance performance and hip strength, respectively, in the CAI population. Individuals with CAI who undergo unilateral balance training have also experienced cross-education effects in which balance performance of the untrained limb is improved. While unilateral balance training is known to activate ipsilateral hip and trunk musculature, it is unclear if unilateral balance training has a cross-education effect on hip strength and lumbopelvic stability. This study aimed to determine if unilateral balance training led to contralateral improvements in balance performance, hip strength, and lumbopelvic stability in individuals with CAI.
**Methods:** Using a randomized-controlled trial, we separated 30 individuals with CAI into control (CON) and balance (BAL) groups. Participants completed baseline and post-intervention tests of balance, hip strength, and lumbopelvic stability on the uninvolved limb. Balance was tested with the Star Excursion Balance Test in anterior (SEBT-ANT), posterolateral (SEBT-PL), and posteromedial (SEBT-PM) directions. Isometric hip strength was measured for external rotation (ER), extension (EXT), and abduction (ABD) using a handheld dynamometer. Lumbopelvic stability was tested with a unilateral hip bridge held for maximum time. The BAL group participated in an 8-week progressive balance training protocol on the involved limb (three 25-minute sessions/week), and CON did not. Missing post-intervention data were estimated with multiple imputations and intention-to-treat analysis. Separate 2-way repeated measures ANOVAs analyzed the effects of group and time on each outcome. Cohen's d effect sizes further analyzed each group's baseline to post-intervention differences. Additionally, each group's mean changes from baseline to post-intervention were compared to the minimal detectable change (MDC) score. Statistical significance was set a priori at $P<0.05$.
**Results:** Eleven participants did not complete the study (5 CON, 6 BAL) due to COVID-19 shutdowns or other undisclosed reasons. Significant group-by-time interactions were present for SEBT-PL ($P=0.03$) and hip bridge ($P=0.03$). No significant group-by-time interactions were found for SEBT-A ($P=0.23$), SEBT-PM ($P=0.15$), EXT ($P=0.13$), ABD ($P=0.09$), or ER ($P=0.18$). BAL experienced large effect sizes for SEBT-PL ($d=0.87[0.10,1.60]$) and hip bridge ($d=0.83[0.07,1.55]$) and moderate effect sizes for SEBT-PM ($d=0.69[-0.06,1.41]$), EXT ($d=0.73[-0.02,1.45]$), and ABD ($d=0.79[0.03,1.51]$). BAL also experienced improvements in ABD, SEBT-PL, and hip bridge that exceeded the MDC. CON had only small-negligible effect sizes and no changes that exceeded the MDCs.
**Conclusions:** Unilateral balance training in a cohort with CAI resulted in contralateral improvements in dynamic balance, hip strength, and lumbopelvic stability. These findings support previous evidence that impairments associated CAI might be correctable through a cross-education effect generated by unilateral balance training.

The larger study from which these findings were derived was funded by a 2018 grant from the Mid-Atlantic Athletic Trainers' Association (MAATA).

**Effects of Chronic Pain on Lower Extremity Muscle Activation in Individuals With Chronic Ankle Instability**

Oh M, Lee H, Han S, Hopkins JT: Department of Exercise Science, Brigham Young University, Provo, UT, and Department of Exercise and Sport Science, University of North Carolina, Chapel Hill, NC

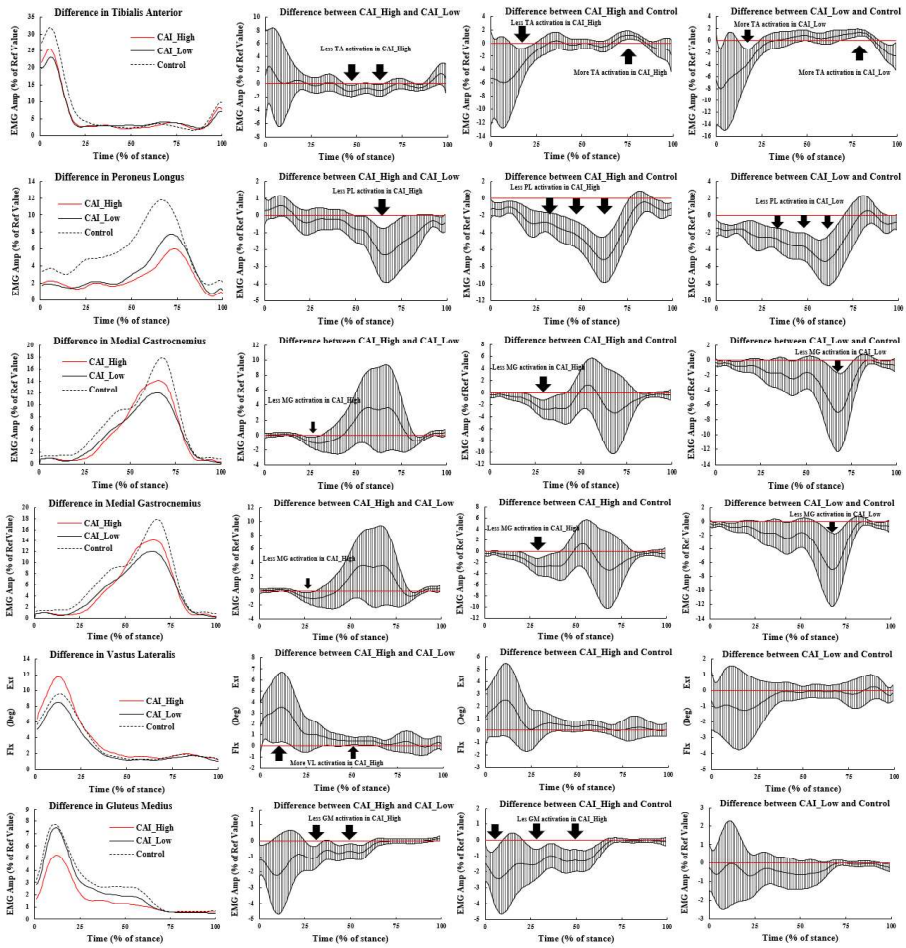
**Context:** Lateral ankle sprains often result in chronic ankle instability (CAI) with residual symptoms including chronic pain, ankle instability, and recurrent ankle sprains. Approximately 60% of individuals with CAI report persistent ankle pain during daily or physical activities, while others report no pain. Previous studies have not considered chronic pain during walking in individuals with CAI. This study aimed to identify the effects of chronic pain on lower extremity muscle activation in individuals with CAI.

**Methods:** This study was a cross-sectional study. We followed guidelines from the International Ankle Consortium's position statement and used the Foot Ankle Outcome Scores to categorize CAI and chronic pain. Twenty high pain individuals with CAI (high pain) (M=9, F=11; 22±2years, 1.74±0.10m, 79.4±14.6kg, 67.4±7.7 pain), 20 low pain individuals with CAI (low pain) (M=9, F=11; 22±3years, 1.73±0.08m, 74.2±12.7kg, 91.7±3.9 pain), and 20 healthy controls (control) (M=9, F=11; 22±1years, 1.74±0.09m, 68.2±10.2kg, 100±0 pain). Electromyography (EMG) data were collected using wireless surface electrodes at a 2,000 Hz sampling rate during 5 walking trials from initial contact to toe-off (0-100% of stance). EMG data were normalized to the reference EMG data collected in a standing position for 3 seconds. The electrodes were placed over the tibialis anterior (TA), peroneus longus (PL), medial gastrocnemius (MG), vastus lateralis (VL), gluteus medius (GM), and gluteus maximus (GX). Functional analyses of variance were used to evaluate between-group differences for muscle activation outcomes.

**Results:** Relative to the low pain group, the high pain group showed less muscle activation during walking, with decreases of up to 1.8%, 2.3%, 3.5%, 1.1%, and 1.6% in TA, PL, MG, VL, GM, and GX, respectively. Relative to the control group, the high pain group displayed less muscle activation during walking, with decreases of up to 3.4%, 7.1%, 2.8%, 2%, and 2.5% in TA, PL, MG, GM, and GX, respectively. The low pain revealed less muscle activation up to 8%, 5.3%, and 1.1% in TA, PL, and GX compared to the control group while showing similar muscle activation patterns in MG, VL, and GM to the control group.

**Conclusions:** Depending on chronic pain levels, individuals with CAI report altered muscle activation of the lower extremity during walking. The high pain demonstrated decreased muscle activation of lower limb muscles. In contrast, the low pain showed a better ability to activate proximal joints, potentially to compensate for the lack of distal joint muscle activation. Therefore, we recommend that clinicians should consider chronic pain as an independent factor that affects muscle activation patterns in individuals with CAI.

Figure 1. Muscle activation during walking



## The Optimal Dose of Balance Training for Individuals With Chronic Ankle Instability: A Systematic Review and Meta-Analysis

Chung SH, Laverdure P, McCann RS, Gabriel EH: Old Dominion University, Norfolk VA, and University of Kentucky, Lexington, KY

**Context:** Balance training is an effective intervention to treat CAI, but the optimal balance training dose to maximize balance performance for this population is unclear. Heterogeneity is prevalent across balance training parameters, potentially preventing clinicians from knowing which balance training protocol is most effective for those with CAI. Therefore, the aim of this systematic review and meta-analysis was to examine the effectiveness of various balance training parameters on balance performance in individuals with CAI.

**Methods:** We performed a systematic literature search according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Electronic databases included PubMed, CINAHL, SPORTDiscus, and MEDLINE to collect randomized controlled trials (RCT) that investigated the effects of balance training on balance performance in those with CAI. We implemented the Downs & Black quality assessment to evaluate the methodological quality of each study. To conduct a meta-analysis, we grouped studies by common balance training parameters such as training period (number of weeks), training frequency (sessions/week), total number of training sessions, and duration of a single training session (minutes) were extracted. For each parameter, we computed standard mean differences (SMD) in balance performance from baseline and post-intervention.

**Results:** A total of 2684 studies were returned from the initial search, and 14 studies were included in the final review. Six studies using 6-weeks of balance training resulted in a large effect size (SMD=0.89[0.77,1.00], P<0.001) while there was a weak effect size across 6 studies using 4-week of balance training (SMD=0.34[0.26,0.42], P<0.001). Two studies implemented 1 week of balance training, resulting in a weak effect size (SMD=0.26[0.12,0.40], P<0.001], and 13 studies implemented balance training three times per week, resulting in a moderate effect size (SMD=0.51[0.45,0.57], P<0.001). A total of 18 sessions of training sessions produced a large effect size (SMD = 0.89[0.77, 1.00], p < 0.001) while studies with a total of 12 sessions resulted in a weak effect size (SMD=0.34[0.26,0.42], P<0.001). Eight of 14 studies reported the duration of each training session, revealing that 30-minute durations resulted in a negligible effect (SMD=0.17[-0.01,0.35], P=0.06) and ≤20-minute durations produced a weak effect (SMD=0.36[0.28,0.44], P<0.001).

**Conclusions:** Our systematic review and meta-analysis indicate that the most effective balance training parameters consist of 6 weeks of training, 3 sessions per week, a total of 18 sessions, and less than 30 minutes to maximize balance performance for individuals with CAI. This evidence-based guideline can help athletic trainers develop optimal rehabilitation protocols for individuals with CAI. Further investigation is necessary to identify the effects of balance training performed outside of the parameters reported in the included studies, as a true optimal balance training dose for those with CAI may have yet to be identified.

**Post-Professional Terminal Degree Student**

**Transcranial Direct Current Stimulation Over the Motor or Frontal Cortex Does Not Improve Dual Task Reaction Times or Cognitive Performance in Individuals With Chronic Ankle Instability**

Watson MG, Howard JS, Skinner JW, Grattan SA, Roberts SE, Everhart KL, Needle AR: Appalachian State University, Boone, NC

**Context:** Patients with CAI often present with impairments performing simultaneous motor-cognitive tasks, theorized to be related to neural changes. Anodal transcranial direct current stimulation (tDCS) can modify neural function when paired with exercise, with motor cortex (M1) stimulation benefiting muscle activation, and stimulation over the dorsolateral prefrontal cortex (DLPFC) benefiting motor planning. The purpose of this study was to determine if tDCS over M1 or the DLPFC paired with rehabilitative exercise could improve reaction times and dual-task ability in patients with CAI.

**Methods:** Forty-five participants with CAI volunteered to participate in a double-masked randomized controlled trial in a university laboratory. Participants were tested for dual-task performance & reaction times at baseline (week 0), mid-training (week 2), post-training (week 4), and at retention (week 6) surrounding a 4-week ankle rehabilitation intervention. Participants stood unipedal, watching lights on a reaction testing device (RoxProX, A-Champs, Barcelona, Spain) change colors on a force plate. Two additional lights in the participant's peripheral vision would light up at random. Participants were instructed to hop towards the green peripheral light onto the adjacent force plate over a 5cm hurdle and to recall the previous 3 colors from the front light. Outcome measures include reaction times and colors correct for medial and lateral hops, with 5 trials in each direction minimum. After baseline testing, participants performed 8 rehabilitation sessions over 4 weeks, while receiving anodal tDCS over M1 (Motor), the DLPFC (Frontal), or Sham stimulation. Stimulation was 1.5mA over 18 minutes, with the Sham group receiving only 1 minute of stimulation. Exercise selection included progressions related to obstacle course walking, reactive unipedal balance, and agility. Data were analyzed using analysis of variance comparing groups, hop direction (medial or lateral), and time ($\alpha$=0.05).

**Results:** Thirty-seven individuals completed the trial (Frontal: n=11, 23±6 yrs, 175.3±12.6cm, 73.2±12.5kg; Motor: n=14, 23±3 yrs, 169.3±12.9cm, 69.3±14.0kg; Sham: n=12. 26±6 yrs, 170.3±9.1cm, 72.4±16.6kg). Reaction time was not significantly different across groups or times ($p>0.05$). Reaction times were faster on lateral hops than medial hops ($F[1,32]=5.329$, $p=0.017$). No significant group-by-time or group difference were observed for correct letters ($p>0.05$); however, there was a significant effect of time ($F[3,99]=10.4$, $p<0.001$) with accuracy improving from baseline to all time points ($p\leq0.005$), and from mid-training to post-training and retention ($p\leq0.008$). Means and variability are presented in the Table.

**Conclusions:** These data suggest that tDCS did not impact dual-task reaction times or cognitive performance compared to sham stimulation, nor did ankle rehabilitation improve dual-task reaction times. Improvements were noted on the cognitive task, suggesting either a learning effect across groups, improved cognitive performance, or increased focus on the cognitive task.

This study was funded by the National Athletic Trainers' Association Foundation General Grant

**Table:** Means (standard deviations) for reaction times and color accuracy across treatment groups and time points. *Medial reaction times significantly slower than lateral reaction times (p=0.017)

| | Lateral Reaction Times (s) | | | Medial Reaction Times (s)* | | | Colors Correct (n) | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Motor* | *Frontal* | *Sham* | *Motor* | *Frontal* | *Sham* | *Motor* | *Frontal* | *Sham* |
| **Baseline** | 1.73 (0.35) | 1.63 (0.37) | 1.84 (0.32) | 1.99 (0.47) | 1.89 (0.25) | 1.86 (0.58) | 2.2 (0.6) | 2.4 (0.4) | 2.6 (0.4) |
| **Mid-Training** | 1.83 (0.68) | 1.55 (0.34) | 2.00 (0.67) | 1.93 (0.56) | 1.76 (0.33) | 1.99 (0.64) | 2.6 (0.3) | 2.6 (0.3) | 2.7 (0.2) |
| **Post-Training** | 1.96 (0.96) | 1.61 (0.18) | 1.82 (0.49) | 2.02 (0.64) | 1.85 (0.25) | 1.81 (0.45) | 2.6 (0.3) | 2.7 (0.2) | 2.7 (0.3) |
| **Retention** | 2.11 (0.90) | 1.62 (0.22) | 1.77 (0.43) | 2.05 (0.88) | 1.74 (0.21) | 1.86 (0.35) | 2.6 (0.4) | 2.8 (0.2) | 2.8 (0.3) |

**Transcranial Direct Current Stimulation With Rehabilitative Exercise Does Not Modify Neural Excitability in Patients With Chronic Ankle Instability**

Picado JM, Skinner JW, Howard JS, Grattan SA, Roberts SE, Everhart KL, Watson MG, Needle AR: Appalachian State University, Boone, NC

**Context:** Joint instability, including CAI has been associated with decreased neural excitability, reflecting neuroplasticity within the central nervous system. Transcranial direct current stimulation (tDCS) is an intervention that utilizes a low-level electrical current over the scalp to aid motor learning and raise excitability. While previous evidence has shown tDCS over the motor cortex during strengthening can improve neural excitability in patients with CAI, it remains unclear if these changes can be elicited with more traditional rehabilitation exercises or alternate tDCS applications. Therefore, we aimed to determine if tDCS over the motor or frontal cortex could improve neural excitability when combined with rehabilitative exercises in patients with CAI.

**Methods:** Forty-five individuals with CAI volunteered for this double-masked randomized controlled trial in a university research laboratory. Participants were randomly allocated into groups that received anodal tDCS over the motor or frontal cortex (1.5mA over 18 minutes), or a sham current over 8 rehabilitation sessions..Prior to randomization, participants were tested for reflexive excitability using the Hoffmann reflex (H-reflex) and cortical excitability using transcranial magnetic stimulation (TMS). The H-reflex was assessed through sciatic nerve electrical stimulation (1mA increments), measuring the ratio of maximal reflexive response (Hmax) and maximal motor response (Mmax) of the tibialis anterior (TA) and soleus. Using TMS, the resting motor threshold (RMT) was measured along with maximum motor evoked potential (MEPmax), normalized to Mmax, for the TA and peroneus longus (PL) muscles. For 4-weeks following baseline tests, participants reported twice per week for rehabilitative exercise consisting of obstacle course walking, dynamic balance, and lateral agility while receiving their allocated treatment. Dependent variables were assessed at baseline (week-0), mid-training (week-2), post-training (week-4), and retention (week-6) and compared across groups and times using factorial analysis of variance ($\alpha$=0.05).

**Results:** Thirty-seven individuals completed the study (Frontal: n=11, 23±6 yrs, 175.3±12.6cm, 73.2±12.5kg; Motor: n=14, 23±3 yrs, 169.3±12.9cm, 69.3±14.0kg; Sham: n=12. 26±6 yrs, 170.3±9.1cm, 72.4±16.6kg). No significant group-by-time effects were observed for Hmax:Mmax (F[6,99]=0.792, p=0.578), RMT (F[6,63]=0.291, p=0.939), or MEPmax (F[6,48]=0.320, p=0.870). Similarly, no main effects of time were noted for Hmax:Mmax (F[3,99]=1.134, p=0.339), RMT (F[3,63]=1.823, p=0.152), or MEPmax (F[3,48]=1.588, p=0.204). Means and variability are presented in the Table.

**Conclusions:** Our results suggested that neither rehabilitative exercise, nor the inclusion of tDCS generated significant differences in neural excitability in patients with CAI. Combined with previous evidence, it appears that effects of tDCS on neural excitability are best achieved with strength training over more general rehabilitative exercises.

This study was funded by the National Athletic Trainers' Association Foundation General Grant

Table: Neural excitability measures across groups & time-points.

| | | Baseline | Mid-training | Post-training | Retention |
|---|---|---|---|---|---|
| **Tibialis Anterior $H_{max}$:$M_{max}$** | *Frontal* | 0.18±0.12 | 0.16±0.08 | 0.29±0.57 | 0.24±0.26 |
| | *Motor* | 0.23±0.18 | 0.17±0.09 | 0.19±0.13 | 0.22±0.15 |
| | *Sham* | 0.16±0.07 | 0.17±0.11 | 0.17±0.10 | 0.19±0.13 |
| **Soleus $H_{max}$:$M_{max}$** | *Frontal* | 0.57±0.20 | 0.52±0.23 | 0.49±0.20 | 0.56±0.19 |
| | *Motor* | 0.54±0.20 | 0.48±0.19 | 0.44±0.18 | 0.43±0.13 |
| | *Sham* | 0.51±0.23 | 0.46±0.20 | 0.51±0.22 | 0.51±0.22 |
| **Tibialis Anterior $MEP_{max}$ ($\%M_{max}$)** | *Frontal* | 0.29±0.33 | 0.10±0.06 | 0.11±0.07 | 0.19±0.16 |
| | *Motor* | 0.17±0.14 | 0.20±0.19 | 0.14±0.07 | 0.24±0.28 |
| | *Sham* | 0.14±0.10 | 0.16±0.11 | 0.11±0.06 | 0.13±0.11 |
| **Peroneus Longus $MEP_{max}$ ($\%M_{max}$)** | *Frontal* | 0.07±0.06 | 0.08±0.08 | 0.05±0.05 | 0.08±0.05 |
| | *Motor* | 0.06±0.05 | 0.06±0.03 | 0.08±0.06 | 0.05±0.03 |
| | *Sham* | 0.09±0.11 | 0.09±0.06 | 0.07±0.05 | 0.08±0.05 |
| **Resting Motor Threshold (%2T)** | *Frontal* | 30.1±11.2 | 30.2±6.5 | 34.8±8.8 | 30.1±15.1 |
| | *Motor* | 35.5±7.4 | 30.0±13.4 | 34.2±11.2 | 30.1±8.0 |
| | *Sham* | 39.4±9.9 | 35.0±12.9 | 38.0±14.0 | 33.9±16.8 |

## How Does Intrinsic Foot Muscle Strength and Size Relate to Performance of the Y-Balance Test in Civilians and Servicemembers With Chronic Ankle Instability?

Xu J, Fraser JJ, Golden DP, Goss DD, Green BS, Heimark NE, Hoch MC, Kosik KB, Silder A, Song K, Torp DM, Hertel J, Saliba SA: University of Virginia, Charlottesville, VA; Naval Health Research Center, San Diego, CA; Leidos Inc, San Diego, CA; University of Kentucky, Lexington, KY; Department of Physical Education, Yonsei University, Seoul, South Korea

**Context:** The strength and size of intrinsic foot muscles (IFM) are important components in the evaluation and rehabilitation of individuals with chronic ankle instability (CAI), as the IFMs aid in stabilization and function. However, there are a lack of clinically relevant methods to measure IFM strength. The purpose of this study is to discover how IFM size and strength are related to a dynamic balance test, specifically in male service members, male civilians, and female civilians and service members combined.

**Methods:** Fifty-two participants with CAI were recruited (age, 25.36 +/- 8.08; height, 171 +/- 9 cm; weight, 76.6 +/- 17.5 kg; n=29 females, n=11 service members[1 female]). Cross-sectional area (CSA) of the abductor hallucis (ABH), flexor hallucis brevis (FHB), flexor digitorum brevis (FDB), and quadratus plantae (QP) were measured via ultrasound in a supine position, in resting and resisted conditions. IFM strength of the greater and lesser toes were assessed hook-lying, with toes off a table edge and pushing on a handheld dynamometer. Dynamic balance was assessed with the Y-Balance test (YBT); individuals stood on their affected lower limb and reached as far as possible with the other limb in anterior, posteromedial, and posterolateral directions (normalized to limb length). Correlations, means, and standard deviations were calculated.

**Results:** Only statistically significant correlations are reported below. Means and standard deviations are reported in Table 1. Full cohort: Great and lesser toe strength were both associated with posteromedial balance (r = 0.30, 0.37, respectively). FDB CSA (r = 0.32 resting, 0.31 resisted), and FHB CSA (r = -0.37 resting) were associated with posteromedial and posterolateral balance, respectively. Male service members: Great toe strength was associated with posterolateral balance (r = -0.79), while FHB CSA was associated with anterior-balance (r = -0.82 resting, -0.70 resisted), and QP CSA with posterolateral balance (r = -0.78 resting). Civilian males: FHB CSA was associated with anterior balance (r = 0.65 resting, 0.78 resisted). Combined females: FDB CSA (r = -0.41 resting) and FHB CSA (r = 0.37 resisted) were associated with posteromedial balance, while FHB CSA (r = -0.55 resting, -0.43 resisted) was associated with posterolateral balance.

**Conclusions:** In patients with CAI, balance was associated with IFM strength and size, though variations exist between different demographic factors; toe flexor muscle CSAs (FHB and FDB) were notably more significant than the ABH and QP. The increased association of toe strength to posteromedial balance compared to other directions could be due to individuals leaning medially and using IFM to maintain their arch height and balance. The YBT could be influenced by other factors (e.g., proprioception, ankle ROM), thus future research should investigate if other balance tests or pathologies would differ in their associations, or if training the IFM could improve balance.

Funding Source: This work was supported by the Congressionally Directed Medical Research Programs, grant W81XWH-20-2-0035. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government. Disclaimer: BSG, JJF, NEH, PHS, and AS are military service members or employees of the U.S. Government and this work was prepared as part of their official duties. Title 17, U.S.C. §105 provides that copyright protection under this title is not available for any work of the U.S. Government. Title 17, U.S.C. §101 defines a U.S. Government work as work prepared by a military service member or employee of the U.S. Government as part of that person's official duties. This work was supported by Congressionally Directed Medical Research Programs, grant W81XWH-20-2-0035 under work unit N2021. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government. The study protocol was approved by the University of Kentucky Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects. Research data were derived from an approved University of Kentucky Institutional Review Board protocol, number UK58500-IR-EP4-5-7-A.

Table 1. Mean and SD of demographics, IFM strength, balance, and IFM size in individuals with CAI

| | Total (n = 52) | | Military Males (n = 10) | | Civilian Males (n = 13) | | Females (n = 29) | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Age | 25.36 yrs | 8.08 | 23.17 yrs | 3.18 | 32.22 yrs | 8.58 | 23.04 yrs | 7.41 |
| Military | n = 11 | | n = 10 | | n = 0 | | n = 1 | |
| Weight | 76.6 kg | 17.5 | 78.8 kg | 10.8 | 83.7 kg | 21.1 | 72.7 kg | 16.9 |
| Height | 170.9 cm | 8.98 | 173.6 cm | 7.28 | 178.9 cm | 8.41 | 166.7 cm | 7.14 |
| Great toe strength | 10.48 kg | 5.35 | 17.46 kg | 4.13 | 12.46 kg | 4.98 | 7.19 kg | 2.33 |
| Lesser toe strength | 9.84 kg | 5.22 | 16.69 kg | 5.27 | 11.01 kg | 4.63 | 6.96 kg | 2.34 |
| Limb length | 88.8 cm | 5.9 | 89.6 cm | 6.0 | 93.1 cm | 3.7 | 86.7 cm | 5.6 |
| Foot length | 25.0 cm | 1.7 | 26.0 cm | 1.2 | 26.8 cm | 1.5 | 23.9 cm | 1.0 |
| Foot width | 9.3 cm | 0.8 | 9.0 cm | 0.7 | 10.2 cm | 0.6 | 9.1 cm | 0.6 |
| YBT anterior | 63.6 cm | 5.4 | 64.6 cm | 7.4 | 63.3 cm | 4.3 | 63.3 cm | 5.2 |
| YBT post-med | 76.9 cm | 9.8 | 84.2 cm | 10.9 | 77.6 cm | 9.1 | 74.1 cm | 8.6 |
| YBT post-lat | 69.7 cm | 11.3 | 75.5 cm | 9.5 | 72.8 cm | 13.9 | 66.5 cm | 9.9 |
| ABH resting CSA | 2.01 $cm^2$ | 0.67 | 2.63 $cm^2$ | 0.80 | 1.93 $cm^2$ | 0.47 | 1.83 $cm^2$ | 0.58 |
| ABH resisted CSA | 2.19 $cm^2$ | 0.77 | 3.00 $cm^2$ | 0.95 | 2.13 $cm^2$ | 0.44 | 1.94 $cm^2$ | 0.64 |
| FDB resting CSA | 1.64 $cm^2$ | 0.49 | 2.07 $cm^2$ | 0.49 | 1.83 $cm^2$ | 0.52 | 1.42 $cm^2$ | 0.36 |
| FDB resisted CSA | 1.72 $cm^2$ | 0.56 | 2.20 $cm^2$ | 0.55 | 2.02 $cm^2$ | 0.62 | 1.43 $cm^2$ | 0.32 |
| QP resting CSA | 0.87 $cm^2$ | 0.43 | 0.93 $cm^2$ | 0.38 | 0.70 $cm^2$ | 0.40 | 0.92 $cm^2$ | 0.44 |
| QP resisted CSA | 0.96 $cm^2$ | 0.35 | 1.11 $cm^2$ | 0.43 | 0.88 $cm^2$ | 0.27 | 0.95 $cm^2$ | 0.36 |
| FHB resting CSA | 2.42 $cm^2$ | 1.22 | 2.07 $cm^2$ | 0.82 | 2.14 $cm^2$ | 0.89 | 2.64 $cm^2$ | 1.41 |
| FHB resisted CSA | 2.57 $cm^2$ | 1.16 | 2.40 $cm^2$ | 0.93 | 2.37 $cm^2$ | 1.03 | 2.70 $cm^2$ | 1.26 |

YBT, Y-Balance test; ABH, abductor hallucis; CSA, cross-sectional area; FDB, flexor digitorum brevis; QP, quadratus plantae; FHB, flexor hallucis brevis

# Free Communications, Rapid Fire Presentations: Interventions and Testing of Physical Performance

Wednesday, June 26, 2024; 10:00 AM-10:55 AM; Room 271-273
Moderator: James Onate, PhD, LAT, ATC

### The Impact of Omega-3 Supplementation on Event Performance, Grip Strength, and Body Composition in NCAA Division I Track and Field Athletes

Gallucci A, Lee K, Chapman-Lopez T, Forsse J, Torres R, Pickler M, Cherpe de Souza L, Funderburk L: Baylor University, Waco, TX

**Context:** Collegiate track and field (T&F) athletes participate in one of the longest competitive seasons of all sports. Appropriate nutrition for these athletes is of utmost importance. Athletes often utilize a variety of nutritional supplements to complement their diet and support their athletic performance and recovery.1 It has been well-established that many student athletes do not consume adequate omega-3 polyunsaturated fatty acids (n-3 PUFA).2 In recent years, omega-3 usage in athletes has shown improvements in performance, strength, and body composition.3,4 The purpose of this study was to examine how n-3 PUFA influence overall performance, hand grip strength, and body composition in NCAA division I T&F athletes.
**Methods:** Twenty-five T&F athletes (14 females, 11 males) on the active roster of a division I athletic department consented to participate in this single-blind randomized controlled trial. Participants were randomly assigned to consume either 4.0g of fish oil or 4.0g of placebo (i.e., coconut oil) daily for an 8-week period coinciding with their outdoor T&F season. Outcome measures included omega 3 index, body composition, hand grip strength, and sport performance. All variables were assessed at baseline and following 8 weeks of supplementation. Body composition was measured utilizing an InBody 570 (InBody USA, Cerritos, CA) bioimpedance analyzer. Participants completed 3 trials utilizing a standard handgrip dynamometer. Performance was assessed utilizing event marks from competitions at the beginning and end of the outdoor season. Change in performance was measured as a percentage to allow for comparison between events (e.g., sprints, shotput). Pre- and post-intervention data were analyzed using a two-way repeated measures ANOVA ($p<0.05$).
**Results:** All participants displayed omega-3 index levels below recommended amounts at the start of the study. Those who supplemented with fish oil saw a significant increase in omega-3 index ($p=.004$). However, increases in the omega-3 index were not associated with differences in key metrics (e.g., fat mass, fat-free mass) of body composition, hand grip strength, or changes in athletic performance. Of note, both study groups (i.e., fish oil, placebo) still displayed omega-3 index levels below current recommendations at the conclusion of the study.
**Conclusions:** Obtaining and maintaining appropriate levels of omega-3 is a challenge in collegiate athletes. Significant changes in body composition metrics, hand grip strength, or overall athletic performance were not identified between groups. This result occurred despite improvement in the omega-3 indices of those in the intervention group. Future studies are needed to determine if fish oil supplementation with appropriate levels of omega-3 can result in improvements in body composition and athletic performance. This research should aim to assess the impact of fish oil supplementation in diverse athletic populations to determine the efficacy of its supplementation. These results could inform practices for athletic trainers, registered dietitians and athletes themselves.

## The Effect of a Neuromuscular-Cognitive Training Program on Static Postural Stability and Hop Test Performance in Collegiate Tennis Athletes

Porter KH, Torp DM, Ochoa L, Hoch MC: University of Kentucky, Lexington, KY

**Context:** Athletic competition requires high situational awareness and cognitive function; however, these qualities are often not considered during training. Incorporating perceptual-cognitive challenges with neuromuscular interventions may improve athlete performance and safety. Therefore, this research aimed to examine the effect of a six-week neuromuscular-cognitive training program on postural stability and hop test performance, with and without perceptual-cognitive challenge.
**Methods:** Ten collegiate female tennis athletes (20.10±1.20y; 170.26±6.58cm; 59.86±5.59kg) volunteered for this quasi-experimental pretest-posttest design. Participants completed two baseline testing sessions, a six-week neuromuscular-cognitive training program, and a post-test session. The training program occurred twice weekly for six weeks, integrating cognitive load (e.g., inhibitory control and cognitive flexibility) during exercise (e.g., hopping and shuffling). During data collection, subjects completed postural stability and hop tests. Postural stability was assessed in a single-leg stance on a force plate. Participants stood as still as possible on their dominant limb with their hands on their hips for three trials of 30 -seconds. During the dual-task, participants completed an upper extremity reaction task (UERT). For the UERT, participants deactivated lights as quickly as possible on a board while maintaining single-leg balance. The center of pressure (CoP) mean velocity (centimeters/second) and time to boundary (TTB) mean minima were captured for each trial. For the single-leg hop test, participants stood on their dominant leg, completed one single-leg hop as far as possible, and stabilized on the same leg for five seconds after landing. For the dual-task condition, participants completed the hop test in response to a light sensor in front of them that flashed different colors. When the sensor turned dark blue, participants completed the single-leg hop as quickly and far as possible, landing and stabilizing on the same leg. A second sensor in front of the participant captured reaction time. Hop distance (centimeters) and average reaction time (seconds) were captured for the three trials. Pre- to post-intervention changes were analyzed using paired t-tests with corresponding Hedge's g effect sizes.
**Results:** Postural stability improvements were for single-task (pre=2.492±0.551; post=2.308±0.601; p=0.050; g=-0.684) and dual-task (pre=7.588±1.736; post=6.812±1.992; p=0.026, g=-0.803) CoP anteroposterior mean velocity, single-task TTB mediolateral mean minima (pre=1.267±0.208; post=1.466±0.318; p=0.014; g=0.921), and single-task (pre=3.977±0.841; post=4.468±0.972; p=0.023, g=0.830) and dual-task (pre=1.276±0.269; post=1.435±0.365; p=0.044, g=0.78) TTB anteroposterior mean minima. Increased UERT was also identified after training (pre=1.037±0.057; post=0.930±0.110; p=0.028, g=-0.795). There were no significant improvements in hop test performance.
**Conclusions:** The neuromuscular-cognitive training program created improvements in single and dual-task postural stability which indicates combining neuromuscular exercises with perceptual-cognitive challenges may be beneficial in addressing certain injury risk factors. Although there were improvements in hop performance, the small sample size may have prevented it from reaching statistical significance. This provides preliminary evidence for neuromuscular-cognitive training that should be expanded upon with a more robust study design.

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**Test-Retest Reliability and Visual Perturbation Performance Costs During 2 Reactive Agility Tasks**

Smith EM, Sherman DA, Duncan S, Murray A, Chaput M, Murray AM, Bazett-Jones DM, Norte GE: University of Toledo, Toledo, OH; Live4 Physical Therapy and Wellness, Acton, MA; Boston University, Boston, MA; University of Central Florida, Orlando, FL

**Context:** Re-injury rates following ACL reconstruction remain unacceptably high, with as many as 1 in 3 individuals experiencing a second knee injury. Such outcomes question the validity of conventional return-to-sport clearance criteria. Isolated physical performance tests within highly controlled environments used in return-to-sport test batteries are not representative of sport where athletes continuously engage in visual search and reactive behaviors. Considering this mismatch, the development of dynamic, agility-based tasks that integrate visual search and reactive decision-making is warranted. Our purpose was to establish the test-retest reliability of two reactive agility tasks and evaluate the impact of visual perturbation on physical performance. We hypothesized that both tasks would demonstrate acceptable test-retest reliability and that visual perturbation would degrade performance (e.g., slower reaction time).

**Methods:** We used a descriptive laboratory study with test-retest design. Fourteen physically active individuals (7 females, age: 22.0±2.6 years, Tegner Activity Scale: 7-10) who were neurologically sound without previous lower extremity injury or surgery participated. The tasks developed for this study encompassed constructs of reaction time (four-corner agility task), working memory and pathfinding (color recall task) (Figure 1). Participants completed four trials of each task over two sessions scheduled 7 days apart. Outcomes included performance metrics of reaction time (seconds), time to target (seconds), number of targets (n), and total test time (seconds) assessed via reactive training timing gates and two-dimensional video. Stroboscopic goggles were used to induce visual perturbation during the fourth trial of each task. We calculated intraclass correlation coefficients (ICC3,1) using a two-way mixed effects model with absolute agreement to assess the test-retest reliability of each outcome. To assess the effect of visual perturbation, we used paired t-tests and Cohen's d effect sizes.

**Results:** Performance metrics of reaction time, time to target, number of targets, and total test time demonstrated good-to-excellent test-retest reliability for both tasks (range ICC3,1 = .800-.937). In the four-corner agility task, visual perturbation increased time to target (normal = 1.88 ± 0.26 seconds, stroboscopic = 2.08 ± 0.27 seconds, P=.022) and decreased number of targets (normal = 15.50 ± 1.00, stroboscopic = 14.83 ± 0.94, P=.039). In the color recall task, visual perturbation increased time to target (normal = 1.92 ± 0.24 seconds, stroboscopic = 2.14 ± 0.27 seconds, P=.001) and total test time (normal = 159.61 ± 17.79 seconds, stroboscopic = 170.89 ± 22.84 seconds, P=.013). Moderate-to-large magnitude degradations in performance were observed (d=0.55-0.87, performance costs ranged -5% to -12%).

**Conclusions:** Both reactive agility tasks demonstrated acceptable test-retest reliability in an uninjured, physically active cohort. Performance degraded with the presence of visual perturbation during both tasks. These results suggest that standardized reactive agility tasks are reliable and appropriate for investigation of validation as components of dynamic return-to-sport testing for individuals recovering from ACL reconstruction.

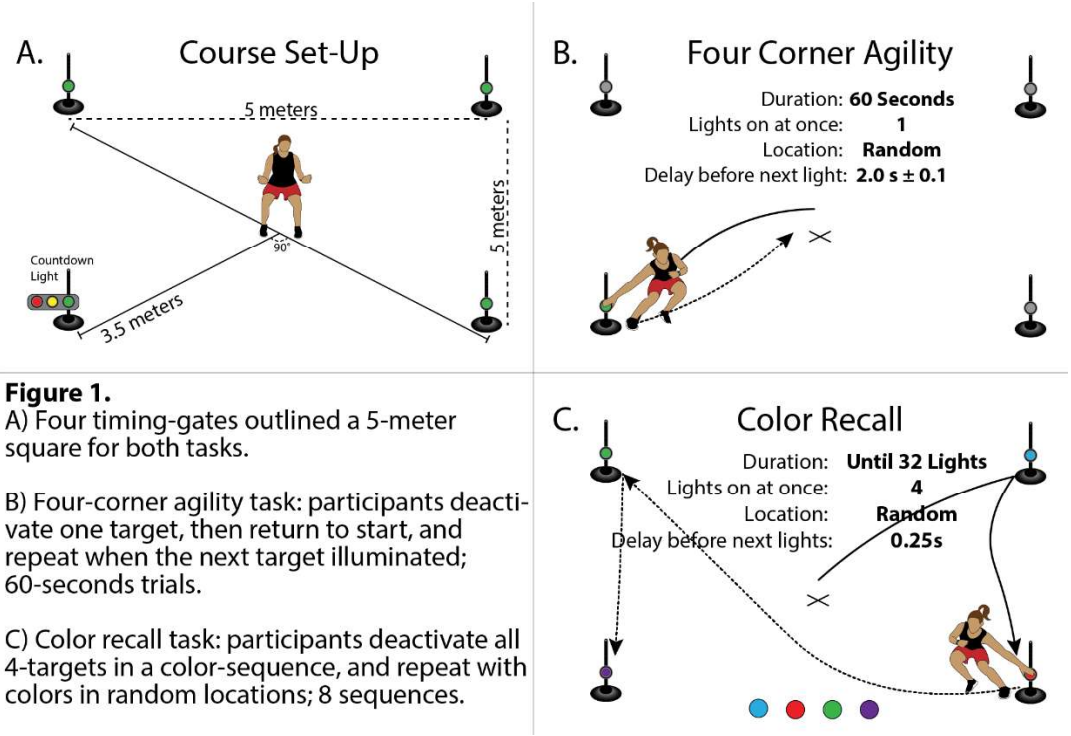


**Figure 1.**
A) Four timing-gates outlined a 5-meter square for both tasks.

B) Four-corner agility task: participants deactivate one target, then return to start, and repeat when the next target illuminated; 60-seconds trials.

C) Color recall task: participants deactivate all 4-targets in a color-sequence, and repeat with colors in random locations; 8 sequences.

**The Effect of Yoga Practices on Anxiety, Balance, and Subjective Sport Performance in Collegiate Softball Players**

Binkley S, Sacko RS, Watson S, Fraley AL: University of South Carolina, Columbia, SC, and The Citadel, Charleston, SC

**Context:** The discipline of yoga is distinguished by its multifaceted nature, encompassing physical, cognitive, and spiritual dimensions, to enhance mental, emotional, physiological, and physical well-being. Yoga exhibits the capacity to mitigate stress, depression, and anxiety symptoms through mechanisms such as hormonal regulation and the reduction of both blood pressure and heart rate. Prior investigations suggest yoga may additionally yield benefits in balance and athletic performance, primarily by enhancing flexibility and equilibrium. While the relationship between yoga, equilibrium, and anxiety has been explored within the general population, understanding of the health-related outcomes of yoga within athletic contexts remains limited. The objective of this study was to assess the effects of a yoga program on anxiety, balance, and sport performance in collegiate softball players over 6 weeks while in-season.
**Methods:** A prospective longitudinal cohort study design was used to evaluate a Division I softball team in the southeastern United States. Individuals competed 3 one-hour sessions of yoga over 6 weeks as part of their training regimen. Twenty-three female softball players (position: infield (6), outfield (6), pitcher (6), catcher (4), utility (1)) were evaluated for anxiety, balance, and subjective sport performance at baseline and after 3 sessions of a yoga program focused on breathwork and total body relaxation. The Generalized Anxiety Disorder-7 (GAD7) Sport Anxiety Scale (SAS), Y-Balance Test (YBT), and Subjective Sport Performance Scale (SSPS) were used to measure anxiety, balance, and sport performance, respectively. Measures were hypothesized to improve over time.
**Results:** Measures of anxiety significantly improved between timepoints (Total GAD7: ($5.09 \pm 3.47$ to $3.91 \pm 3.32$, $p = 0.035$), with additional specific improvement with the somatic anxiety subscale ($9.09 \pm 2.79$ to $7.57 \pm 1.97$, $p < 0.001$). Sport anxiety also significantly improved (Total SAS: $25.75 \pm 6.72$ to $23.39 \pm 7.15$, $p = 0.019$). Significant differences in YPT measures and the SPSS were not observed between time points ($p > 0.05$).
**Conclusions:** Findings indicate that the incorporation of breathwork and relaxation-focused yoga may be effectively integrated into a collegiate softball season with the purpose of improving both generalized and somatic anxiety levels. Other types of yoga utilizing balanced-focused postures may have an influence on YBT measures and should be investigated. Further examination spanning diverse demographic and age groups, athletic proficiency levels, and a spectrum of physical demands is warranted. Subsequent research endeavors should also evaluate yoga's impact on objective performance metrics and injury incidence rates.

NATA Foundation Master's Grant project.

## The Association Between Sport Specialization Level and Athletic Abilities Among Flag Football Athletes and Non-Sport Female Adolescents

Hedrick R, Brna M, Kemp L, Howell DR, Walker GA: Children's Hospital Colorado, Aurora, CO, and University of Colorado Anschutz Medical Campus, Aurora, CO

**Context:** Sport specialization, participating and/or training for a single sport year-round, has become increasingly common among youth athletes. While the role of sport specialization has been investigated related to injury risk, whether athletic abilities (i.e., neuromuscular control, fitness, coordination) differ among youth athletes of different specialization levels and among non-athletes is unclear. Our objective was to examine the association between sport specialization level and athletic testing outcomes among high school girls participating in flag football, relative to non-athlete high school girls.

**Methods:** We conducted a cross-sectional study comparing four groups: non-athletes (not playing a sport/did not play a sport in the past year), low specialized athletes, moderate specialized athletes, and high specialized athletes (via the Jayanthi Scale). Outcome measures included modified Balance Error Scoring System (mBESS) total errors, standing long jump (cm), and modified Harvard fitness test. The mBESS assessed balance control in double, single, and tandem stance conditions with eyes closed. The standing long jump assessed average jump distance from a double leg take-off and landing. The modified Harvard Fitness Test required 30 steps per minute for 5 minutes or until failure at a 30 cm height box, with heart rate assessment 3 minutes after completion to calculate an overall fitness score. For continuous variables, we compared outcomes among the four groups using one-way ANOVAs and Tukey post-hoc tests. We used Fisher's exact tests to assess proportional differences for categorical variables.

**Results:** We tested 93 female high school flag football athletes (mean age=16.4±1.1 years of age): 15 (16%) non-athletes, 24 (26%) low specialized, 30 (32%) medium specialized, and 24 (26%) highly specialized athletes. There were no significant differences between groups for age (p=0.88), height (p=0.29), weight (0.97), or participation restriction history (p=0.55). There was an overall group effect of sport specialization level on total mBESS errors (p=0.005), where the medium specialized group (mean=2.2±1.7 errors) made significantly fewer errors than the non-sport group (mean=5.0±3.3 errors; p=0.007) and the highly specialized group (mean=4.2±3.0 errors; p=0.03). We observed group differences for standing long jump distance (p<0.001), where the non-sport group (mean=150.3±29.7 cm) jumped significantly shorter than the low (mean=173.7.3±24.8 cm; p=0.03), medium (mean=180.1±21.2 cm; p=0.002), and highly (mean=186.3±22.5 cm; p<0.001) specialized groups. We grouped differences for fitness index score (p=0.007), where the non-sport group (mean score=26.1±5.2) was significantly lower than the medium (mean=33.1±6.8; p=0.03), and highly (mean=35.0±8.0; p=0.004) specialized groups.

**Conclusions:** Our data indicates fitness, coordination, and neuromuscular control differences between youth athletes of varying specialization level and non-athletes. The non-specialized cohort, compared to the medium and high specialized cohorts, performed worse on the modified Harvard Fitness Test and standing long jump. However, the high specialized cohort had significantly poorer mBESS scores when compared to the low or medium specialized athletes.

Denver Broncos Foundation funded this research.

**The Impact of Caffeine on Softball Performance in Female Collegiate Athletes: A Randomized Control Trial**

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**Context:** Caffeine is a widely used supplement across the globe that offers numerous health benefits. Caffeine consumption has been adopted across athletics in recent decades to enhance energy supply, and some research suggests a dose performance gain. However, it is unclear what the immediate effects of caffeine consumption have on sports performance; therefore, this study aimed to evaluate the impact of caffeine consumption on overhand arm speed, bat exit velocity, and home-to-first speed times in collegiate softball players. We hypothesized individuals with caffeine supplements would improve from baseline to trial times in overhand arm speed, bat exit velocity, and home-to-first speed.

**Methods:** This single-blind randomized control trial included a purposeful sampling of 10 Division I NCAA softball athletes with a treatment group (4mg/kg dose of caffeine) and a placebo group (sucralose tablets). Participants completed two trials over a one-week time frame. All trials were conducted in an indoor practice facility on artificial turf. During the baseline trial, participants answered a pre-study general medical questionnaire, took vitals (Blood Pressure, Pulse, HR, Temperature), and completed the study performance assessments (overhand arm speed, bat exit velocity, and home-to-first time). On trial day, participants were administered either a placebo or caffeine tablets followed by 60 minutes of quiet sitting. After 60 minutes, participants completed a team warmup, and then performance assessments were measured. Pre- and post-caffeine consumption vitals were taken. Independent variables included the intervention group. Dependent variables included arm speed(mph), bat exit velocity(mph), and home-to-first speed(sec). Descriptive statistics included means and standard deviations for all variables, independent t-tests were analyzed for group differences ($p<0.05$), and paired t-tests were used for treatment group differences between time points ($p<0.05$).

**Results:** Ten athletes (treatment group: n=6, placebo: n=4; 3.1 years in college, average caffeine ingestion= 165mg, average sleep hours= 7, Table 1) participated. No significant group differences were found for, overhand arm speed, bat exit velocity, or home-to-first average ($p's>0.05$). No significant differences were found within the treatment group by trial for and overhand arm speed ($p= 0.20$) and home-to-first average ($p=.92$). However, bat exit velocity averages significantly declined within treatment group ($p= 0.006$). There were no significant differences between baseline vitals and post-treatment vitals ($p's>0.05$)( Table 1).

**Conclusions:** At a 4mg/kg dose, caffeine consumption before activity does not significantly improve specific softball performance tasks. While performance and vitals did not change due to caffeine ingestion, it is still unclear if the dosage of caffeine and time since ingestion would influence performance. Future research should explore overall caffeine intake and whether a history of caffeine dosing influences performance. Athletic trainers should continue to monitor athletes' caffeine intake before competition.

This project was funded by the Drake University Harris Student Funds.

**Comparison of Perceived Vs. Actual Ability Level in Elite Athletes Using a Sport-Specific Task**

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**Context:** While decisions and actions are commonly measured in assessments of sport performance, one's perception – including perception of the environment and perception of one's ability level – ultimately determines the subsequent decision and action that are selected. An error in the perception of one's ability may lead to a misjudgment such as over- or under-estimating one's ability, and evidence from other populations suggest both of these estimation errors are clinically relevant. The purpose of this study was to explore if elite soccer athletes have accurate perceptions of their ability and if they are capable of adapting these perceptions with experience.
**Methods:** Twenty-six healthy athletes from the University of Utah Women's Soccer Team completed the sensorimotor soccer interceptive task (Figure 1). Participants completed three separate blocks, 1st viewing only, action, and 2nd viewing only. For each block, the 50% chance threshold for success was determined by fitting a psychometric curve to the success / failure data from each trial. Performance error was defined as the difference in 50% chance threshold between perceived and actual ability for both perceived blocks. Consistency of one's perceived ability was calculated as the reciprocal of the slope of the perceived curve at the 50% chance threshold, with smaller values indicating greater precision in perceived ability. Descriptive statistics assessed the average performance error and consistency for each block, paired t-tests compared the change in performance error and consistency as indication of adaption with experience.
**Results:** Athletes initially overestimated their ability by a mean (SD) of 0.93 (0.59) m / s. However, athletes significantly reduced their performance error to 0.44 (0.47) m / s after completing the action block (p=0.0002). Similarly, athletes improved the consistency of their perceived ability between the 1st and 2nd viewing-only blocks from 0.66 (0.41) m / s to 0.48 (0.26) m / s (p = 0.048).When introduced to a new sport-related task, elite athletes may initially overestimate their ability. However, athletes can rapidly reduce these overestimation errors and gain consistency with experience in the task, demonstrating an ability to recalibrate their internal models of their ability. Elite athletes may be more aggressive in their decision making on new tasks, but are able to rapidly correct errors in their judgement given proper feedback.
**Conclusions:** When introduced to a new sport-related task, elite athletes may initially overestimate their ability. However, athletes can rapidly reduce these overestimation errors and gain consistency with experience in the task, demonstrating an ability to recalibrate their internal models of their ability. Elite athletes may be more aggressive in their decision making on new tasks, but are able to rapidly correct errors in their judgement given proper feedback.

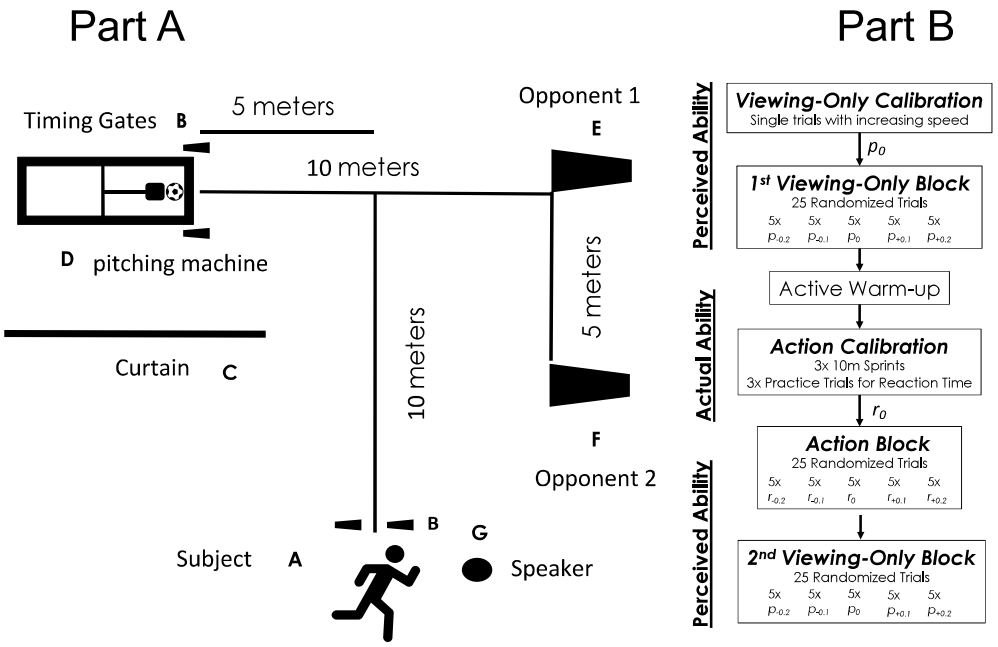


Figure 1: Sensorimotor soccer interceptive task layout (A) procedure overview (B)

### The Association of Vitamin D, Bone Mineral Density, and Injuries Among Acrobatics and Tumbling Athletes

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**Context:** Acrobatics and Tumbling (A&T) incorporates high-impact elements of gymnastics and cheerleading. Vitamin D deficiency is a concern for its impact on bone health and is a known concern among indoor sports such as A&T.1 Athletes participating in high-impact activity tend to have greater bone mineral density (BMD) than non-athletes.2 Because A&T is an emerging sport, little is known about the relationship between vitamin D and BMD. An increased understanding of this relationship while accounting for injury incidence may be useful to medical and nutrition staffs treating these athletes. The objective of this study was to evaluate the relationship between BMD, serum vitamin D, and injury incidence among A&T athletes.

**Methods:** Forty-two A&T athletes on the roster of the sponsoring institution participated in this cohort study. The sample consisted of 19 tops and 23 bases, with an average age of 19.69 ± 1.199 years. Serum vitamin D was analyzed at the beginning and end of fall 20-hour training, 8 weeks apart. Injury data was collected by the team's athletic trainer during the study period. Results of routinely performed DXAs were provided by the nutrition staff for BMD. Outcome measures included serum vitamin D (ng/ml), injury incidence, and BMD (Z score - femur, lumbar spine). T tests were utilized to identify differences in serum vitamin D or BMD based on injury status (i.e., injured vs. uninjured) or position. Correlations were completed to identify relationships between BMD and serum vitamin D. Poisson regressions were utilized to determine if BMD or serum vitamin D predicted the injuries sustained.

**Results:** At weeks 1 and 8, 8 and 13 participants presented with insufficient vitamin D. During this period, participants experienced a significant loss of vitamin D (6.093 ± 10.973, p<.001). Differences by position revealed the loss was only significant in tops (p=.007). Refer to Table 1 for average serum vitamin D and BMD. BMD differences by position revealed a significant difference in the lumbar spine between tops (1.605 ± 1.086) and bases (2.239 ± 0.839) (p=.039). No difference existed for the femur. BMD did not significantly differ based on injury status at either site. No significant correlations were identified between BMD and serum vitamin D. Further, injury incidence was not impacted by BMD or serum vitamin D.

**Conclusions:** Differences were found among BMD by position group, with bases having higher BMD in their spine than tops, likely related to the differing demands of the base position. However, injury incidence was not impacted by BMD or serum vitamin D. Further, a direct relationship between serum vitamin D and BMD was not identified. Low serum vitamin D despite high average BMD in the sample may provide interesting insight for healthcare providers working with A&T.

***Table 1 Vitamin D and BMD Position and Injury Status Comparisons***

| | Total | Tops | Bases | *P* (Position) |
|---|---|---|---|---|
| (ng/ml) Vitamin D T1 | 47.976 ± 18.874 | 52.846 ± 24.083 | 43.952 ± 12.327 | .130 |
| (ng/ml) Vitamin D T2 | 41.883 ± 18.453 | 44.873 ± 24.195 | 39.413 ± 11.895 | .346 |
| (ng/ml) Difference | -6.093 ± 10.973 | -7.974 ± 11.417 | -4.539 ± 10.591 | .319 |
| *P* (Time) | **<.001** | **.007** | .052 | |
| | Total | Tops | Bases | *P* (Position) |
| (Z) BMD femur | 1.836 ± 0.842 | 1.737 ± 0.783 | 1.917 ± 0.897 | .496 |
| (Z) BMD spine | 1.952 ± 0.998 | 1.605 ± 1.086 | 2.239 ± 0.839 | **.039** |
| | | Injured | Uninjured | *P* (Injury Status) |
| (Z) BMD femur | | 1.686 ± 0.749 | 2.005 ± 0.845 | .251 |
| (Z) BMD spine | | 1.859 ± 0.957 | 2.145 ± 1.096 | .127 |

BMD = bone mineral density

## Higher Cumulative Impact Intensities Are Associated With Lower Extremity Injury in Collegiate Basketball Athletes

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**Context:** Excessive impact loads during landing maneuvers may be injurious to musculoskeletal tissue including bone or cartilage. Both acute and cumulative impact forces have been cited as strong predictors of running related injuries. There is less evidence to indicate that cumulative impact loading has the same relationship with ankle and knee joint injuries commonly sustained during basketball activities. The purpose of our study was to determine if cumulative impact load metrics sustained during basketball activities correlate with the incidence of lower extremity injuries sustained during a single season. We hypothesized that higher cumulative impact load intensity would be associated with higher incidence of lower extremity injury.

**Methods:** Eleven collegiate women's basketball athletes (height:1.86 meters, mass:82.0 kilograms, age:20.54 years) participated in a prospective longitudinal study evaluating lower extremity impact load intensity and injury incidence. Impact load intensity was collected during practices using inertial measurement units secured to the distal medial tibiae. Intensities for each limb (right, left) and summation of both limbs (L+R) were categorized as low (0-5g's), medium (6-20g's), and high (20-200g's). Injury was defined as restriction of participation for 1 or more days beyond day of initial injury. Cumulative impact load intensity was calculated over each week of the season. Cumulative impact intensity over the week prior to any documented injury was used for analysis. Point biserial and Pearson product moment correlations were utilized to determine the relationship between impact load metrics, serum biomarkers, and injury.

**Results:** Greater number of right limb cumulative impacts (738.94 ± 237.91 impacts) in the medium range (6-20gs) were moderately associated with injury during week 4 ($r=0.631$, $p=0.037$). Greater medium range cumulative impacts during week 5 for right (725.52 ± 194.46 impacts; $r=0.711$, $p=0.014$), left (721.63 ± 234.02 impacts; $r=0.609$, $p=0.037$) and both limbs (1447.15 ± 416.55 impacts; $r=0.674$, $p=0.023$) were significantly associated with injury. Lastly, greater high range impact intensities (20-200g's) during week 8 for right (337.15 ± 187.61 impacts; $r=0.698$, $p=0.017$), left (328.71 ± 181.27 impacts; $r=0.631$, $p=0.037$) and both limbs (665.86 ± 365.03 impacts; $r=0.672$, $p=0.024$) were also significantly associated with injury. No other weekly cumulative impact intensities were significantly associated with injury incidence across the season.

**Conclusions:** The number of medium and high intensity impacts sustained over the course of a week (week 4,5, & 8) were significantly associated with subsequent lower extremity injury. Those athletes who experienced increased cumulative impact intensities in these ranges went on to sustain lower extremity injury. Managing impact intensities early during the season may be an important factor in mitigating possible lower extremity injury risk. Further studies should explore these relationships to determine predictive capabilities in larger cohorts.

This work was funded by the Arthroscopic Association of North America Research Grant.

## The Influence of Neutral and Motion Control Footwear on Running Mechanics of Adolescent Long-Distance Runners

Barnes MR, Garcia MC, Rosario S, Murray AM, Norte GE, Bazett-Jones DM: University of Toledo, Toledo, OH, and University of Central Florida, Orlando, FL

**Context:** Distance running is a popular sport among adolescent athletes, but running-related injuries are common within this population. Running-related injuries are multifactorial; most are "overuse" injuries that are thought to result from cumulative loads placed on the lower extremity. Healthcare providers and runners believe footwear (e.g., motion control, neutral) is one contributor to injuries and recommend running footwear accordingly. However, the effects of neutral and motion control running shoes has not been reported in adolescent long-distance runners. The aim of this study was to investigate kinematics and self-reported comfort levels of adolescent long-distance runners when running in neutral and motion control footwear compared to their personal running shoes.
**Methods:** The study was a cross-sectional, repeated measures design. Fourteen (F=10, M=4) adolescent long-distance runners who were uninjured participated in this study. Participants completed a single lab visit with overground running trials in their personal running shoes and provided neutral and motion control footwear (counterbalanced). Peak joint angles [°] of the lower extremity were obtained with a 3D motion capture collected system and comfort was assessed via a 100m visual analog scale. One-way repeated measures ANOVAs compared dependent variables ($p < .05$) and Sidak-Holm pairwise comparisons were completed for significant main effects. Mean differences (MD) between footwear were compared to previously reported minimal detectable changes (MDC) to determine meaningful differences. Cohen's d was calculated for each pairwise comparison and described as small ( < 0.5), medium (0.5-0.8), and large ( > 0.8).
**Results:** We observed greater dorsiflexion in motion control than neutral shoes (p=.003, MD=1.4°), greater shoe eversion in neutral than personal shoes (p=.001, MD=1.7°), greater shoe eversion in neutral than motion control shoes (p=.03, MD=1.2°), and greater shoe inversion in personal than neutral shoes (p=.01, MD=1.7°) and motion control shoes (p=.03, MD=1.3°, Table 1). Significant differences showed greater heel width comfort in personal and motion control than neutral shoes (p=.03, MD=11.9 pts; p=.04, MD=14.6 pts); and greater arch comfort in personal than motion control shoes (p=.04, MD=22.2 pts).
**Conclusions:** We observed minimal differences in adolescent long-distance runners' biomechanics between neutral and motion control running footwear. The shoe eversion differences we found between the shoe conditions were below the MDC threshold (2.3°) and therefore are not clinically meaningful. These results suggest that running biomechanics in adolescent long-distance runners are not influenced by different types of footwear. The differences reported in heel width and arch comfort levels had medium-to-large effect sizes (d=0.69, d=1.06) demonstrating the subjective nature of comfort. These findings are limited by varied participant maturational stages and individual bias to personal running shoes. We recommend adolescent long-distance runners select footwear based on comfort.

This work was supported by a shoe donation from the Nike Sports Research Lab. The authors report no relevant financial disclosures.

**Table 1: Comparison of Kinematic Measures among Footwear Conditions**

| | Personal | Neutral | Motion Control | Main Effect | Personal vs Neutral | | Personal vs Motion Control | | Neutral vs Motion Control | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Mean±SD | Mean±SD | Mean±SD | p | p | d | p | d | p | d |
| Running Speed [m/s] | 3.1±0.4 | 3.1±0.4 | 3.1±0.37 | .91 | N/A | 0.02 | N/A | 0.03 | N/A | 0.01 |
| Pelvic Anterior Tilt [°] | 18.2±4.4 | 18.2±4.4 | 18.1±4.3 | .96 | N/A | 0.00 | N/A | 0.02 | N/A | 0.02 |
| Pelvic Contralateral Drop [°] | 3.5± 2.5 | 3.4± 2.5 | 3.7± 2.3 | .83 | N/A | 0.03 | N/A | 0.07 | N/A | 0.10 |
| Hip Flexion [°] | 39.7±5.0 | 38.7±4.0 | 38.8±5.3 | .19 | N/A | 0.24 | N/A | 0.18 | N/A | 0.03 |
| Hip Adduction [°] | 11.6±4.0 | 11.6±4.1 | 11.6±3.5 | .99 | N/A | 0.01 | N/A | 0.01 | N/A | 0.01 |
| Hip Internal Rotation [°] | 5.8±9.4 | 5.2±9.6 | 5.8±9.5 | .73 | N/A | 0.06 | N/A | 0.01 | N/A | 0.06 |
| Knee Flexion [°] | 48.4±4.8 | 48.2±4.8 | 47.7±5.1 | .57 | N/A | 0.05 | N/A | 0.15 | N/A | 0.10 |
| Knee Abduction [°] | 2.4±3.6 | 1.9±4.4 | 1.8±3.8 | .65 | N/A | 0.12 | N/A | 0.15 | N/A | 0.02 |
| Ankle Dorsiflexion [°] | 27.6± 2.5 | 26.7± 3.2 | 28.1± 2.9 | .03* | .13 | 0.33 | .37 | 0.19 | .003* | 0.47 |
| Shoe Eversion [°] | -7.2±3.9 | -8.9±3.3 | -7.7±3.0 | .004* | .001* | 0.48 | .37 | 0.15 | .03* | 0.38 |
| Shoe Inversion [°] | 11.5±4.2 | 9.8±3.8 | 10.2±3.2 | .005* | .01* | 0.43 | .03* | 0.35 | .21 | 0.12 |

Abbreviations: d = Cohen's d effect size, p = p-value, SD=standard deviation *Statistical significance ($p < .05$)

## Anti-Rotation Training in NCAA Division 1 Volleyball Players: A Pilot Study

Stapleton DT, Muckle N, Cruz W, Ralston C, Boergers RJ: Rider University, Lawrence Township, NJ, and Seton Hall University, South Orange, NJ

**Context:** Coordinated movement and power transfer from the upper and lower extremities is aided by a highly functioning core. Previously, seven inter-dependent myofascial chains have been described in the literature (i.e., superficial back line, spiral line, lateral line), all of which include muscles of the trunk and pelvis. Athletes whose movements dominate one side may become unbalanced, diminishing control and recruitment of each myofascial chain. Anti-rotation exercises target muscles of these chains, potentially improving control and performance. Investigations examining the effects of core stability have demonstrated positive effects on performance, however have lacked anti-rotation exercises. Therefore, the purpose of this study was to assess the impact of 8 weeks of supplemental anti-rotation strength training on athletic performance.

**Methods:** Eight (8) female NCAA Division 1 volleyball players (1.76m ± 0.08m, 72kg ± 10.08kg) participated. The participants completed 2 training sessions per week for 8 weeks during the non-championship season. Exercises consisted of serape squat, weighted plank pull through, half kneeling cable chop, Pallof press, and Rip Trainer drive marching. Main outcome measures included the T-test for agility (s), triple crossover hop for distance (m) for the right (TCHDR) and left (TCHDL) legs, single leg squat for the right and left legs (SLSR and SLSL) (poor=0, fair=1, good=2), and the Bunkie test (s) [anterior power line (APL), posterior power line (PPL), posterior stabilizing line (PSL), medial stabilizing line (MSL) and lateral stabilizing line (LSL) for both the right and left side], and a rotational medicine ball throw (m) to the R (RMBTR) and L (RMBTL). Paired samples t tests were used to assess differences from pre to post intervention for all performance measures except single leg squat, which used a wilcoxon t test for ordinal data. Effect sizes were reported by Cohen's d and had the following operational definitions (small 0.2, medium 0.5, large 0.8).

**Results:** Significant improvements were found for TCHDR (4.52m ± 0.69m, 5.41m ± 1.00m, p=0.05), RMBTL (8.35m ± 1.42m, 9.24m ± 1.59m, p=0.04), LSLL (26.72s ± 9.79s, 32.64 ± 8.45s, p=0.03) and SLSR (1.86 ± 3.78, 1.29 ± 0.49, p=0.03). Several outcomes did not reach statistical significance however had large effect sizes: T test for agility (11.42s ± 0.42s, 11.02s ± 0.47s, p=0.06, Cohen's d: 0.89), PPLR (28.10s± 9.96s,36.26s ± 5.74s, p=0.06, Cohen's d: 0.87 ), PPLL (27.82s ± 9.07s, 36.39s ± 6.83, p=0.06, Cohen's d: 0.86).

**Conclusions:** After 8 weeks of supplemental anti-rotation training, measures of trunk stability, lower extremity control, and rotational power improved, demonstrating potential for the use of anti-rotation training for athletes.

**A Retrospective Review of the University Dance Performance and Injury Prevention Program**

Rubach A, DeLuccio J, Stapleton DT: Rider University, Lawrenceville, NJ; Moravian University, Bethlehem, PA; Movement Logic LLC, Lambertville, NJ

**Context:** Pre-participation screening of musculoskeletal health provides an opportunity to identify potential areas for concern with a dancer's functional movement that may impact performance and/or injury development. The purpose of this investigation was to describe the outcomes of the Dance Performance and Injury Prevention (DPIP) © program and to explore the relationships between measures of musculoskeletal function in university dancers.

**Methods:** A musculoskeletal health screening program, including a health history questionnaire and the Functional Movement Screen(™) [Deep squat (DS), hurdle step (HS), in-line lunge (ILL), trunk stability push up (TSPU), rotary stability (RS), active straight leg raise (ASLR), shoulder mobility (SM)], the Y Balance Test [anterior (ANT), posteromedial (PM), and posterolateral (PL)], femoroacetabular rotation range of motion, the Hruska Adduction Lift test (HALT), and the Adductor Drop Test, was implemented in the Fall of 2018 and conducted annually for all incoming dance students. Descriptive statistics (i.e., mean and standard deviation) were calculated. Independent sample t-tests were used to examine differences in FMS scores, YBT performance (including asymmetry), HALT, and Hip ER and IR measures between patients based on prior injury status (yes/no) and current pain (yes/no). Relationships between screening measures were examined using Pearson or Chi-square correlations.

**Results:** A total of 117 subjects (female = 107 (91.5%), age 18.77 years ± 2.62 years) were screened between 2018 and 2022. Significant differences between uninjured and injured at the time of the screening for the DS (1.92 ± 0.62; 1.53 ± 0.71, p=0.01), HS (2.09 ± 0.29; 1.88 ± 0.61, p=0.04), and the ILL (2.28 ± 0.62; 1.84 ± 1.08, p=0.04). Hruska Adduction Lift Test was significantly greater for those without injury at the time of assessment for both the R (2.77 ± 0.60, 2.38 ± 0.65, p=0.01) and L (2.71 ± 0.70, 2.35 ± 0.73, p=0.02). Significant, positive correlations were found between composite FMS and composite YBT (r=0.50, p<0.001). DS (r=0.39, p=<0.001), HS (r=0.43-0.46, p=<0.001), ILL, (r=0.49-0.51, p=<0.001) , SM (r=0.32, p=<0.001), ASLR (r=0.41-0.42, p=<0.001), TSPU (r=0.20, p=0.06), and RS (r=0.33-0.36, p=0.001-0.002) were all moderately correlated with composite YBT for right and left limbs. Significant, moderate relationships were found between R Rib Flare and TSPU (τb=0.261, p=0.03) and L Rib Flare and RS (τb= 0.24, p=0.03).

**Conclusions:** The relationships determined between measures collected provide further evidence of the synergy of stability and mobility of between body segments needed for optimal dance performance. The data presented here provide opportunity for intervention and future development.

**Athletic Trainer Reported Facilitators and Barriers for High School Teams Performing a Dynamic Warm-up**

Sheldon LN, Glaviano NR, Devaney LL, Eason CM, Root HJ, DiStefano LJ: University of Connecticut, Storrs, CT, and Northern Arizona University, Flagstaff, AZ

**Context:** Preventive training programs (PTPs), commonly performed as a dynamic warm-up (DWU), reduce sport-related musculoskeletal injury, but are not widely implemented. Minimal research has investigated perceptions about PTPs at the high school level or among athletic trainers (ATs) in this setting, which may provide insight for future dissemination and implementation strategies. Our purpose was to evaluate the perceptions of ATs in the high school setting regarding implementation of DWUs, a foundation for PTPs. We hypothesized most teams are performing a DWU and there is a difference in perception of factors that facilitate or inhibit DWU implementation between schools performing a DWU already and those that are not.

**Methods:** A web-based survey was distributed to high school ATs via the Athletic Training Locations and Services database. Survey questions were guided by the 2018 NATA Position Statement: Prevention of ACL Injury and validated using the content validity index. Questions were piloted with three ATs for clarity and ease of completion. ATs were asked a variety of questions regarding the DWU performance of teams at their high school and their perceptions on how that could be changed. Chi-square tests were performed on the three most prevalent barriers and facilitators to determine if there was an association ($p < .05$) between reported DWU performance (Yes DWU, No DWU) and perceptions of barriers and facilitators to implementing a team-based DWU.

**Results:** 405 ATs (9% response rate) participated in the survey. No difference in the top three facilitators or barriers was observed between ATs that reported their teams were performing a DWU (n=390) or not (n=15) ($p > .05$). The top facilitators were in-person training sessions (Yes DWU: 206 / 390 53%, No DWU: 8 / 15 53%), access to examples of DWU programs at other schools (Yes DWU: 197 / 390 50%, No DWU: 6 / 15 40%), and having online resources to reference (Yes DWU: 191 / 390 49%, No DWU: 5 / 15 33%). The top barriers were resistance or apprehension from head coaches (Yes DWU: 201 / 390 52%, No DWU: 6 / 15 40%), my school does not have the time to train the coaches and school personnel (Yes DWU: 101 / 390 26%, No DWU: 4 / 15 27%), and other reasons (Yes DWU: 94 / 390 24%, No DWU: 2 / 15 13%).

**Conclusions:** Most ATs in high schools report that teams are performing a team-based DWU, but these data do not describe if the DWU was an evidence-based PTP. Future implementation efforts should focus on addressing perceptions of barriers and facilitators to improve existing DWUs, making them evidence-based. A centralized webpage with accessible resources and example programs could be beneficial for all ATs and the long-term sustainability of a PTP.

## Influence of Surface Type on Cumulative Load During a 5-Km Trail Run

Rosario S, Crutchfield EM, Garcia MC, Murray AM, Norte GE, Bazett-Jones DM: University of Toledo, Toledo, OH, and University of Central Florida, Orlando, FL

**Context:** Running is a popular form of physical activity but due to its repetitive nature, there are high rates of injury. One variable that is thought to contribute to injury is surface type. Previous research has reported conflicting results about impact forces among varying surfaces, but these studies are limited to short distances/durations. There is a paucity of research about surface during prolonged running sessions. Cumulative loading may be more vital to understanding injury in runners due to the prolonged nature of the sport. Measuring impact loading via tibial acceleration allows calculation of cumulative load during prolonged running. Surface type may be more definitively important when considering its cumulative effect and provide more information regarding its use as a method of reducing loading in runners.

**Methods:** We recruited 30 healthy adult runners (Sex: F=16, M=14, Age: 28.78±4.28) between the ages of 18-35 years old. Participants completed two visits to a local park (7-10 days apart) and ran on either paved or unpaved trail surfaces in a randomized and counterbalanced order. We attached a Global Positioning System watch (Forerunner 45, Garmin Ltd, Olathe, KS) around the participant's wrist and triaxial inertial measurement units (IMUs; Blue Trident, IMeasureU, Denver, CO) to the participant's medial distal tibia, bilaterally. Prior to starting the running session, participants completed a 5-minute self-selected warm-up on the surface that was assigned to that visit. Participants then completed a 5-kilometer run on the assigned surface at a self-reported moderate-intensity training speed, which was controlled by the watch. Triaxial accelerations were exported from CaptureU software and imported into a custom MATLAB script. For statistical analysis, we used a one-way repeated measures ANCOVA with running speed as the covariate. Alpha was set at $p < .05$. Effect sizes were calculated as Cohen's d. Effect sizes were categorized as small ( < 0.5), medium (0.5-0.8), or large ( > 0.8).

**Results:** The average running speed for the paved and unpaved conditions was 3.21±0.60 m/s and 3.01±0.56 m/s, respectively, with no significant differences (p=.19). When controlling for running speed, we found no significant differences with small effect sizes (Table 1) in cumulative axial tibial acceleration (p=.56), cumulative resultant tibial acceleration (p=.72), or cadence (p=.99) between paved and unpaved trail surfaces.

**Conclusions:** We found no significant difference in cumulative axial or resultant impact loading during a prolonged run on paved and unpaved trail surfaces. It is unlikely the surface type has a strong influence on loading, which is a proposed proxy for injury. Although there was no meaningful difference in cumulative impact loading over a 5-km run, runners may still experience other physical and mental health benefits from running on trails, regardless of the surface type.

**Table 1.** Comparisons of Running Loads and Cadence Between Paved and Unpaved Trail Surfaces when Controlling for Speed

| | Paved (SD) | Unpaved (SD) | P-Value | Cohen's d |
|---|---|---|---|---|
| Cumulative Axial TA | 14265.2 (5893.0) | 16183.5 (5904.2) | .56 | -0.33 |
| Cumulative Resultant TA | 21668.5 (6337.9) | 23859.453 (6350.3) | .72 | -0.35 |
| Cadence | 169 (8.6) | 170 (8.6) | .99 | -0.12 |

Estimated marginal mean values for running biomechanical variables between surface types adjusted for speed (3.0 m/s). Abbreviations: TA, tibial acceleration; SD, standard deviation

# Free Communications, Rapid Fire Presentations: All Hands on Deck! Emergency Considerations

Wednesday, June 26, 2024; 1:15 PM-2:20 PM; Room 271-273
Moderator: Susan Yeargin, PhD, ATC

## Frequency of EMS Calls and Surgical Interventions Within College Recreational Sport and Activity Programs

Carson R, Ingersoll CD, Mangum LC: University of Central Florida, Orlando, FL

**Context:** Nationwide millions of college students participate in campus recreation activities including intramural and club sport programs. Benefits of participating in recreational sport activities include higher retention rates, improved student academic success, and increased sense of belonging. However, sport-related injuries may result in the activation of EMS, referral to other medical facilities, and/or the treatment of surgical interventions. Athletic trainers can provide medical services to injured athletes, yet they may not be easily accessible to college recreational sport athletes. Therefore, the purpose of this study was to assess the injury frequency and association of EMS calls, medical referrals, confirmed treatment of surgical interventions, and follow-up injury diagnosis that occurred during club and intramural sport programs.

**Methods:** We used a descriptive cross-sectional design, which included individuals who sustained a documented injury at a University Recreation Center during the academic years of 2013-2019. Basic injury reports were documented acutely during intramural and club sport activity by Recreation Center employees. Athletic trainers de-identified and compiled injury report information (n=1308) into a spreadsheet. Inclusion in the present analysis required a follow-up injury report to determine diagnosis of the injury; thus, resulting in 592 injuries. Numerical codes were assigned for activity, EMS activation, surgical intervention, and follow-up injury diagnosis. Descriptive statistics were calculated for injury frequency by activity, EMS calls, surgical treatments, referrals, and follow-up injury diagnosis. Chi square analysis established a statistical association between variables with alpha set to ≤0.05. Cramer's v was calculated to determine effect size.

**Results:** Descriptive statistics of injury frequencies are summarized in Table 1. The following variables had a significant association, and moderate effect size: activity and EMS calls ($p < .001$; Cramer's v=.225); activity and referrals ($p < .001$; Cramer's v=.363); activity and diagnosis ($p < .001$; Cramer's v=.225); EMS and referral ($p < .001$; Cramer's v=.394); EMS and diagnosis ($p < .001$; Cramer's v=.282); referral and diagnosis ($p < .001$; Cramer's v=.282); referral and surgery ($p<.001$; Cramer's v=.205); diagnosis and surgery ($p < .001$; Cramer's v=.205). The following variables did not have a significant association: activity and surgery (p=.264); EMS and surgery (p=.124).

**Conclusions:** Nearly half of all injured athletes had a ligament sprain at the time of follow-up diagnosis, and it was the most common diagnosis among intramural and club athletes. Although 16.2% of injuries required surgical intervention, more than half of injured athletes were not referred for outside care, and only a small percentage were referred to orthopedic specialists. Club sport injuries had the highest frequency of EMS and surgical interventions. Due to the frequency of musculoskeletal injuries requiring follow-up care, University Recreation Centers should be encouraged to have medical professionals such as athletic trainers accessible for both intramural and especially club sport athletes.

Table 1. Intramural and Club Sport Injury Frequencies

| | Total Frequency (Percentage) | Intramural Sport Frequency (Percentage) | Club Sport Frequency (Percentage) |
|---|---|---|---|
| Activity | | | |
| Intramural Sport | 516 (87.2%) | ---- | ---- |
| Club Sport | 76 (12.8%) | ---- | ---- |
| EMS Activation | | | |
| No | 557 (94.1%) | 496 (96.1%) | 61 (80.3%) |
| Yes | 35 (5.1%) | 20 (3.9%) | 15 (19.7%) |
| Surgical Intervention | | | |
| No | 476 (80.4%) | 420 (81.4%) | 56 (73.7%) |
| Yes | 96 (16.2%) | 80 (15.5%) | 16 (21.1%) |
| Unknown | 20 (3.4%) | 16 (3.1%) | 4 (5.3%) |
| Referral | | | |
| No Referral | 385 (65.0%) | 357 (69.2%) | 28 (36.8%) |
| Athletic Trainer | 23 (3.9%) | 13 (2.5%) | 10 (13.2%) |
| Student Health Services | 45 (7.6%) | 41 (7.9%) | 4 (5.3%) |
| Emergency Department/Urgent Care | 100 (16.9%) | 85 (16.5%) | 15 (19.7%) |
| Orthopedic Specialist | 11 (1.9%) | 7 (1.4%) | 4 (5.3%) |
| Other | 28 (4.7%) | 13 (2.5%) | 15 (19.7%) |
| Follow-Up Injury Diagnosis | | | |
| Concussion | 38 (6.4%) | 28 (5.4%) | 10 (13.2%) |
| Contusion | 63 (10.6%) | 52 (10.1%) | 11 (14.5%) |
| Dislocation | 39 (6.6%) | 33 (6.4%) | 6 (7.9%) |
| Fracture/Avulsion | 69 (11.7%) | 59 (11.4%) | 10 (13.2%) |
| Laceration/Abrasion | 17 (2.9%) | 11 (2.1%) | 6 (7.9%) |
| Ligament Sprain | 283 (47.8%) | 261 (50.6%) | 22 (28.9%) |
| Muscle/Tendon Strain | 62 (10.5%) | 56 (10.9%) | 6 (7.9%) |
| Illness/Infection | 6 (1.0%) | 3 (0.6%) | 2 (2.6%) |
| Other | 15 (2.5%) | 13 (2.5%) | 3 (3.9%) |

## Athletic Trainers' Adherence to American Heart Association CPR Guidelines

Claiborne TL, Bucher R, Moreno J, Goetschius J: Adrian College, Adrian, MI, and James Madison University, Harrisonburg, VA

**Context:** Exercise places a great demand on the cardiovascular system, which puts athletes at a greater risk for cardiac arrest. Although the American Heart Association (AHA) sets clear cardiopulmonary resuscitation (CPR) guidelines, research indicates that healthcare professionals' CPR skills are not necessarily up to standard. With few studies and varying methodologies, it is unclear whether these trends carry over into the field of athletic training. Therefore, the purpose of this study was to determine if athletic trainers are proficient in performing high-quality single-rescuer CPR with a pocket mask per AHA guidelines.

**Methods:** During this cross-sectional study, a convenience sample of 41 practicing athletic trainers (mean age = 33.92, SD 8.48 yrs.) simulated CPR in a controlled environment. Each volunteer performed a single two-minute round of CPR using a pocket mask. All bouts of CPR were performed on a hard floor surface using a Brayden Pro Manikin®. Based on the 2020 AHA CPR standards, the Brayden Pro Application® provided an overall CPR score, and the raw data for the critical components of CPR including chest compression rate, depth, hand placement, chest recoil, chest compression fraction as well as ventilation volume.

**Results:** The average scores and proportion of participants who met the performance criteria for each CPR outcome are presented in Table 1. Only 58.5% (24/41) of athletic trainers' overall CPR scores were above passing. The mean overall CPR score of all participants was 74.1%+11.0%. The most common errors were fast chest compression rates (>120 compressions per minute), shallow chest compression depths (<5.0 cm), and improper ventilation volumes. Of particular note, only 7.3% (3/41) of participants were able to provide at least one ventilation at the proper volume (500-600ml) during the entire two-minute CPR cycle. Across the entire 2-minute cycle, ventilation volumes were only performed correctly an average of 5.4% of the time.

**Conclusions:** Even before emergency medical services arrive, athletic trainers are often the first to respond to a cardiac event. Therefore, to give a victim the best chance of survival, it is especially critical that ATs are proficient in performing high quality CPR. Despite being certified in single-rescuer CPR using a pocket mask, only 58.5% of participants in our study were able achieve the minimum overall CPR score, and only 7.3% of participants were able to provide at least one proper ventilation. In comparison with other health care providers, athletic trainers are not unique. Research has supported that EMTs, paramedics and nurses also demonstrate modest CPR proficiency. Future research should assess the impact of periodic practice on CPR proficiency and determine whether the bi-annual certification is adequate to maintain high risk, low frequency skills such as CPR.

## Risk for Exertional Heat Illness Among New Soldiers: Comparison of Wet Bulb Globe Temperature and Universal Thermal Comfort Index

Kazman JB, Clifton DR, Nelson DA, Deuster PA, Lewandowski S: Consortium for Health and Military Performance, Department of Military and Emergency Medicine, F. Edward Hébert School of Medicine, Uniformed Services University of the Health Sciences, Bethesda, MD; Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc, Bethesda, MD; Department of Research, Womack Army Medical Center, Fort Liberty, NC

**Context:** A primary strategy to prevent exertional heat illness (EHI) is to modify activity/hydration using Wet Bulb Globe Temperature (WBGT). The WBGT occasionally misclassifies heat strain, especially when humidity is high and wind is low. An alternative is the Universal Thermal Comfort Index (UTCI), which uses similar inputs but is based on a more modern thermoregulatory model. We characterized EHI incidence rates (IRs) among Army soldiers in their first year of service and compared prediction accuracy across WBGT and UTCI.

**Methods:** Using military career and medical health records contained in the Medical Assessment and Readiness System (MARS), we examined 443,828 enlisted soldiers who joined between 2012 and 2019 and were assigned to a training unit. Soldiers were examined through their first year of service for incident cases of EHI, which we classified as severe (heat stroke or heat exhaustion with complications, e.g., end-organ damage or inpatient admission) or mild (heat exhaustion without complications). Daily mean WBGT or UTCI was derived from a gridded climate dataset (ERA5 from Copernicus Climate Change Service) for each installation's centroid within the continental US. We examined UTCI and WBGT predictions with discrete-time logit models executed at the person-day and used model comparison metrics (Akaike Information Criteria [AIC], area under the curve [AUC]).

**Results:** We observed 600 severe (IR: 1.7 per 1,000 person-years, 95%CI: 1.6, 1.9) and 1,420 mild EHIs (IR: 4.1, 95%CI: 3.9, 4.3). IRs were highest in the first month of service (severe: 3.3, 95%CI: 2.7, 3.9; mild: 7.5, 95%CI: 6.7, 8.5), followed by a decline through months 3-4 (severe: 0.6, 95%CI: 0.4, 1.0; mild: 2.0, 95%CI: 1.6, 2.6), and a steady rise through days 330-360 (severe: 2.2, 1.6, 2.8; mild: 5.1, 95%CI: 4.3, 6.1; trend for day/month: p's < 0.01). The UTCI model outperformed the WBGT model, although the differences were slight (severe: ΔAIC: -32; ΔAUC: 0.004; mild: ΔAIC: -85; ΔAUC: 0.003). To further compare the two indexes, we converted them to relative percentiles, and plotted IRs and sensitivity/specificity over the range of measures. Per visual inspection, both demonstrated similar increases in IRs starting at the 60th percentile, and then exponential increases starting around the 80th percentile. UTCI models had slightly higher specificity and sensitivity than WBGT models; these differences were consistent over percentiles (e.g., they were not confined to hot or mild days).

**Conclusions:** Among soldiers in their first year of service in the continental US, EHI risk is high in the first month of service, followed by a decline and a steady increase. UTCI outperformed WBGT in prediction models, which provides evidence that UTCI could potentially replace WBGT. Although prediction differences were slight, this finding was notable due to the long-standing role of WBGT in setting Army activity modifications.

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## A Traumatic Open Tibial and Closed Fibular Compound Fracture in a Division I Triple Jumper

Showalter KE, Fitzpatrick SG, Pasque CB, Panter BI: University of Oklahoma, Norman, OK; University of Oklahoma College of Medicine, Oklahoma City, OK; McBride Orthopedic Hospital, Oklahoma City, OK

**Background:** A 22-year-old male Division I triple jumper experienced a right midshaft open tibial fracture and closed fibular fracture as a result of planting his foot on the runway to jump into the sandpit. The athlete was placed in a vacuum splint and transported to McBride Orthopedic Hospital, where an intermedullary rod was inserted into his tibia.
**Differential Diagnosis:** Traumatic injury, no differential diagnosis suspected.
**Intervention & Treatment:** During his follow-up with the team physician, it was determined via x-ray that he had three stress fractures proximal to the fracture site and one distal. Upon further conversation with the athlete, it was discovered that he was doing additional training and jumping after practices at night, and frequently experienced shin pain but never reported it to the athletic training staff. His open fracture was likely the result of one of his multiple, non-union stress fractures in the anterior tibial cortex. The athlete was non-weightbearing on crutches for approximately four weeks, then he began to progress back into weight-bearing and include low-impact aerobic activities and low-impact strengthening activities including HydroworxTM, open-chain knee and hip strengthening, and gait training. At 10-weeks post-injury, his bone showed signs of healing with good callus formation, but the physician was concerned that he may develop a nonunion of his fracture site. It was recommended that he utilize a bone-stimulator to help further facilitate healing. At eight months post-injury, the athlete returned to jumping activity and reported no issues. At 11 months post-injury, the athlete was completing jumping drills in the indoor training facility when he felt and heard a loud pop in his leg and pain over the central region where his leg was previously fractured. With physical examination by the physician, as well as x-ray and CT scan, it was hard to determine what caused the noise and accompanying sensation. The physician suspected that he may have broken through some healing callus, but the hardware remained intact and no significant changes were noted. The athlete began using the bone stimulator daily, again, and progressed back into his previous activity level over the next two months. At this point, the chances of this athlete being able to handle the high-impact demands of triple jump again were determined to be very low.
**Uniqueness:** This case involved a very demanding and high-velocity athletic endeavor and a complex and traumatic injury. Because of the underlying stress injuries, the athlete's injury risk was inflated. This athlete returned to a near pre-injury status.
**Conclusions:** This case study highlights the importance of early recognition of stress fractures, educating athletes on the possible effects of over-training, and encouraging athlete communication. This may help prevent simple injuries from becoming complex career-ending injuries. In the early months post-surgery, there was not a strong emphasis placed on the use of a bone stimulator. It is possible that this may have impacted the outcome for this athlete. There also may be alternative rehab methods that could have been more effective in achieving a better outcome like a larger emphasis on high-intensity strength training and earlier plyometric exercise.

**Assessing and Improving AED Maintenance and Access on a College Campus: A Quality Improvement Project**

Pagnotta KD: Thomas Jefferson University, Philadelphia, PA

**Context:** Current guidelines recommend having access to an AED and the shock applied less than 3 minutes after a person collapses. ATs often strive for a shorter time in athletics due to the presence of medical care at many events, however, the responsibility for placement and maintenance of the other AEDs available to the public on a college campus often varies. This project focused on examining and improving the maintenance and access to public AEDs on a college campus.

**Methods:** The Plan Do Study Act strategy for quality improvement focusing on AED access on a college campus was preformed over the course of several years. We purposely excluded venues used for athletics exclusively and focused on the access of AEDs publicly accessible on campus. During the initial phase, we first sought to better understand AED placement on campus and looked to verify their locations. During this preliminary check, it was noted that many of the AEDs indicating low or dead batteries. This restarted our process and we, initially, refocused on the maintenance and upkeep of the existing AEDs on campus. We performed AED checks and reported these findings to various stakeholders on campus. We also performed mock "time-to-shock" checks for various AEDs on campus indicating how long it would take to retrieve the closest AED and return to a "victim". These data, along with recommendations were then communicated with various stakeholders on campus.

**Results:** During the initial investigation, we found several areas of improvement for AED maintenance and access on the campus. Time to shock varied greatly depending on location. There were several locations on campus with access to AEDs in less than 2 minutes, but others were not within the 2-3 minutes. These results were on ideal conditions where the responder knew exactly where the closest AED was. When the time-test was performed with little to no pre-planning and the responder wasn't directly told where the closest AED was, the time significantly increased and in one case the AED couldn't be found, and the "responder" gave up. Ongoing improvements in maintenance and access have been noted since the start of this project, including the purchase of 12 additional AEDs, updated signage and updated plans/ protocols for maintenance and checks.

**Conclusions:** Assessments of AED locations and "time to shock" evaluations should occur with little to know planning to accurately assess response and more closely simulate real life emergencies. Emergency action planning on college campuses should be an on-going process and because ATs have expertise in the development, practice, revision, and implementation of EAPS, we should be engaged in these processes across campus. By working alongside public safety or campus police, student health and other stakeholders there is the potential for improvement on emergency response.

## Rare Case of Pulmonary Embolism in Division I Football Athlete: Type 4 CASE Study

Kessler KG, Foster SZ, Blankenship VT, Monseau AJ, Berkowitz JN, Moll S, Nguyen A: West Virginia University, Morgantown, WV; University of North Carolina at Chapel Hill, Chapel Hill, NC; Frostburg State University, Frostburg, MD

**Background:** A 21-year-old, Division I, defensive end football player, with no significant medical history, presented with low back pain, left shoulder/pectoral pain and shortness of breath during spring football conditioning. Upon evaluation, the patient showed no acute distress and reported no mechanism of injury. Musculoskeletal evaluation was unremarkable with no obvious injury to shoulder, pectoral muscle or back. While the patient continued to show no signs of acute distress, the patient was referred to team physician for heart and lung assessment due to persistent shortness of breath over multiple days.
**Differential Diagnosis:** Low back pain, muscle strain, innominate rotation and possible pathology related to the cardiovascular or respiratory systems.
**Intervention & Treatment:** The patient underwent team physician evaluation and lab testing including complete blood count (CBC), basic metabolic panel (BMP), urinalysis test (UA) and a D-dimer test, which revealed extremely high levels of D-dimer, approximately 800 ng/mL, indicating a high likelihood of a pulmonary embolism (PE). The patient was admitted to the hospital for additional lab work and computed tomography angiography (CTA). CTA results confirmed a diagnosis of a lower left lobe segmental and subsegmental PE. The patient was discharged after 2 days and prescribed an oral anticoagulant two times daily. The patient returned to limited activity that included conditioning and weight training, but no participation in any football activity. Following the spring season, the patient was evaluated by a hematologist to establish a plan of case and follow-up testing to determine the level of coagulation. Results indicated a return to baseline homeostatic environment clotting levels (below 10 nanograms) approximately 16 hours following a single dose of anticoagulant. During the fall season, the patient began a normal week of football activity, including practice, conditioning and weightlifting. A plan of intermittent anticoagulant dosing, as well as post-activity wellness checks, was implemented. This included 2 doses of an anticoagulant per day, with a 12-hour span between doses. Frequency and timing of the doses were variable, adjusted to account for the type of practice (contact vs. non-contact), practice start time and competition start time. This intermittent dosing strategy ensured the patient returned to baseline clotting levels before contact practices or competition and to account for possible injuries that may have occurred during activities. After each practice, the sports medicine staff completed a wellness check to determine if any type of injury was sustained.
**Uniqueness:** PEs are blood clots that form in the pulmonary arteries, commonly seen in individuals who live sedentary lifestyles. PEs are rarely found in young, healthy, active individuals. Adding to the complexity of this case, the PE was unprovoked, no signs of deep vein thrombosis (DVT) or other blood clots. Diagnosis and treatment of PEs must be quick and effective for high mortality rates. The patient has been on this plan since June 2023 and has participated in all football related activities. Due to the unprovoked nature of the PE, the recommendation is life-long anticoagulation. While intermittent anticoagulation is not an ideal treatment plan, this approach has been increasingly used in athletics to allow athletes to continue their career.
**Conclusions:** The 21-year-old football athlete sustained a potentially life-threatening condition, resulting in multiple testing procedures and a detailed plan of care. The patient continues to follow the daily plan and has safely participated in football activities without restrictions or recurrent symptoms. The patient will continue to follow this plan throughout the remainder of the season and will follow up with the hematologist after the season. Through the team approach of care, the patient has successfully participated in each football game this season, without any major concerns of the PE.

## Factors Associated With Second ACL Reconstruction: A Taiwan National Health Insurance Research Database Study


Liao CC, Chen YT, Hong JP, Shao YH, Chang CL, Huang YL: National Taiwan Normal University, Taipei, Taiwan; Taipei Medical University Shuang Ho Hospital, New Taipei City, Taiwan; Taipei Medical University, Taipei, Taiwan



**Context:** The risk of suffering a second ACL injury remains elevated following primary ACL reconstruction (ACLR). Earlier research has identified age and sex as factors linked to a higher risk of second ACL injuries. Additionally, a history of previous injuries, including concussion and concomitant injuries to the primary ACL, has been associated with an elevated risk. However, no study has explored the potential risk factors for subsequent ACLR in Taiwan, using a national-level database. Therefore, this study aimed to utilize the Taiwan National Health Insurance research database (NHIRD) to determine the risk of the second ACLR in the general population.

**Methods:** A 20-year retrospective cohort study utilized NHIRD to analyze patients diagnosed with primary ACL injury who underwent reconstruction (01/01/2001–12/31/2020). Patients with unknown birth year, sex or who passed away within one week post primary ACLR index date were excluded. The study analyzed the incidence of a second ACLR within 5 years post primary ACLR. Multivariate regression was performed to examine the effects of age, sex, concomitant injuries of the primary ACLR and concussion diagnosis between primary and second ACLR. Risk factors for a second ACLR were identified using Cox regression model. The Kaplan-Meier method was used to estimate the probability of a second ACLR within 5 years after primary ACLR.

**Results:** A total of 36,772 patients (male: 67.4%; female: 32.6%), with the mean age of 32.3±12.5 years, were included. There were 907 (2.5%) patients underwent a second ACLR within 5 years post primary ACL injury (median follow-up time: 1.8, IQR: 0.8-3.1 years). Patients under 20-year-old had the highest risk of second ACLR (adjusted hazard ratio (aHR): 1.92, p<.001), following by 40-59 group (aHR: 0.78, p=.009) and 60-79 group (aHR: 0.46, p=.011), with the 20-39 age group as the reference. Males had a higher risk than females (aHR: 1.20, p=.016). Patients with concomitant injuries of collateral ligament injuries (aHR: 3.61, p=.009), medial (aHR: 1.17, p=.039) and lateral meniscus injury (aHR: 1.21, p=.033) also demonstrated elevated risk. Conversely, patients diagnosed of concussion after primary ACLR, either with (aHR: 0.40, p=.040) or without loss of consciousness (aHR: 0.49, p=.004), displayed a reduced risk of second ACLR.

**Conclusions:** Approximal 2.5% of patients in Taiwan underwent a second ACLR within 5 years following primary ACLR, with an elevated risk observed in younger males and those with collateral ligament and meniscus injuries- consistent with prior research. Unexpectedly, in the general population, patients who experienced a concussion after primary ACLR showed a reduced risk of subsequence ACLR. This contradicts previous findings that suggested a heightened ACL injury risk following a concussion among athletes. The mechanism behind this reduced risk of second ACLR following primary ACLR remains unclear, warranting further investigation.



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## Factors Influencing Overuse and Non-Time-Loss Injury Occurrence in Division I Collegiate Athletes

Brown CN, Bovbjerg VE, Choe S, Soucy M, Fredericson M, Simon JE: Oregon State University, Corvallis, OR; Stanford University, Stanford, CA; Ohio University, Athens, OH

**Context:** Overuse and non-time-loss (NTL) injuries occur frequently in collegiate athletics and contribute substantially to increasing clinician workload and poor athlete health outcomes. To develop appropriate prevention programs, factors influencing the occurrence of these injuries must be identified. Our purpose was to identify potential factors that influenced the occurrence of both overuse and NTL injuries in select Division I sports. We hypothesized participation in women's and technical/aerobic sports would be influential factors.

**Methods:** In this cross-sectional study, de-identified medical records from student-athletes who authorized their use for research were obtained from August 2018 to July 2022 from a conference. The data represent 925 team-seasons (394 men and 531 women) from 15 men's and 16 women's sports. Injuries were classified by mechanism (acute or overuse) as well as time-loss (TL) or NTL status. Categorical factors included team (men's or women's), sport designation (technical/aerobic: baseball, cross country, golf, gymnastics, rowing, softball, swimming, tennis, track and field, and volleyball; non-technical/aerobic: basketball, football, skiing, soccer, water polo, and wrestling), and season of occurrence (pre-, in-, post-, off-, or non-traditional season). Two binomial logistic regressions were performed to determine the effects of those variables on the likelihood the injuries were categorized as overuse or as NTL ($\alpha<0.05$).

**Results:** Of 29,469 sport-related injuries, 29,202 (99.1%) and 27,574 (93.6%) of cases were valid with complete information for overuse and NTL models, respectively. Frequencies and reference categories are reported in Table 1. The overuse model was statistically significant $\chi2(6, N=29,202) = 2625.6$, Nagelkerke R2=0.13, $p<0.001$, with correct classification of 77.5% of cases. The NTL model was statistically significant $\chi2(6, N=27,574) = 304.5$, Nagelkerke R2=0.02, $p<0.001$, with correct classification of 56.0% of cases. Significant predictors to the overuse model and parameter estimates indicated participation in women's sports and technical aerobic sports influenced overuse injury occurrence, while participation in women's sports influenced NTL injury (Table 1). **Conclusions:** Gender (as represented by team) influenced overuse and NTL injuries, as did participation in an aerobic/technical sport for overuse injury. While the models and individual factor contributions were statistically significant, the variance explained by the models and the percent of cases correctly identified was low. Additionally, season of injury onset contribution varied by mechanism and NTL status. These findings support previous studies indicating women and those in technical/aerobic sports may experience greater overuse injuries and NTL injuries. Few prevention programs are specifically designed to address overuse and NTL injuries, and future research should focus on the contributions of season to injury occurrence and potential variations within specific sports.

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**Table 1.** Parameter Estimates for Binomial Logistic Regression Models

| | | | | | | | | | | 95% CI for Exp(B) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Category | Frequencies | B | S.E. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Overuse Model | Team | Men | 17,236 | | | | | | Ref | | |
| | | Women | 11,966 | 0.42 | 0.03 | 179.93 | 1 | <.001 | 1.52 | 1.43 | 1.62 |
| | Technical/ Aerobic Sport | Non-Technical/ Aerobic | 17,411 | | | | | | Ref | | |
| | | Technical/ Aerobic | 11,791 | 1.23 | 0.03 | 1476.44 | 1 | <.001 | 3.43 | 3.22 | 3.65 |
| | Season | | | | | 206.64 | 4 | <.001 | | | |
| | | In-Season | 12,620 | | | | | | Ref | | |
| | | Pre-Season | 7,497 | 0.27 | 0.04 | 57.24 | 1 | <.001 | 1.32 | 1.23 | 1.41 |
| | | Post-Season | 1,186 | -0.13 | 0.09 | 2.14 | 1 | 0.14 | 0.88 | 0.74 | 1.04 |
| | | Off-Season | 6,794 | 0.50 | 0.04 | 177.16 | 1 | <.001 | 1.66 | 1.54 | 1.78 |
| | | Non-Traditional Season | 1,105 | 0.02 | 0.08 | 0.04 | 1 | 0.84 | 1.02 | 0.87 | 1.19 |
| | Constant | | | -2.24 | 0.03 | 5140.66 | 1 | <.001 | 0.11 | | |
| Non-Time-Loss Model | Team | Men | 16,405 | | | | | | Ref | | |
| | | Women | 11,169 | 0.31 | 0.03 | 133.28 | 1 | <.001 | 1.36 | 1.29 | 1.44 |
| | Technical/ Aerobic Sport | Non-Technical/ Aerobic | 16,508 | | | | | | Ref | | |
| | | Technical/ Aerobic | 11,066 | -0.27 | 0.03 | 101.29 | 1 | <.001 | 0.76 | 0.72 | 0.80 |
| | Season | | | | | 129.84 | 4 | <.001 | | | |
| | | In-Season | 11,982 | | | | | | Ref | | |
| | | Pre-Season | 7,104 | -0.14 | 0.03 | 21.03 | 1 | <.001 | 0.87 | 0.82 | 0.92 |
| | | Post-Season | 1,099 | -0.02 | 0.06 | 0.06 | 1 | 0.81 | 0.99 | 0.87 | 1.12 |
| | | Off-Season | 6,375 | -0.33 | 0.03 | 107.64 | 1 | <.001 | 0.72 | 0.68 | 0.77 |
| | | Non-Traditional Season | 1,014 | -0.40 | 0.07 | 34.35 | 1 | <.001 | 0.67 | 0.59 | 0.77 |
| | Constant | | | -0.10 | 0.02 | 19.66 | 1 | <.001 | 0.91 | | |

**Prevalence and Diagnosis Status of Non-Sport-Related Concussions in a Sample of High School, College, and Professional Athletes**

Register-Mihalik JK, Ingram BM, Mihalik JP, Guskiewicz KM, Marshall SW, McCulloch KL, Mrazik M, Murphy I, Naidu D, Ranapurwala SI, Schneider KJ, Gildner P, Salmon DM, Auton B, Bowman TG, Hall EE, Hynes LM, Jewell E, Ketcham CJ, Wesley Siler C, Sullivan SJ, McCrea MA: Matthew Gfeller Center, Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC; Injury Prevention Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC; Department of Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, NC; Division of Physical Therapy, Department of Health Sciences, School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC; Faculty of Education, University of Alberta, Edmonton, AB, Canada; Canadian Football League, Toronto, ON, Canada; Injury Prevention and Player Welfare, New Zealand Rugby, Wellington, New Zealand; Faculty of Medicine & Dentistry, University of Alberta, Edmonton, AB, Canada; Sport Injury Prevention Research Centre, Faculty of Kinesiology, Alberta Children's Hospital Research Institute, Hotchkiss Brain Institute, University of Calgary, Calgary, AB, Canada; World Rugby, Player Welfare and Rugby Services, Dublin, Ireland; Catawba College, Salisbury, NC; College of Health Sciences, University of Lynchburg, Lynchburg, VA; Department of Exercise Science, Elon University, Elon, NC; School of Kinesiology & Health Science, York University, Toronto, ON, Canada; Department of Kinesiology and Recreation Administration, North Carolina Central University, Durham, NC; Center for Neurotrauma Research (CNTR), Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, WI

**Context:** Non-sport-related concussions (NSRC) often occur in environments and situations where medical presence and athletic trainer (AT) access are limited. Few studies have examined NSRC prevalence and associated outcomes. The purpose of this study was to examine the association between prior NSRCs [NSRC / Sport-Related Concussion (SRC)] and diagnosis status (undiagnosed / diagnosed) in high school, college, and professional athletes. We hypothesized NSRCs would be less likely to be diagnosed than SRCs.
**Methods:** For this cross-sectional study, pre-season measures from high school, college, and professional athletes (total n = 3511) across 28 sites and 26 sports in Canada, New Zealand, and the United States were collected. The study measures reported here were obtained during the baseline assessment in a classroom setting for a parent clinical trial (NCT02988596). Analyses reported in this abstract were limited to those self-reporting prior NSRC or SRCs [n=1,382; median age = 21 years (Q1=18, Q3=24); 314 (22.7%) female] during the preseason baseline assessment. Measures of interest included demographics and concussion history (NSRC / SRC, diagnosed / undiagnosed). Descriptive statistics summarized: 1) prevalence of previous NSRCs and SRCs and 2) diagnosis status (diagnosed vs. undiagnosed) of these reported concussion types. An exact test examined the association between prior concussion type (NSRC versus SRC) and diagnosis status (diagnosed versus undiagnosed; a priori $\alpha = .05$). For this analysis, concussions were the analysis unit.
**Results:** Participants reported 2,162 prior concussions. These events were reported by 1,382 / 3,511 (39.4%) of all larger study participants. In those 1,382, 172 (12.7%) reported 1+ NSRCs for a total 188 NSRCs. These NSRCs accounted for 8.7% of all concussions; 1206 (87.3%) reported a history of only SRC for a total of 1,974 SRCs. SRCs accounted for 91.3% of all concussions. Of the prior concussions, 41 / 188 (21.8%) NSRCs compared to 219 / 1,974 (11.1%) SRCs were reported as undiagnosed ($P<.001$).
**Conclusions:** In the study sample, 8.9% of prior concussions reported were attributed to non-sport-related mechanisms. A significantly higher proportion of prior NSRCs compared to SRCs (21.8% versus 11.1%) were reported as undiagnosed. These findings indicate a need to improve care pathways for non-sport-related injuries. Additionally, concussion education and access to appropriate concussion-related care in non-sport related settings (schools, community centers, emergency departments, etc) are essential to improve care and access for individuals sustaining concussions outside of sport. ATs and other sports medicine clinicians should be mindful of: 1) negative outcomes in patients with NSRCs; 2) opportunities to educate about concussions occurring outside of sport; and 3) strategies to develop improved identifications pathways for NSRCs at all levels of sport.

This study was funded in part by the National Football League. The design, analysis, and interpretation of the results are solely those of the authors.

**Winner of the Established Career Category**

**Incidence and Characteristics of Shoulder Injuries Before and After the Implementation of the Targeting Rule in American High School Football**

Roos K, Harrison L, Resnick P, Nakajima M, Collins CL: California State University Long Beach, Long Beach, CA; Sacramento State University, Sacramento, CA; Datalys Center for Sports Injury Research and Prevention, Indianapolis, IN

**Context:** To reduce head and neck injuries from helmet-to-helmet contact, the National Federation of State High Schools enacted a rule against targeting in 2014. A hypothesis is that this rule change would shift the distribution of injuries from head to shoulder. Currently, there is no research on whether the rule change has influenced shoulder injury incidence or characteristics. This investigation will determine if the implementation of this rule affected the incidence and characteristics of shoulder injuries in American high school football.

**Methods:** This epidemiologic investigation analyzed injury surveillance data from the High School Reporting Information Online Database for the 2005 / 06 through 2020 / 21 academic years. Data were reported by Certified Athletic Trainers regarding athlete and injury characteristics, and athlete-exposures (AEs). Included injuries were limited to shoulder injuries in football players, from all injury mechanisms. Pre-targeting rule injuries occurred from 2005 / 2006 through 2013 / 14; post-targeting rule injuries occurred from 2014 / 15 through 2020 / 21. Rates, incidence rate ratios (IRR), chi-squares (X2) and 95% confidence intervals (CIs) were calculated using SPSS v.29.

**Results:** A total of 1634 shoulder injuries occurred pre-targeting rule (2.76 / 10,000AEs); 1051 shoulder injuries occurred post-targeting rule (2.33 / 10,000AEs). Fewer shoulder injuries occurred post-targeting rule (IRR: 0.846; 95%CI: 0.782-0.914). While the distribution of basic mechanism of injury changed post-targeting rule (X2: 16.111, p=0.013); football-specific mechanisms were solely from tackling or being tackled, with no distribution change post-rule change (X2: 0.366, p=0.545). The proportion of shoulder injuries that occurred during games increased post-targeting rule (61.0% vs 69.0%; X2: 17.902, $p < 0.001$; Table 1). The distribution of shoulder injuries amongst levels of play changed pre to post-targeting rule with more varsity players having shoulder injures post-rule (62.4% vs 71.9%; X2: 33.415, $p < 0.001$). A higher proportion of shoulder injuries presented preseason pre-targeting rule (24.0% vs 18.3%; X2: 20.401, $p < 0.001$). The outcomes of shoulder injuries differed pre- to post-targeting rule with more medical disqualifications pre-rule (7.1% vs. 5.0%) and more season ending before return to play from injury post-rule (6.1% vs 13.0%; X2: 42.781, $p < 0.001$). The proportion of shoulder injuries requiring surgery increased post-targeting rule (8.8% vs 12.9%; X2: 43.973, $p < 0.001$).

**Conclusions:** Post-targeting rule, the rate of high school football athletes who sustained shoulder injuries was lower than the rate of shoulder injuries pre-targeting rule. The distribution of shoulder injuries also changed following the implementation of the rule with more shoulder injuries occurring in varsity athletes, occurring during games, and occurring later in the season, which may account for the larger proportion of injured athletes whose seasons end before returning to play. Future research should include prospective studies to investigate the mechanics of shoulder injuries when they occur.

Table 1: Characteristics of high school football shoulder injuries pre and post targeting rule implementation.

| Characteristic | | Pre-targeting rule n | Pre-targeting rule % | Post targeting rule n | Post targeting rule % |
|---|---|---|---|---|---|
| Level of Play | Varsity | 930 | 62.4% | 755 | 71.9% |
| | JV | 323 | 21.7% | 194 | 18.5% |
| | Freshman | 160 | 10.7% | 79 | 7.5% |
| | Combined / Other | 77 | 5.2% | 22 | 2.1% |
| Season | Preseason | 391 | 24.0% | 192 | 18.3% |
| | Regular season | 1164 | 71.3% | 813 | 77.6% |
| | Postseason | 77 | 4.7% | 39 | 3.7% |
| | Unknown / Other | 0 | 0.0% | 4 | 0.4% |
| Outcome | Returned in 1-6 days | 653 | 41.0% | 404 | 40.3% |
| | Returned in 7-9 days | 232 | 14.8% | 127 | 12.7% |
| | Returned in 10-21 days | 296 | 18.9% | 185 | 18.4% |
| | Returned in 22 days or more | 132 | 8.4% | 75 | 7.5% |
| | MDQ for season | 111 | 7.1% | 50 | 5.0% |
| | MDQ for career / Athlete chooses not to continue | 22 | 1.4% | 16 | 1.6% |
| | Other* | 34 | 2.3% | 16 | 1.6% |
| | Season ended before RTP | 95 | 6.1% | 130 | 13.0% |
| Surgery | Yes | 139 | 8.8% | 132 | 12.8% |
| | No | 1449 | 91.2% | 892 | 87.1% |

*Other includes: Athlete released from team and Returned to activity in less than one day

## Epidemiology of Thigh Injuries in NCAA Men's and Women's Soccer: 2009/10-2018/19

Boltz AJ, Rao N, Lempke LB, Collins CL, Broglio SP, Chandran A: Datalys Center for Sports Injury Research and Prevention, Indianapolis, IN, and Michigan Concussion Center, University of Michigan, Ann Arbor, MI

**Context:** Thigh injuries are prevalent in soccer due to physical demands on the lower extremities. As epidemiological investigations of such injuries are crucial for appraising injury patterns and subsequently developing effective injury prevention strategies, we sought to examine the epidemiology of thigh injuries in NCAA Men's and Women's Soccer. We hypothesize that overall thigh injury rates will be comparable across sex, and that time loss (TL) prevalence will be higher in men's than in women's soccer.
**Methods:** The NCAA Injury Surveillance Program captured thigh injury and exposure data voluntarily reported by athletic trainers at participating institutions from 2009/10-2018/19. Thigh injury rates (stratified by sex and event type) per 1,000 athlete-exposures (AEs) were estimated, and injury characteristics were examined by injury-mechanism (player contact, surface contact, apparatus contact, other), -diagnosis, and -history (new/recurrent). The prevalence of TL (>1 day TL) injuries and mean TL were also estimated. Differential injury rates across sex (male, female) and event types (competitions, practices) were assessed using Injury Rate Ratios (IRRs). Injury Proportion Ratios (IPRs) were used to assess differential distributions of injuries across the same explanatory variables. IPRs and IRRs with 95% Confidence Intervals (CIs) excluding 1.00 were deemed statistically significant.
**Results:** A total of 698 thigh injuries from 491,402 AEs (Rate= 1.42 per 1,000 AEs) were reported in NCAA men's soccer, and 887 thigh injuries from 669,821 AEs (Rate= 1.32 per 1,000 AEs) were reported in NCAA women's soccer during the study period. Overall rates were comparable between men's and women's soccer (IRR= 1.07; 95% CI= 0.97, 1.18). Competition-related thigh injury rates were higher than practice rates in both men's- (IRR= 2.77; 95% CI= [2.39, 3.22]), and women's-soccer (IRR= 1.69; 95% CI= [1.48, 1.94]). Thigh injuries were most commonly attributed to non-contact mechanisms in men's- (46.1%) and women's- (46.0%) soccer and accounted for comparable proportions of thigh injuries in both groups (IPR: 1.00; 95% CI=[0.90,1.12]). Strains were more prevalent in women's- (67.5%) compared to men's-soccer (61.5%; IPR: 1.10; 95% CI=[1.02,1.18]). Comparable proportions of thigh injuries in men's (82.1%) and women's (83.7%) soccer were new injuries (IPR: 0.98; 95% CI=[0.94,1.03]). Similarly, comparable proportions of all thigh injuries resulted in TL in both men's (50.7%) and women's (46.8%) soccer (IPR: 1.08; 95% CI=[0.98,1.20]). The average TL among those injuries was 5.6 days (SD= 10.5; Median= 2.0; IQR= 7.0) in men's- and 4.4 days (SD= 10.7; Median= 1.0; IQR= 5.0) in women's-soccer.
**Conclusions:** Our findings suggest that thigh injuries are a significant concern in both men's and women's soccer, with competition being associated with higher injury rates. Strains were the most common thigh injury diagnosis in both groups. These results offer insights into settings and conditions of focus for mitigating the burden of thigh injuries in NCAA soccer.

The NCAA Injury Surveillance Program was funded by the NCAA. The Datalys Center is an independent nonprofit organization that manages the operations of the NCAA ISP. The content of this report is solely the responsibility of the authors and does not necessarily represent the official views of the funding organization. We thank the many ATs who have volunteered their time and efforts to submit data to the NCAA ISP. Their efforts are greatly appreciated and have had a tremendously positive effect on the safety of collegiate student-athletes.

## Epidemiology of Soft-Tissue Lower Extremity Injuries in NCAA Field Sports: 2009/10 to 2018/19

Rao N, Boltz AJ, DeJong Lempke AF, Anderson M, Collins CL, Chandran A: Datalys Center for Sports Injury Research and Prevention, Indianapolis, IN; Michigan Concussion Center, School of Kinesiology, University of Michigan, Ann Arbor, MI; Human Performance and Sport Science Center (HPSSC), School of Kinesiology, University of Michigan, Ann Arbor, MI

**Context:** Lower extremity injuries (LEIs) are prevalent in National Collegiate Athletic Association (NCAA) sports. Soft-tissue LEIs represent particularly complicated and heterogeneous recovery trajectories for athletes. Previous research suggests potential relationships between playing surface, injury mechanism, and LEIs in athlete populations. However, epidemiological investigations into soft-tissue LEIs specifically are limited in NCAA sports. Therefore, we aimed to describe the epidemiology of soft-tissue LEIs in men's and women's NCAA field sports (soccer, field hockey, football, lacrosse).

**Methods:** LEI exposure and injury data reported to the NCAA Injury Surveillance Program (ISP) from the 2009 / 10 to 2018 / 19 academic years were examined. Athletic trainers at participating institutions contributed data via their Electronic Medical Record systems. Acute soft-tissue (ligaments, tendons, muscles, etc.) LEIs were targeted for analysis and injury incidence (expressed as rates per 1,000 athlete exposures [AEs]) was examined overall, by sex, sport, and event type (practice, competition). Distributions of soft-tissue LEIs were examined by injury mechanism (player contact, surface contact, apparatus contact, non-contact), injury history (new, recurrent), body part, surface type (grass, turf, other) and diagnosis, as frequencies (%). Prevalence of time loss (TL) ( >= 1 missed day) injuries and average TL were also estimated. Differential injury incidence across explanatory variables of interest were assessed using Injury Rate Ratios (IRRs) and differential distributions were assessed using Injury Proportional Ratios (IPRs); effect estimates with 95% Confidence Intervals (CIs) excluding 1.00 were deemed statistically significant.

**Results:** During the study period, 16,120 soft-tissue LEIs from 5,017,858 AEs (Rate=3.21 per 1,000 AEs) were reported among field sports. Soft-tissue LEI rates were higher in men's sports compared to women's sports (IRR=1.20, 95% CI=1.16, 1.25); highest rates were in men's soccer (Rate=3.70) and women's soccer (Rate=3.64), and in competition compared to practice (IRR=4.67, 95% CI=4.53, 4.82). Most injuries were new (83.63%), diagnosed as sprains (46.76%) or strains (31.56%), and localized to the ankle (29.39%), knee (24.88%), or thigh (20.72%). A large proportion of injuries were associated with player contact (44.16%) or non-contact mechanisms (40.09%). Soft-tissue LEIs commonly occurred on turf surfaces (58.18%); a higher proportion of injuries occurred on turf compared to grass surfaces (IPR=1.44, 95% CI=1.41, 1.48), though there was no significant difference in injury rates (IRR=1.03, 95% CI=1.00. 1.07). Almost half (45.51%) of all injuries resulted in TL; the average reported TL was 7.8 days (SD=23.8; Median=2.0; IQR=7.0).

**Conclusions:** Soft-tissue LEI incidence density was highest in men's and women's soccer; most were categorized as sprains and strains. A higher proportion of soft-tissue LEIs occurred on turf than natural grass surfaces. Our results indicate that the ankle, knee, and thigh represent body parts of particular interest for such injuries. Stakeholders in athlete health can utilize these findings to inform injury prevention strategies and for developing evidence-based rehabilitation programs.

The NCAA Injury Surveillance Program was funded by the NCAA. The Datalys Center is an independent nonprofit organization that manages the operations of the NCAA ISP. The content of this report is solely the responsibility of the authors and does not necessarily represent the official views of the funding organization. We thank the many ATs who have volunteered their time and efforts to submit data to the NCAA ISP. Their efforts are greatly appreciated and have had a tremendously positive effect on the safety of collegiate student-athletes.

# Free Communications, Rapid Fire Presentations: Protect Those Who Protect Us: Military Injuries

Thursday, June 27, 2024; 10:25 AM-11:20 AM; Room 260-262
Moderator: Earl Ware, MEd, ATC, CSCS

### Mental Toughness and Future Lower Extremity Musculoskeletal Injury Risk in U.S. Army Soldiers

Roach MH, Bird MB, Helton M, Marshall AR, Mauntel TC: Extremity Trauma and Amputation Center of Excellence, Defense Health Agency, Falls Church, VA; Womack Army Medical Center, Fort Liberty, NC; Uniformed Services University, Department of Surgery, Bethesda, MD; Tripler Army Medical Center, Honolulu, HI; U.S. Army, Fort Liberty, NC

**Context:** Mental toughness is positively associated with resilience and sport performance; however, few studies have examined the association between mental toughness and future musculoskeletal injury (MSKI). The purpose of this study was to explore the association between mental toughness and future lower extremity MSKI in U.S. Army Soldiers.
**Methods:** We conducted a retrospective cohort study of 1,690 Soldiers (12.6% female; age=24.8±5.7 years) using existing data from a clinical-based MSKI risk assessment and MSKI data from the Military Health System Management Analysis and Reporting Tool (M2). Soldiers in-processing to a U.S. Army unit (September 2021 – March 2022) completed a self-report clinical-based MSKI risk assessment, which included the Mental Toughness Index (MTI) and a squat-jump-land movement assessment. The 8-item MTI measures each characteristic on a 7-point Likert scale (1=false 100% of the time; 7=true 100% of the time) with a total score range of 7 to 56. During the squat-jump-land, Soldiers reported if they experienced pain (yes, no). To identify MSKIs, the Soldiers medical records were reviewed for the subsequent 12-months. MSKI data including date, body region, and MSKI type, were extracted from M2 using relevant International Classification of Diseases, tenth revision (ICD-10) codes. A dissimilarity matrix using Gower distance was calculated on the eight MTI items and then clustered using partitioning around medoids to account for outliers and categorical variables. Each cluster was examined and classified as low, moderate, and high mental toughness. MTI median ± standard error scores and prevalence of MSKI were calculated by cluster. Chi-square analyses compared frequencies of lower extremity MSKI between mental toughness clusters (low, moderate, high). MSKI relative risk (RR) and associated 95% confidence intervals (CI) were calculated with the high mental toughness cluster designated as the reference group. CIs that did not include 1.0 were considered significantly different from the reference group. Gender (male, female) and pain during the squat-jump-land (yes, no) proportions were also assessed across clusters.
**Results:** The cluster analysis identified three mental toughness profiles based on the MTI: high (51%; MTI: 55.00±0.05), moderate (43%; MTI: 48.00±0.11), and low (6%; MTI: 35.00±0.85). The highest frequency of MSKI was in the low mental toughness cluster (44%) versus moderate (34%) and high (32%) ($x^2$=6.49, p=0.039). The risk of future lower extremity MSKI was greater in subjects classified with low mental toughness (RR=1.39; 95%CI=1.09-1.75) compared to subjects with high mental toughness but did not differ between the moderate and high clusters (RR=1.05; 95%CI=0.91-1.21). Gender and subjects reporting pain during the squat-jump-land were equally distributed across clusters.
**Conclusions:** Soldiers who were categorized as having low mental toughness were at greater risk for future lower extremity MSKIs within 12-months of in-processing to a new unit. Mental toughness should be considered when developing comprehensive MSKI risk assessments.

## Relationship Between Single-Leg Memory Hop Distance and Maximum Vertical Jump Height in Healthy U.S. Marines

Heimark NE, Porter KH, Bergin R, Djafar TE, Green BS, Fraser JJ, Heebner NR, Ross JA, Sessoms PH, Silder A, Taylor M, Torp DM, Winters JD, Hoch MC: University of Kentucky Sports Medicine Research Institute, Lexington, KY; Warfighter Performance Department, Naval Health Research Center, San Diego, CA; Leidos, Inc., San Diego, CA

**Context:** Field testing is commonly used to evaluate physical performance and health in military service members. While many field tests are available to measure physical performance, vertical jump testing is commonly used to assess lower body power. However, evaluating physical performance amid some form of cognitive challenge, such as neurocognitive hop tests, is an emerging strategy for assessment in tactical and clinical settings. Previous literature found high correlations between hop tests under traditional and neurocognitive conditions. Yet, little is known regarding the relationship between performance on neurocognitive hop testing and traditional field tests such as maximum vertical jump assessments. Therefore, the purpose of the study was to evaluate the relationship between single-leg memory hop (SLMH) distance and vertical jump test performance in active-duty Marines.

**Methods:** This cross-sectional study was performed using 433 healthy U.S. Marines from the School of Infantry-West (male: 316, female: 102, unreported: 15; 20.10±2.53 years, 172.35±9.12 cm, 73.45±11.19 kg). Participants were included if they did not report a musculoskeletal injury in the previous 3 months and were medically cleared for active duty. During a single visit, participants completed the vertical jump and SLMH. For the vertical jump test, participants were instructed to perform countermovement jumps as high as possible while taking off and landing on force plates. Maximum jump height (cm) was averaged across three trials. For the SLMH, participants stood on their dominant leg while a light sensor positioned in front of them flashed a series of colors. Participants were instructed to complete a single-limb jump forward as quickly and as far as possible in response to the dark blue light. For the trial to be successful, participants had to stick the landing and maintain balance for 5 seconds. Hop distance was normalized to body height (% body height) and averaged across three trials. The relationship between SLMH and vertical jump test outcomes was examined with Pearson correlation coefficients (r) with statistical significance set at $p \leq 0.05$.

**Results:** Normalized hop distances (86.88±18.62%) demonstrated a moderate relationship to vertical jump height (29.37±8.59 cm; $r=0.62$, $p<0.001$).

**Conclusions:** Neurocognitive performance testing, such as the SLMH, is an emerging clinical outcome assessment. This study determined Marines who achieved greater hop distances on the SLMH tended to achieve greater jump height on the vertical jump test. These findings suggest the SLMH has some overlap with the vertical jump test for assessing physical performance, but there is also uniqueness between these assessments. Therefore, utilizing the SLMH in conjunction with traditional jump testing during field testing may bridge the gap between clinical and performance testing in military settings.

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**Implementing a Direct Access Care Model to Mitigate Injuries in Career Firefighters: A Retrospective Analysis**

Reiner SL, Heebner NR, Abel MG, Hoch JM, Uhl TL, Gribble PA: Sports Medicine Research Institute, University of Kentucky, Lexington, KY, and First Responder Research Laboratory, University of Kentucky, Lexington, KY

**Context:** Musculoskeletal injuries (MSIs) are consistently documented as the most prevalent injury of all reported firefighter incidents-contributing to lost duty time and reduced capacity to conduct occupational tasks safely and efficiently. The National Fire Protection Association estimates that U.S. firefighters (FFs) sustain over 60,000 injuries per year. A successful model for managing MSI in occupational settings is direct access and early intervention from integrated health care practitioners (HCPs), such as athletic trainers and physical therapists. Unfortunately, there is no widespread implementation of this model among fire departments. Therefore, the purpose of this study is to explore the impact of the HCP direct access model in reducing workers' compensation costs and mitigating time loss associated with MSI.

**Methods:** Retrospective workers' compensation claim reports were compiled from two large metropolitan professional fire departments between July 1st, 2022 to June 30th, 2023. One department (~1,000 FFs) followed the direct access care model (DACM) with embedded HCPs, and the other (~625 FFs) followed a traditional worker's compensation model (TWCM). The data were de-identified and all cardiovascular event, exposure, and laceration reports were removed. Using a descriptive retrospective cohort design, simple descriptive statistics were used to examine the normalized values calculated for injuries, time loss, and modified duty time person years using the total number of FFs per department (represented as FFyears) between these two departments.

**Results:** The FFs included in the analysis had a mean age of 42±9 years and consisted of 386 male and 42 female FFs. Other demographic data, such as height and mass, were not made available to the investigative team. A total of 673 injuries were reported from both fire departments, of which 428 were classified as MSIs (Table 1). Table 1 highlights the outcome values normalized to FFyears. The DACM department had 46.4% less injuries/FFyears, 47.8% less MSI/FFyears, paid $4,808 less, and 76.3% less lost days/FFyears compared to the TWCM department. Light days were similar (3.6 vs 3.8 days/FFyears).

**Conclusions:** Over a 1-year period, a large metro fire department with a TWCM incurred more MSIs, total time loss days, and higher MSI-related costs than the DACM department of similar size and demographic. Relative to the fire department size, the DACM appeared to reduce workers' compensation costs and experienced a faster return to modified duty when compared to the TWCM. These findings provide preliminary evidence of favorable returns of an integrated HCP within the fire service on injury rates and healthcare costs. The DACM expedites access to an HCP for timely assessment, management, and prevention of MSIs, making it a feasible solution for implementation in a variety of tactical populations.

Federal Emergency Management Agency of the United States Department of Homeland Security

Table 1. Descriptive and Normative Values for MSI Cost, Lost Days, and Light Days

| | Injuries | MSI | Cost | Lost Days | Light Days |
|---|---|---|---|---|---|
| TWCM | 425 | 274 | $ 4,221,103.00 | 4607 | 2259 |
| DACM | 249 | 155 | $ 1,945,401.00 | 991 | 3807 |
| NORM | Inj/FFyears | MSI/FFyears | Cost/FFyears | LostDays/FFyears | LightDays/FFyears |
| TWCM | 0.68 | 0.4384 | $ 6,753.76 | 7.3712 | 3.6144 |
| DACM | 0.249 | 0.155 | $ 1,945.40 | 0.991 | 3.807 |

Abbreviations: FF, firefighter; MSI, musculoskeletal injury; TWCM, traditional worker's compensation model; DACM, direct access care model

## Influence of Military Training and Recent Musculoskeletal Injury on Movement Patterns

de la Motte SJ, Dartt CE, Ricker EA: Consortium for Health and Military Performance, Department of Military and Emergency Medicine, Uniformed Services University, Bethesda, MD, and Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Bethesda, MD

**Context:** We undertook the Reducing Injuries with Training Enhancement, Targeted Rehabilitation And Core Conditioning (RITE-TRACC) study in enlisted Marines who recently graduated basic training (BT) and were entering infantry training (IT) to better understand movement proficiency and the influence of subsequent musculoskeletal injury (MSK-I) on movement.
**Methods:** Male Marines (N=313, age: 19.7±1.7 yrs.; BMI: 23.9±2.1 kg/m2) entering IT consented and were screened at entry to training (baseline) and, when available, shortly before graduation (graduation) using the In-Line Lunge (ILL), Active Straight Leg Raise (ASLR), and Trunk Stability Push-Up (TSPU) from the Functional Movement Screen; a modified Balance Error Scoring System (mBESS); the Landing Error Scoring System (LESS-22); and an overhead squat (OHS) and single leg squat (SLS). Self-reported history of recent MSK-I was obtained at baseline (i.e., during BT) and at graduation (i.e., during IT). Movement screening scores were dichotomized as "Poor / Pain" and "Average / Good;" differences by recent MSK-I were first evaluated with Chi-Square tests. Generalized Estimating Equations (GEE) with logit link function were conducted for each movement screen in those with baseline and graduation data to assess main and interactive effects of study timepoint (baseline, graduation) and MSK-I during IT (yes / no).
**Results:** Corresponding graduation movement and MSK-I data were available for 86% of enrolled Marines (n=268 / 313). There were no differences in baseline movement proficiency/screening scores based on recent history of MSK-I ($p > 0.05$) (Table 1). GEE results revealed: 1) A main effect of MSK-I during training for ILL ($p \leq 0.001$) and ASLR ($p=0.001$): compared to those without a MSK-I during training, trainees with a MSK-I during training had 4.4x greater odds of poor ILL (pairwise OR: 4.4, 95% CI: 2.2-8.8, $p < 0.001$), and 3.5x greater odds of poor ASLR (pairwise OR: 3.5, 95% CI: 1.7-7.2, $p=0.001$); 2) A main effect of study timepoint for ASLR ($p=0.004$) and TSPU ($p=0.018$): compared to baseline, trainees at graduation had 2.1x greater odds of poor ASLR (pairwise OR: 2.1, 95% CI: 1.3-4.5, $p=0.004$), and 3.5x greater odds of poor TSPU (pairwise OR: 3.50, 95% CI: 1.24-9.87, $p=0.018$); 3) A MSK-I*study timepoint interaction effect for ILL ($p=0.010$) and LESS-22 ($p \leq 0.041$): at graduation, trainees with a MSK-I had 9.3x greater odds of poor ILL versus those with no MSK-I (pairwise OR: 9.3, 95%CI 3.9-22.5, $p < 0.001$); post-hoc comparisons for the LESS-22 were not significant.
**Conclusions:** ASLR and TSPU scores were significantly poorer at graduation compared to baseline. Additionally, Marines who reported a MSK-I during IT had poorer ILL and ASLR overall, and those trainees with a MSK-I during IT had greater odds of poor ILL at graduation. Lower extremity and core movement patterns appear to be important to include in training recovery efforts, and as targets for MSK-I risk mitigation.

This research was funded by the Congressionally Directed Medical Research Program Military Injuries Training Award Number 0130-14-0003-00019. The opinions and assertions expressed herein are those of the authors and do not reflect the official policy or position of the Uniformed Services University or the Department of Defense. The contents of this publication are the sole responsibility of the authors and do not necessarily reflect the views, opinions or policies of The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc. Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. Government. The authors have no financial interests or relationships to disclose.

**Table 1. Baseline movement associations with recent history of musculoskeletal injury (MSK-I)**

| | Recent MSK-I | | | | | |
|---|---|---|---|---|---|---|
| | Yes (11%; n=35) | | No (89%; n=278) | | | |
| **LESS-22 (n=153)** | | | | | **Pearson X2 Value** | **p-value** |
| Poor (6-22 errors) | 8 | 47% | 54 | 40% | 0.34 | 0.56 |
| Good (0-5 errors) | 9 | 53% | 82 | 60% | | |
| TOTAL | 17 | | 136 | | | |
| **mBESS (n=274)** | | | | | **Pearson X2 Value** | |
| Poor (3-10 errors) | 14 | 45% | 90 | 37% | 0.77 | 0.38 |
| Good (0-2 errors) | 17 | 55% | 153 | 63% | | |
| TOTAL | 31 | | 243 | | | |
| **In-Line Lunge (n=299)** | | | | | | |
| Poor (0/1) | 5 | 15% | 27 | 10% | Fisher's Exact | 0.39 |
| Good (2/3) | 29 | 85% | 238 | 90% | | |
| TOTAL | 34 | | 265 | | | |
| **Active Straight Leg Raise (n=298)** | | | | | | |
| Poor (0/1) | 4 | 13% | 22 | 8% | Fisher's Exact | 0.50 |
| Good (2/3) | 28 | 87% | 244 | 92% | | |
| TOTAL | 32 | | 266 | | | |
| **Trunk Stability Push Up (n=304)** | | | | | | |
| Poor (0/1) | 2 | 6% | 8 | 3% | Fisher's Exact | 0.31 |
| Good (2/3) | 32 | 94% | 262 | 97% | | |
| TOTAL | 34 | | 270 | | | |
| **Overhead Squat (n=203)** | | | | | | |
| Poor (Poor) | 2 | 10% | 26 | 14% | Fisher's Exact | 0.75 |
| Good (Average/Excellent) | 19 | 90% | 156 | 86% | | |
| TOTAL | 21 | | 182 | | | |
| **Single Leg Squat (n=215)** | | | | | | |
| Poor (Poor) | 5 | 21% | 30 | 16% | Fisher's Exact | 0.56 |
| Good (Average/Excellent) | 19 | 79% | 161 | 84% | | |
| TOTAL | 24 | | 191 | | | |

## Associations Between Motivation and Care-Seeking for Musculoskeletal Injuries and Pain Among U.S. Marine Corp Officers in Training

Pegues CW, Barrett AS, de la Motte SJ, Ricker EA: Consortium for Health and Military Performance, Department of Military and Emergency Medicine, F. Edward Hébert School of Medicine, Uniformed Services University, Bethesda, MD, and The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc, Bethesda, MD

**Context:** We assessed associations between motivation for a given activity, in this case, military training (Situational Motivation Scale (SIMS)), and musculoskeletal injury/pain (MSK-I/MSK-P) care-seeking behaviors among male (M) and female (F) U.S. Marine Corps officers in the six-month Basic Officer Course at The Basic School, Quantico, VA.

**Methods:** This was a secondary analysis using data from a larger study. Male and female officers completed paper/tablet surveys, including the SIMS, at entry to training (baseline). SIMS comprises 4 subscales (Amotivation; External Regulation; Identified Regulation; Intrinsic Motivation), each scored by averaging 4 Likert-scale items. At graduation, officers self-reported whether they experienced MSK-I (yes/no) and/or MSK-P (yes/no and pain level from the modified Defense and Veterans Pain Rating Scale (mDVPRS) 0-10) during training, and if so, whether they sought medical care (yes/no). Only officers who reported MSK-I (F=33, M=112) or MSK-P (F=48, M=225) were included in the current analysis. Chi-square tests evaluated associations between sex and care-seeking for MSK-I/MSK-P. Mann-Whitney U tests assessed differences in pain level by sex. Controlling for sex, commissioning source, and race, separate logistic regressions modeled associations between SIMS subscale scores and odds of care-seeking for 1) MSK-I and 2) MSK-P (controlled for mDVPRS pain level).

**Results:** SIMS subscale scores (mean±SD) for officers who reported MSK-I and/or MSK-P (n=307) were: Amotivation: 1.9±1.2; External Regulation: 4.7±1.8; Identified Regulation: 5.6±1.4; Intrinsic Motivation: 4.4±1.5. For officers who self-reported a MSK-I (n=145), care-seeking did not differ by sex (F: 88% n=29/33; M: 78% n=87/112; X2=1.7, p=0.198). Logistic regression revealed that every point increase in baseline Amotivation score was associated with 39% reduced odds of MSK-I care-seeking (OR: 0.62, 95%CI 0.40-0.95, p=0.029) (Table 1). For officers who self-reported MSK-P (n=273), mDVPRS pain level did not differ by sex (F: 5.7±1.7; M: 5.2±1.7, p=0.137). A greater percentage of females (54%; n=26/48) than males (33%; n=75/225) sought care for their MSK-P (X2=7.4, p=0.007). Logistic regression showed females had 2.4x the odds of seeking care for MSK-P compared to males (OR: 2.4, 95%CI 1.1-5.2, p=0.024) and that each point increase in DVPRS pain rating was associated with 40% higher odds of MSK-P care-seeking (OR: 1.4, 95%CI 1.2-1.7, p < 0.001) (Table 1).

**Conclusions:** Amotivation, or perceived disconnect between one's behaviors and outcomes, was related to lower odds of seeking care for MSK-I. However, care-seeking was high overall. This analysis was exploratory, and more work is needed to understand amotivation and associated sequelae in Marine officers. With respect to MSK-P, females had greater odds of care-seeking than males despite not having higher mDVPRS pain levels. Care-seeking for MSK-P was also associated with mDVPRS pain level. mDVPRS pain averages were high: a mDVPRS score of 5 equates to pain that interrupts activities, suggesting this was a main driver to seek care for MSK-P.

**Table 1. Logistic Regression Assessing Odds of Care-Seeking for MSK-I and MSK-P**

| | MSK-I | | | | MSK-P | | | |
|---|---|---|---|---|---|---|---|---|
| | n | OR | 95%CI | p | n | OR | 95%CI | p |
| **Situational Motivation Scale** | | | | | | | | |
| Amotivation | 145 | **0.62** | **0.40-0.95** | **0.029*** | 247 | 1.05 | 0.80-1.39 | 0.698 |
| External regulation | 145 | 0.87 | 0.65-1.16 | 0.355 | 247 | 0.92 | 0.78-1.09 | 0.358 |
| Identified regulation | 145 | 0.88 | 0.53-1.47 | 0.642 | 247 | 0.77 | 0.57-1.04 | 0.100 |
| Intrinsic motivation | 145 | 0.70 | 0.44-1.10 | 0.128 | 247 | 1.28 | 0.98-1.69 | 0.070 |
| **Commissioning Source** | | | | | | | | |
| US Naval Academy | 11 | 1.00 | -- | REF | 23 | 1.00 | -- | REF |
| Enlisted commission | 19 | 0.76 | 0.04-14.11 | 0.857 | 28 | 1.46 | 0.31-6.89 | 0.629 |
| Leadership course | 29 | 0.19 | 0.01-1.88 | 0.156 | 50 | 0.36 | 0.10-1.28 | 0.116 |
| Officer training | 66 | 0.47 | 0.04-4.82 | 0.530 | 111 | 1.25 | 0.42-3.75 | 0.684 |
| Reserve Officers' Training Corps | 17 | 1.76 | 0.08-35.45 | 0.711 | 32 | 0.76 | 0.21-2.72 | 0.681 |
| Other | 3 | 0.22 | 0.00-7.15 | 0.397 | 3 | 0.55 | 0.02-12.49 | 0.711 |
| **Race** | | | | | | | | |
| White/Caucasian | 104 | 1.00 | -- | REF | 189 | 1.00 | -- | REF |
| Non-white | 41 | 1.07 | 0.38-3.00 | 0.892 | 58 | 1.21 | 0.61-2.42 | 0.575 |
| **Sex** | | | | | | | | |
| Male | 112 | 1.00 | -- | REF | 207 | 1.00 | -- | REF |
| Female | 33 | 1.28 | 0.37-4.39 | 0.694 | 40 | **2.42** | **1.12-5.21** | **0.024*** |
| **mDVPRS Pain Rating** | | | | | | | | |
| Pain rating (0-10) | -- | -- | -- | -- | 247 | **1.39** | **1.15-1.67** | **<0.001*** |

Abbreviations: MSK-I/P, musculoskeletal injury/pain; n, number; OR, odds ratio; 95%CI, 95% confidence interval; REF, reference; mDVPRS, Modified Defense and Veterans Pain Rating Scale

*p < 0.05; Sample size for MSK-P (n=247) reduced from full sample (n=273) due to missing pain rating data.

**Assessment of ROTC Cadet Performance Capabilities from Immersive Virtual Reality Metrics and Survey Responses**

Colston MA, Smith EM, Tucker MP, Sneed GC: The University of Tennessee at Chattanooga, Chattanooga, TN

**Context:** : Operational effectiveness of military personnel can depend on rapid and accurate execution of responses to environmental stimuli, which may be impaired by physical, mental, or behavioral factors that detract from overall well-being. Inefficiency of neural processing within or between distributed brain networks may be indirectly estimated by immersive virtual reality (VR) measurements of movement responses to visual stimuli. The purpose of this study was to determine whether ROTC cadets' ratings of factors affecting overall wellness would demonstrate any associations with perceptual-motor performance metrics derived from an immersive VR test.
**Methods:** This cohort study included 40 ROTC cadets (10 females) who provided responses to Overall Wellness Index (OWI) survey items and performed a 40-trial immersive VR test that required left or right directional movement responses to moving visual stimuli. The only exclusionary criterion was an injury that precluded performance of simultaneous neck rotation, arm reaching, and single step lunging movements. Suboptimal wellness was defined as a 0-100 OWI score at or below the cohort median value. Prior assessment of the internal consistency of OWI responses yielded Cronbach's α=.817. Time elapsed from stimulus appearance to initiation of a given body movement (i.e., 6 degrees of neck rotation, 10 cm of arm reach, or 10 cm of lunging) defined perceptual latency (PL). Time elapsed from stimulus appearance to movement completion defined response time (RT). We calculated 40-trial average values for PL (PL-Avg) and RT (RT-Avg) for simultaneous neck, arm, and step movements, as well as intra-individual variability values for PL (PL-IIV) and RT (RT-IIV). We assessed speed-accuracy trade-off through calculation of a rate correct score (RCS) derived from the number of correct responses divided by the 40-trial sum of elapsed time for arm PL and arm RT. Intraclass correlation coefficients demonstrating acceptable test-retest reliability have previously been documented, with PL-Avg and RT-Avg values ranging from .837 to .922, PL-IIV and RT-IIV values ranging from .693 to .836, and PL-RCS and RT-RCS values of .851 and .887, respectively. Receiver operating characteristic analysis area under curve (AUC) and logistic regression were used to quantify associations.
**Results:** Strongest OWI categories contributing to suboptimal wellness (0-100 OWI ≤ 90) were Sleep/Stamina (AUC=.767) and Mood/Emotional (AUC=.765). A meaningful association of neck PL-IIV (AUC=.689) with suboptimal wellness was also evident. The combination of any Sleep/Stamina problem with neck PL-IIV ≥ 0.241 was strongly associated with suboptimal wellness (Figure; AUC=.776; OR=9.52; 95% CI: 2.02, 44.91).
**Conclusions:** Disordered sleep appears to be a key contributor to an ROTC cadet's perception of suboptimal wellness, which may be interrelated with inconsistency in the speed of neck responses to immersive VR visual stimuli. Thus, these findings support the validity of specific OWI item responses and immersive VR PL-IIV as indicators of suboptimal wellness.

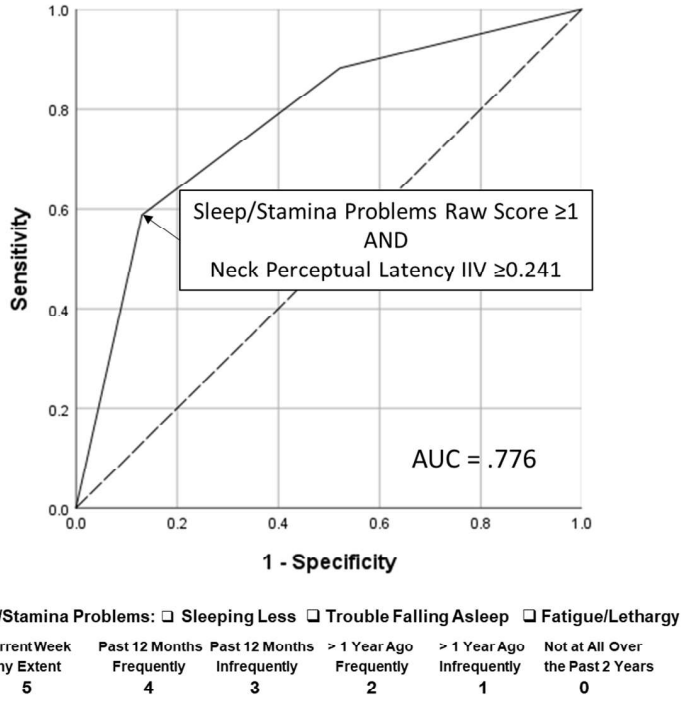



Figure. Receiver operating characteristic curve: Association of any Sleep/Stamina Problem and Neck Perceptual Latency Intra-Individual Variability ≥0.241 with ROTC cadet perception of suboptimal wellness (i.e., Overall Wellness Index 0-100 score ≤90).

# Free Communications, Rapid Fire Presentations: Reevaluating Clinical Recovery After Concussion

Thursday, June 27, 2024; 9:00 AM-9:55 AM; Room 265-268

Moderator: Johna Register-Mihalik, PhD, LAT, ATC, FNATA

## Post-Concussion Daily Naturalistic Driving Behavior Throughout Concussion Recovery

Hashida K, Drattell JD, Lynall RC, Gore RK, Devos H, Schmidt JD: UGA Concussion Research Laboratory at University of Georgia, Athens, GA; Shepherd Center, Atlanta, GA; University of Kansas Medical Center, Kansas City, KS

**Context:** Driving simulator studies show that individuals with concussion present notable alterations in driving performance during the acute phase of the injury and perform better as recovery progresses. Although driving simulation creates a safe environment and provides sensitive outcomes to measure impaired driving, it does not reflect driving safety and behaviors in the days following injury. Therefore, we aimed to compare the naturalistic driving behavior of individuals with a concussion across the 2 weeks following injury, relative to non-concussed controls.

**Methods:** Prospective cohort study. Twelve individuals with concussion (age: 19.9±1.6 years, 50.0% Female) and 17 non-concussed controls (age: 20.1±1.6 years, 58.8% Female) installed a GPS sensor (Azuga Inc, San Jose, California) in their personal vehicle at initial evaluation (range: 2-11 days of injury) and uninstalled it when asymptomatic. We compared naturalistic driving outcomes between groups from day 2 up to 2 weeks after the injury. The total distance driven (miles), total duration driven (sec), average speed (mph), and number of trips taken per day as well as aggressive driving behaviors including the number of hard braking, hardcore braking, and sudden acceleration events were collected as outcome measures. We compared the naturalistic driving outcomes using a series of linear mixed regression models fit using either a Poisson or normal distribution with group main effect, time main effects, and interaction (group x time) effect. This abstract focuses on the interaction effect.

**Results:** There was a significant interaction between group and time for driving distance (P=0.014, Figure 1A), driving duration (P=0.020, Figure 1B), number of hard braking events (P=0.008, Figure 1C), and the number of sudden acceleration events (P=0.026, Figure 1D). The concussion group drove a shorter distance than the control group on day 2 (P=0.019) and day 13 (P=0.015) post-concussion. The concussion group drove shorter duration than the control group on day 6 post-concussion (P=0.015). The concussion group displayed more hard braking (P=0.018) and sudden acceleration (P=0.018) on day 13 and less hard braking on day 4 post-concussion (P=0.001).

**Conclusions:** This is the first study to describe post-concussion naturalistic driving behavior. While the concussion group displayed conservative driving behavior in some measures, most of the behaviors of the concussion group were similar to the control group during the acute phase of the injury. This is concerning because previous research indicates individuals with concussion display poorer driving performance patterns that are associated with motor vehicle crash, especially during the acute phase. Additionally, the concussion group did not gradually return to driving over time, suggesting that they are not refraining from driving within 72 hours of injury. Further study is needed to establish return to drive protocols to guide healthcare providers in assessing fitness to drive.

The research reported in this abstract was supported by Andee's Army Foundation and the National Center for Advancing Translational Sciences of The National Institutes of Health under Award Number UL1TR002378. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

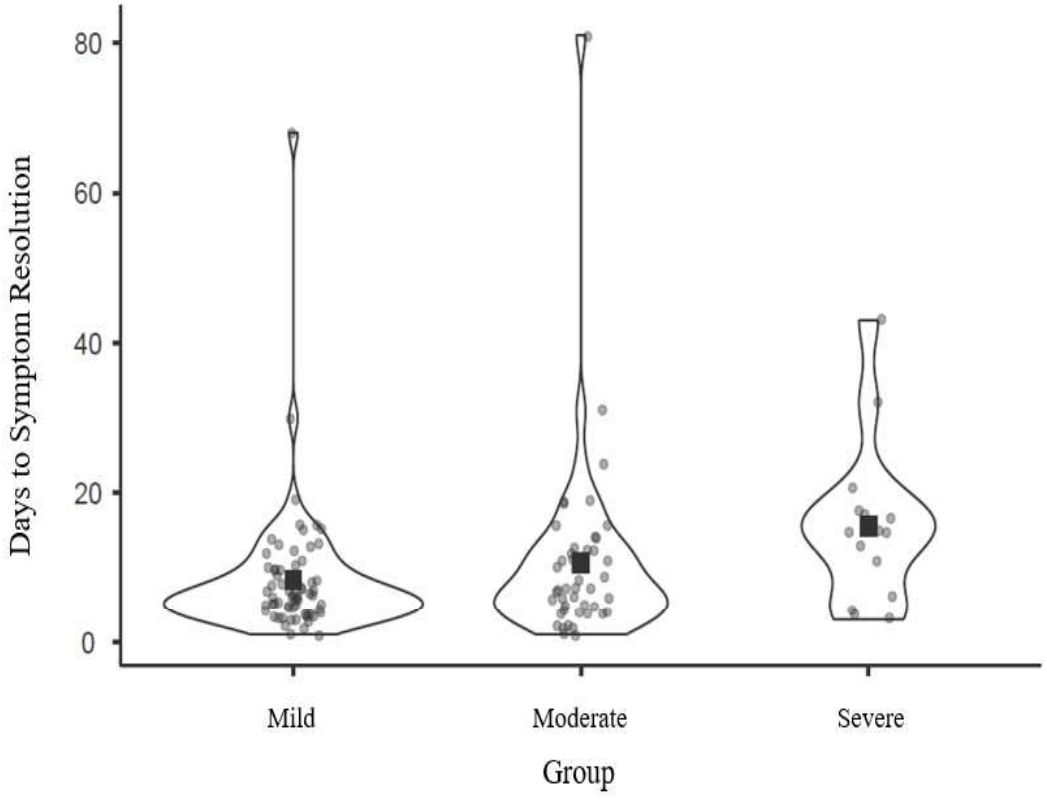

Figure 1: (A) Drive Distance, (B) Drive Duration, (C) Number of Hard Braking Events, and (D) Number of Sudden Acceleration Events each day in concussion and control groups.

**The Role of Acute Dizziness as a Predictor of Recovery From Concussion in Collegiate Athletes**

Akard CM, Rosenblum DJ, Resch JE: The University of Virginia, Charlottesville, VA

**Context:** The clinical presentation of concussion varies between and within individuals. Despite the heterogenous clinical presentation of concussion, dizziness is one of the most commonly reported symptoms following injury. Previous research has identified a relationship between on-field dizziness and prolonged recovery from concussion in high school athletes. The relationship between acute dizziness and recovery from concussion has yet to be explored in collegiate athletes with concussion. The purpose of this study was to determine the relationship between dizziness, as reported as part of the acute sideline concussion assessment, and days until symptom resolution at rest in collegiate athletes. We hypothesized that collegiate athletes who endorsed more severe dizziness during their acute concussion assessment would take more days to achieve symptom resolution at rest as compared to athletes with mild dizziness.
**Methods:** Division I collegiate athletes (N= 127, 45% female, 19.9+1.5 years of age) participated in this descriptive laboratory study. All participants were administered the Post Concussion Symptom Scale (PCSS) as part of the Sport Concussion Assessment Tool-5 within 72 hours of a suspected concussion. The PCSS consists of 21 symptoms, including dizziness. Dizziness was rated on a Likert Scale which ranged from "0", not present to "6", severe. Participants were then divided into groups based on if they endorsed mild (MILD [1-2 (n=66)]), moderate (MOD[3-4(n=45)]), or severe (SEV [5-6(n=16)]) dizziness. Following the concussion diagnosis, participants were administered the Revised Head Injury Scale daily until symptom resolution at rest was achieved. A Spearman's correlations coefficient (ρ) was calculated to examine the relationship between dizziness severity and days until symptom resolution at rest. A Kruskal-Wallis test was also performed to compare the number of days until symptom resolution at rest following a diagnosed concussion between groups. All analyses were performed with $\alpha = 0.05$.
**Results:** Interestingly, all participants endorsed dizziness as part of their acute concussion assessment. A significant, yet weak, correlation ($\rho=0.23$, $p=0.008$) was observed between severity of dizziness and days until symptom resolution at rest. In terms of the between group comparison, a significant difference ($H2=9.76$, $p=0.008$) was observed between the MILD participants who recovered on median (interquartile range) 6.0 (6.0) days and SEV participants who recovered 15.0 (40) days after their injury (Figure 1). No additional differences were observed between groups.
**Conclusions:** Our findings suggest that acute dizziness can modify recovery from SRC in collegiate athletes. Interestingly, participants with severe dizziness took more than twice as long to achieve symptom resolution at rest as compared to those who reported mild dizziness. When administering the PCSS as part of the SCAT5, or an alternate symptom inventory, clinicians should consider the presence and severity of dizziness as a modifier of recovery from SRC in collegiate athletes.

**Days Until Symptom Resolution in Collegiate Athletes with Acute Mild, Moderate, or Severe Dizziness**



**The Influence of Kinesiophobia on Days Until Symptom Free in Collegiate Athletes With Concussion**

Rosenblum DJ, Resch JE: University of Virginia, Charlottesville, VA

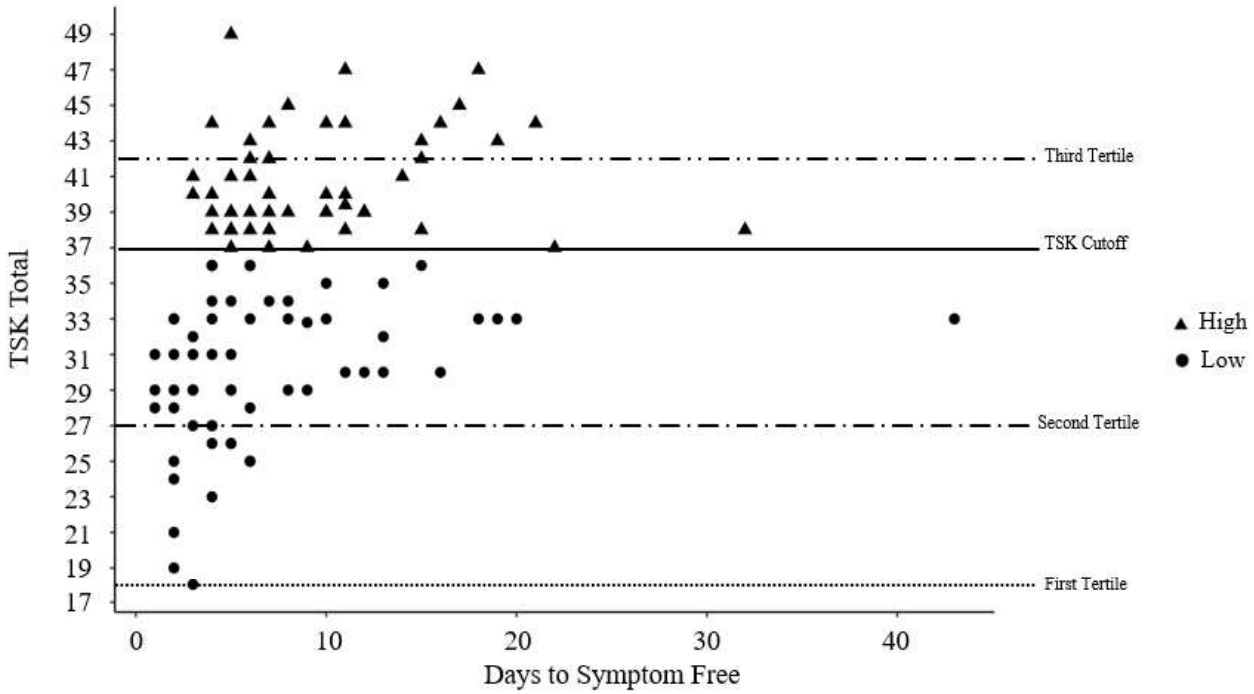
**Context:** Several factors such as acute total symptom severity (TSS) as well as pre-morbid anxiety and/or depression have been demonstrated to associate with concussion recovery. Kinesiophobia has been associated with recovery from low back pain and anterior cruciate ligament tears. Elevated kinesiophobia values have also been observed to associate with increased reaction time and vestibular-ocular motor dysfunction following SRC, however, it has yet to be evaluated as a modifier of concussion recovery time. This study evaluated the role of acute kinesiophobia levels on days until symptom free (DUSF) in collegiate athletes with concussion. We hypothesized that collegiate athletes who endorsed Tampa-Scale of Kinesiophobia (TSK) scores above a clinically accepted threshold would take a greater number of days to report symptom free (SF) as compared to athletes with subthreshold values.

**Methods:** Division I collegiate athletes diagnosed with a concussion (N=113, 19.9±1.5 years, 42% female) participated in this descriptive laboratory study. Participants were assigned to high (>37[H-TSK, n=54]) or low TSK (<37[L-TSK, n=59]) groups based on the first TSK values recorded within 72 hours of their concussion. Participants were also administered the Revised Head Injury Scale (HIS-r) to collect TSS < 72 hours of injury and the Immediate Postconcussion and Cognitive Test (ImPACT) battery to gather demographic variables such as biological sex, age, history of anxiety/depression, and concussion history as part of their SF assessment. DUSF between H-TSK and L-TSK groups were compared using a Mann-Whitney U test. Spearman's rank correlation coefficient was calculated to determine the relationship between TSK and DUSF. Multiple linear regression was used to evaluate DUSF as a function of the TSK total score, controlling for the HIS-r and ImPACT variables.

**Results:** DUSF was significantly longer in the H-TSK group (median difference=2.5 days, $p<0.001$) compared to the L-TSK group. A significant, moderate positive correlation between TSK score and DUSF ($\rho=0.45$, $p<0.001$) was observed which was also the strongest correlation among all variables. Our regression model demonstrated that for every point increase on the TSK, DUSF increased by 0.23 days while controlling for TSS, concussion history, psychiatric history, and biological sex ($\beta_{TSK\_Total}$ Total=0.23, p=0.016 [Figure 1]). All other variables entered to the regression were not statistically significant.

**Conclusions:** Our data suggest that athletes with TSK scores ≥37 within 72 hours of a concussion had a greater number of DUSF when compared to athletes with TSK values < 37. In this large sample of concussed collegiate athletes, the TSK score had the highest correlation with DUSF when compared to other known modifiers of recovery, inclusive of acute TSS. The TSK score was also the strongest predicter of DUSF. Collectively, these findings suggest that the TSK score should be considered by health care professionals to help inform effective management strategies for collegiate athletes with concussion.

**Days Until Symptom Free in Collegiate Athletes with High or Low Levels of Kinesiophobia Following Concussion**



## Test-Retest Reliability and Minimal Detectable Change of an Ecologically Valid Return to Activity Evaluation: The Functional Assessment of Neurocognition in Sport (FANS)

Lempke LB, Terry DP, Meehan WP, Brett BL: Virginia Commonwealth University, Richmond, VA; Vanderbilt University Medical Center, Nashville, TN; Boston Children's Hospital, Boston, MA; Medical College of Wisconsin, Milwaukee, WI

**Context:** Most assessment tools used after concussion provide strong diagnostic accuracy and aid in initial healthcare planning, but have limited utility after the acute timeframe. Additionally, most concussion assessment tools used have low ecological validity in assessing return-to-activity, given the importance for athletes to perform well in highly dynamic environments requiring efficient cognitive processing to facilitate split-second decisions and coordinate complex movements. We developed a functional assessment protocol called the Functional Assessment of Neurocognition in Sport (FANS) to address these limitations, but its psychometric properties are unknown. We evaluated the test-retest reliability, standard error of measurement (SEM), and minimal detectable change (MDC) of FANS in a healthy cohort, and hypothesized most FANS outcomes would have acceptable test-retest reliability.
**Methods:** Seventeen healthy, physically active individuals (age:21.9±3.2years, 58.8% female, height:170.5±11.4cm, mass:73.0±26.7kg, 76.5% no lifetime concussion history) completed FANS at two-timepoints, 14-days apart. Participants did not have any confounding developmental, psychiatric, or balance disorders, or a recent musculoskeletal injury or concussion. FANS was completed identically at both timepoints with standardized instruction scripts. In brief, FANS examines 7-cognitive domains (i.e., verbal memory, visual memory, reaction time, processing speed, cognitive-motor interference, delayed verbal memory, delayed visual memory). FANS emulates cognitive domain-specific traditional neuropsychological tests by having participants complete similar tasks but responding with whole-body movement tasks rather than on paper or a keyboard. FANS uses common low-cost equipment (e.g., buckets, athletic cones, penlight, stopwatch) and is completed within 40-minutes. We used intraclass correlation coefficient (ICC3,k) models with 95% confidence intervals (95% CI) to evaluate test-retest reliability for FANS outcomes, with ICCs ≤ 0.50 interpreted as inadequate reliability. We then derived SEM and MDC statistics for each FANS outcome.
**Results:** All FANS outcomes displayed acceptable test-retest reliability (ICCs ≥ 0.63; Table 1), with the lowest being verbal memory's interference (ICC=0.63), and the highest being delayed visual memory's recognition (ICC=1.00). Across reaction time and cognitive-motor interference domains, test-retest reliability was stable regardless of increased task complexity (e.g., single-task versus dual-task ICC difference of 0.03 and -0.05, respectively). Greater reliability was observed for visual memory subtests (ICCs = 0.73-1.00) as compared to verbal memory subtests (ICCs= 0.63-0.77). SEMs and MDCs (Table 1) overall displayed small values indicating low measurement error and ability to detect measurement change. The highest MDCs were observed for percentage-based metrics within a domain, such as processing speed's accuracy (MDC=11.43%) or cognitive-motor interference's dual-task cost (MDC=17.37%).
**Conclusions:** FANS overall displayed acceptable test-retest reliability, with similar test-retest reliability to computerized neurocognitive testing and traditional paper-and-pencil neuropsychological tests. Small SEMs and MDCs were observed, and thus FANS has appropriate psychometrics for evaluating cognitive performance via sport-like human movement. Though FANS is appropriate for clinical use, future research is needed to establish FANS concussion-specific utility for return-to-activity decision-making.

This study was fully funded by a research grant from the Eastern Athletic Trainers' Association, Inc. All authors have no other potential disclosures relevant to this work.

**Table 1. FANS Test-Retest Reliability, SEM, and MDC**

| Outcome | $ICC_{3,k}$ | (95% CI) | SEM | MDC |
|---|---|---|---|---|
| ***Verbal Memory Outcomes*** | | | | |
| Free Recall (# Correct) | 0.77 | (0.37, 0.92) | 2.36 | 6.56 |
| Interference (# Correct) | 0.63 | (0.01, 0.87) | 0.77 | 2.14 |
| Immediate Recall (# Correct) | 0.74 | (0.30, 0.91) | 1.19 | 3.31 |
| ***Visual Memory Outcomes*** | | | | |
| Free Recall (Visual-Motor Efficiency; VME) | 0.84 | (0.55, 0.94) | 0.01 | 0.04 |
| Interference (VME) | 0.78 | (0.39, 0.92) | 0.04 | 0.10 |
| Immediate Recall (VME) | 0.73 | (0.26, 0.90) | 0.02 | 0.06 |
| ***Reaction Time Outcomes*** | | | | |
| Single-Task Composite (s) | 0.82 | (0.49, 0.93) | 0.01 | 0.03 |
| Dual-Task Composite (s) | 0.79 | (0.43, 0.92) | 0.02 | 0.07 |
| Overall Composite (s) | 0.82 | (0.49, 0.93) | 0.01 | 0.04 |
| ***Processing Speed Outcomes*** | | | | |
| Total Correct (#) | 0.92 | (0.78, 0.97) | 1.55 | 4.31 |
| Speed (response/s) | 0.93 | (0.82, 0.98) | 0.01 | 0.02 |
| Accuracy (%) | 0.81 | (0.48, 0.93) | 4.12 | 11.43 |
| ***Cognitive-Motor Interference Outcomes*** | | | | |
| Single-Task (s) | 0.91 | (0.75, 0.97) | 0.44 | 1.23 |
| Dual-Task (s) | 0.96 | (0.90, 0.99) | 0.73 | 2.03 |
| Dual-Task Cost (%) | 0.93 | (0.81, 0.97) | 6.27 | 17.37 |
| ***Delayed Verbal Memory Outcomes*** | | | | |
| Delayed Recall (# Correct) | 0.64 | (0.00, 0.87) | 1.33 | 3.67 |
| Recognition (# Correct) | 0.76 | (0.33, 0.91) | 0.65 | 1.79 |
| ***Delayed Visual Memory Outcomes*** | | | | |
| Delayed Recall (VME) | 0.81 | (0.47, 0.93) | 0.02 | 0.05 |
| Recognition (# Correct) | 1.00 | (1.00, 1.00) | 0.00 | 0.00 |

## Persisting Deficits in Clinical Measures of Concussion in Collegiate Athletes Who Achieve Symptom Resolution at Rest

Schwartz ER, Rosenblum DJ, Resch JE: University of Virginia, Charlottesville, VA

**Context:** A multidimensional approach has been demonstrated to have the highest sensitivity and specificity to detecting concussion in collegiate athletes within 48 hours of injury. Limited evidence exists to support the external responsiveness of the same multidimensional assessment upon an athlete achieving symptom resolution. (SR). The purpose of this study was to determine which clinical measures were most frequently observed to indicate persisting concussion-related deficits despite achieving SR. We hypothesized that the Sensory Organization Test (SOT) and the Immediate Postconcussion and Cognitive Test (ImPACT) battery would most frequently limit return-to-sport (RTS) progression in collegiate athletes following a concussion.

**Methods:** Data were collected between the 2021-22' - 2023-24' sport seasons. Division I collegiate athletes (n=84 [41.6% female]) who were on average 19.8±1.44 years of age participated in this descriptive laboratory study. All participants completed a pre-injury (baseline) concussion assessment which consisted of the: Revised Head Injury Scale (HIS-r), ImPACT, SOT, Tampa Scale of Kinesiophobia (TSK), Tandem Gait (TG) test, and Vestibular Ocular Motor Screen (VOMS). Following a diagnosed concussion by an athletic trainer or physician, all participants were administered the HIS-r until SRA was achieved, after which, they were re-administered all clinical measures. All clinical measure outcome scores were compared to baseline performance and interpreted using manufacturer guidelines or relevant evidence to determine if participants were or were not allowed to proceed to the next stage of the RTS protocol. Descriptive analyses were performed to determine the frequency (%) of collegiate athletes who had persisting deficits on one or more clinical measures that prevented their progression through the RTS protocol.

**Results:** Participants achieved SRA on median (interquartile range) 8.0 (10.0) days following their concussion. Approximately 81% (68/84) of participants were not allowed to proceed to the next stage of the RTS protocol following their SRA assessment. The singular measures that limited RTS progression were the SOT (11.8%), TG (5.9%), ImPACT (4.4%), TSK (4.4%), and the VOMS (2.9%). In combination with one or more of the previously mentioned clinical measures, the SOT (27.9%), TG (23.5%), ImPACT (20.6%), TSK (20.6%), and the VOMS (17.6%) most frequently prevented RTS progression (Figure 1).

**Conclusions:** Our findings suggest that the SOT, when analyzed separately, most frequently identified persisting deficits following concussion upon collegiate athletes achieving SRA. Interestingly, the proportion of athletes who had clinically meaningful deficits was similar for the SOT, TG test, ImPACT, and the TSK when analyzed as part of a multidimensional assessment. A multidimensional assessment, when administered upon an athlete achieving SRA, indicated two to four times more deficits than any singular measure. These findings support the use of a multidimensional assessment to inform RTS decision-making following a concussion in collegiate athletes who achieve SRA.

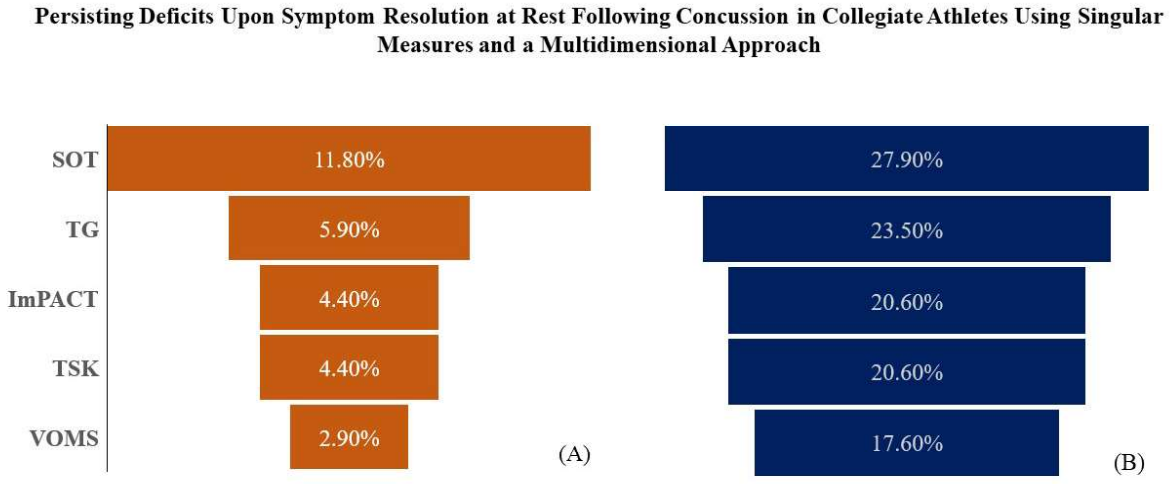



**Figure 1.** A comparison of clinical measures analyzed separately (A) or as a multidimensional assessment (B) to evaluate persisting deficits upon achieving SRA after concussion. SOT=Sensory Organization Test; TG=Tandem Gait; ImPACT=Immediate Postconcussion and Cognitive Test battery; TSK=Tampa Scale of Kinesiophobia; VOMS=Vestibular Ocular Motor Screen.

## Baseline Sleep Behavior Is a Modifier of Recovery Following Concussion in Collegiate Athletes

Calhoun RC, Rosenblum DR, Donahue CC, Resch JE: University of Virginia, Charlottesville, VA

**Context:** Sleep disturbances are associated with prolonged recovery from concussion in high school and collegiate athletes. Limited evidence exists of the relationship between pre-injury (baseline) sleep habits and recovery from concussion. The purpose of this study was to determine if baseline sleep behavior, in conjunction with other known modifiers, influenced collegiate athletes' days until symptom resolution at rest (SRA) following concussion. The ASBQ is a survey designed to assess athlete sleep behavior with higher global scores indicative of poorer sleep behavior. We hypothesized that poor sleep behavior, as quantified by the Athlete Sleep Behavior Questionnaire (ASBQ), would be associated with a greater number of days until SRA in collegiate athletes.
**Methods:** Division I collegiate athletes (n=80 [46.3% female]) who were on average 19.1+1.40 years of age participated in this cohort study. Data were collected between the 2021-2023 sport seasons. All participants were administered the ASBQ, the Generalized Anxiety Disorder assessment (GAD-7), the Revised Head Injury Scale (HIS-r) and the 9-Item Patient Health Questionnaire (PHQ-9) as part of their baseline concussion assessment. Following the diagnosis of a concussion by an athletic trainer or physician, participants were administered the HIS-r daily until SRA. A Spearman correlation coefficient was calculated to determine the relationship between days until SRA and the ASBQ, GAD-7, HIS-r, and PHQ-9 outcome scores. A multivariate linear regression was used with days until SRA as the dependent variable and the ASBQ, GAD-7, HIS-r total symptom severity, and PHQ-9 outcome scores as independent variables. Analyses were performed with $\alpha=0.05$.
**Results:** On median (interquartile range), participants achieved SRA at 6.0 (6.0) days after concussion. A weak, yet statistically significant correlation ($\rho=-0.25$, $p=0.03$), was observed for days until SRA and the ASBQ global score. No additional significant correlations were observed (all $p>0.05$). Our final regression formula consisted solely of the ASBQ ($\beta=-0.58$) with $R=0.33$, which explained 11% of the total variance of days until SRA ($R2=0.11$), while controlling for GAD-7, HIS-r, and PHQ-9 values. For every point increase on the ASBQ, days until SRA decreased by 0.58 days.
**Conclusions:** The ASBQ score was observed to associate with days until SRA in collegiate athletes with concussion. Contrary to our hypothesis, higher ASBQ scores were associated with a shorter time until SRA. The administration of the ASBQ during the baseline assessment may have contributed to the observed inverse relationship between the inventory and days until SRA. Further research should address the influence of sleep behavior on days of SRA acutely after concussion and throughout recovery. Though our findings were unexpected, our results are suggestive of the importance of sleep behavior on recovery from concussion in collegiate athletes.

## Known-Groups Validity of the SWAY Balance Mobile Application Inspection Time Test to Detect Mild Traumatic Brain Injury

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**Context:** Neurocognitive function is often impaired in patients after mild traumatic brain injury (mTBI). (1, 2) Inspection time is one measure used to evaluate cognitive status throughout the management of mTBI. Current methods to measure inspection time lack portability and are generally inaccessible for acute sports medicine practitioners. The Sway Balance Mobile Application (SWAY; Sway Medical, Tulsa, OK) uses a smart device to assess inspection time,3 however, the psychometric properties of the tool in patients following mTBI remain unknown. This study aimed to determine the SWAY Inspection Time test's known-groups validity and responsiveness in patients after an mTBI. We hypothesized SWAY Inspection Time would differentiate individuals within 72 hours of mTBI from healthy controls and that SWAY Inspection Time would improve over time in the mTBI group but not in the control group.
**Methods:** The Regional Health Command Atlantic IRB approved this prospective case-control study. The data presented in this abstract are part of a larger grant-funded project. Forty participants were recruited via convenience sampling within a military physical therapy clinic and volunteered to participate (age, 20 ± 2 years; height, 70 ± 4 inches; 32 males / 8 females), including 20 individuals within 72 hours of mTBI diagnosis, and 20 age, sex, and height-matched healthy controls. The mTBI group completed the SWAY Inspection Time test at their initial visit (within 72 hours of mTBI event), at one-week post-mTBI (one week), and at the time of full return to activity (RTA). The healthy controls completed the SWAY Inspection Time test at the same time intervals as their matched mTBI cases. Independent samples t-tests and paired samples t-tests were performed to determine the between-group differences and within-group changes in SWAY Inspection Time scores.
**Results:** Inspection time measured by the SWAY was worse in participants within 72 hours of mTBI diagnosis (Mean (M)=43 ± standard deviation (SD) 34 ms) than in healthy controls (M = 71 ± 38 ms; t = -2.40; p = .022). Consistent with current literature,(2) the mTBI group improved from the initial to one-week timepoint (MD = 25 ± 40 ms; t = 2.73; p=.013) while the control group did not (MD = 0 ± 38 ms; t = .000; p=1.0)
**Conclusions:** The SWAY Inspection Time test demonstrated adequate known-groups validity in detecting inspection time differences between a healthy and acute mTBI group and was responsive to changes in cognitive function in patients during recovery from an mTBI. The timely administration of cognitive assessments in managing mTBI is critical, as a delay in evaluation may lead to misdiagnosis, potentially leading to further harm. Our results support the SWAY Inspection Time test as an accessible and portable tool for clinicians assessing patients with suspected mTBI.

The authors report no relevant financial disclosures. The views, opinions, and findings contained in this research are those of the authors and do not necessarily reflect the views of the Department of Defense and should not be construed as an official DoD/Army position, policy, or decision unless designated by other documentation. No official endorsement should be made. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government.

### Exertional Heatstroke Survivors' Knowledge and Beliefs About Exertional Heatstroke Diagnosis, Treatment, and Return to Play

Miller KC, Amaria NY, Scarneo-Miller SE, Casa DJ, Jardine JJ, Stearns RL, O'Connor P: Texas State University, San Marcos, TX; University of Michigan, Ann Arbor MI; West Virginia University, Morgantown, WV; Korey Stringer Institute at the University of Connecticut, CT; Central Michigan University, Mt. Pleasant, MI

**Context:** Exertional heatstroke (EHS) is a life-threatening injury but has been 100% survivable if diagnosed quickly and treated with aggressive whole-body cooling. The knowledge, beliefs, and attitudes of EHS best practices varies considerably across populations (e.g., athletic trainers, coaches) yet little information exists from EHS survivors. Our purpose was to learn what patients know about EHS best practices to better understand where clinicians need to focus educational efforts to ensure survival and safe return-to-play following EHS.
**Methods:** In this cross-sectional descriptive study, medical professionals evaluated runners requiring medical intervention at the finish line of an 11.3-km road race. If rectal temperatures (Trec) were ≥40°C and concomitant central nervous system dysfunction (CNS) was observed, EHS was diagnosed and patients were immersed in a 189.3-L tub filled with ice-water. Cooling ceased when Trec was ≤39.4°C. Post-treatment, patients were moved to a recovery area and monitored to ensure Trec was stable and any CNS symptoms had resolved prior to medical discharge. Before discharge, we interviewed EHS patients and asked 15 questions about their experience and knowledge of some EHS best practices. Survey items were piloted and validated by 3 experts and 8 laypersons a priori (content validity index ≥0.88 for items and scale). Frequencies, means±SD, and medians [IQR] were calculated, as appropriate.
**Results:** We surveyed 68% (42 of 62) of runners with EHS in August 2022 and 2023 (15 women, 27 men; age:33±15 y; pre-treatment Trec:41.5±0.9°C). Sixty-seven percent (28 of 42) of patients correctly indicated EHS could be fatal and 76% (32 of 42) indicated it negatively affected health. Seventy-nine percent (33 of 42) correctly identified Trec as the best temperature site to diagnose EHS with most patients (32 of 42) saying Trec was necessary for diagnosis. Patients were neither comfortable nor uncomfortable when the medical team measured their Trec (5 [9]; response scale:0=uncomfortable, 5=neither comfortable or uncomfortable, 10=comfortable). Eight patients (19%) had no memory of the medical team measuring Trec. Most patients had low levels of concern regarding short-term damage (2 [3]) or long-term damage from their EHS (1 [3]; response scale:0=not at all concerned, 5=highly concerned). Most patients (74%, 31 of 42) expected to return to their normal exercise routine within 1 week after their EHS. Sixty-nine percent (29 of 42) stated their EHS would not impact future race participation. Most patients (69%, 29 of 42) intended to tell their primary care physician about their EHS.
**Conclusions:** Our patients were well educated on the potential seriousness of EHS and importance of Trec. Clinicians should never hesitate to perform Trec if they suspect EHS due to the importance of accurate temperature measurement, and it is noteworthy Trec was not deemed uncomfortable. Educational efforts should be directed towards helping patients understand safe return-to-play timelines following EHS.

**Comparing On-Site Wet Bulb Globe Temperature Measurements With Phone Application Estimates and Their Influence on High School Sports Activity Modification**

Yeargin SW, Grundstein AJ, Cooper ER, Cargile L, Stearns RL, Lopez RM, Scarneo-Miller S, Miller KC, Montalvo AM: University of South Carolina, Columbia, SC; University of Georgia, Athens, GA; Korey Stringer Institute, University of Connecticut, Storrs, CT; University of South Florida, Tampa, FL; West Virginia University, Morgantown, WV; Texas State University, San Marcos, TX; Arizona State University, Phoenix, AZ

**Context:** Measuring WBGT, and modifying sports activity as environmental conditions increase, is an effective exertional heat illness prevention strategy. Many states mandate this strategy and experts recommend WBGT be measured on-site. Phone applications (PA) exist to estimate WBGT but have not been systematically evaluated in public research compared to on-site device (OS) measurements. The purpose of our study was to determine accuracy of PA measures compared to OS WBGT measures. The secondary purpose was to determine if the different measures impacted activity modification categories.

**Methods:** An observational research design was utilized. The independent variable was measurement type (OS, PA). A convenience sample of high schools in possession of an OS WBGT thermometer (Kestrel 5400) across the United States was used. Environmental data were collected daily by athletic trainers, for a minimum of 2 weeks (August 1-September 30). All OS devices were set-up > ten minutes before the session; positioned on the same surface as the sport activity site. WBGT was recorded a minimum of two readings per activity session. WBGT was measured simultaneously by a PA (Zelus Sports-basic). A google sheet gathered date, time, surface type, and the dependent variables of WBGT and its components (dry bulb, natural wet bulb, globe temperatures). Activity modification categories, based on the NATA position statement, were determined ex post facto using WBGT (category 1 [<27.77°] through category 5 [>33.33°C]). Descriptive statistics were calculated for each dependent variable. The mean absolute error (MAE) and root mean square error (RMSE) were used to quantify differences between paired observations. The probability of detection, or hit rate (hit/(miss+hit); 0 worst, 1 perfect), was calculated to determine how closely PA matched the activity modification category identified by OS measurements.

**Results:** Schools recorded 1056 paired measurements (OS vs PA), representing 30 high schools in 11 states, across multiple surfaces (artificial turf 53%, natural grass 44%, and other 3%). The mean OS WBGT was 27.92±4.14°C (range: 13.72-37.11°C). The mean PA was 26.78±3.66°C (range: 10.27-35.27°C). MAE and RMSE were calculated for overall WBGT (1.76°C; 2.16°C), dry bulb (1.48°C; 2.04°C), wet bulb (1.83°C; 2.27°C), and globe temperature (3.49°C; 4.38°C). Hit rate was 0.95 for category 1 (observations n=489), 0.46 for category 2 (n=259), 0.26 for category 3 (n=118), 0.10 for category 4 (n=91), and 0.13 for category 5 (n=99).

**Conclusions:** RMSE and MAE were lowest for dry bulb and highest for globe temperature, possibly explaining a source of error in the PA WBGT estimate. The PA did a good job matching the activity modification category identified by OS devices at the coolest category but did progressively worse at hotter categories. Caution should be applied when using the PA in hot conditions when activity modifications are the most important to implement for heat safety.

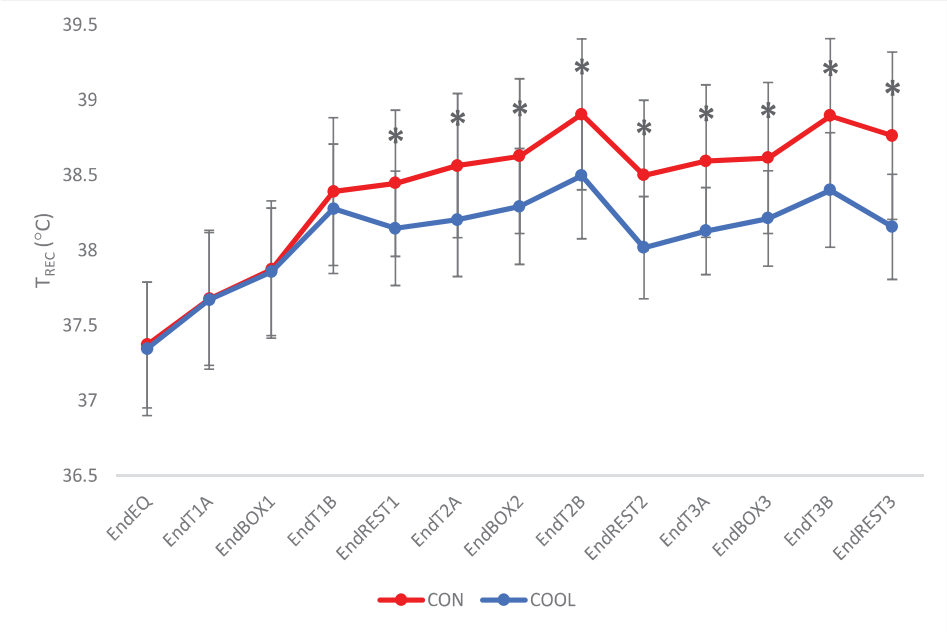
## The Effect of Body Cooling on Physiological Responses and Productivity Outcomes During Simulated Occupational Work in the Heat

Kaufman CE, Marcelino M, Morrissey-Basler MC, Stearns RL, Casa DJ: Korey Stringer Institute, Department of Kinesiology, University of Connecticut, Storrs, CT, and Department of Health Sciences, Providence College, Providence, RI

**Context:** Laborers who perform their work in high ambient temperatures have a dramatically increased incidence of exertional heat illnesses and a reduction in productivity.1–3 To maximize the safety and productivity of laborers, it is important to consider how different body cooling strategies can reduce this burden. Therefore, the purpose of this study was to examine the effects of body cooling (compared to no cooling) on physiological responses and productivity outcomes during simulated work in the heat.
**Methods:** Fourteen physically-active men (age: 26±3 years, maximal oxygen consumption (VO2max): 42.7±7.9 ml·kg-1·min-1) were asked to complete two randomized-control trials in a hot, humid environment (40C, 40% relative humidity). Each trial included three cycles of: 15 min of treadmill walking (TW), 5 min of box lifting (BL), 15 min of TW. A 10-min rest break (RB) followed the first and third cycles and a 20-min RB followed the second. BL for time was performed at the end of each trial. During the cooling trial (COOL), participants wore cooling garments (hat, sleeves, neck gaiter) that were dunked in ice water (prior to each TW) in addition to cooling towels during RB. The control trial (CON) did not include any body cooling intervention. A Two-Way (group by time) Repeated Measures Analysis of Variance examined changes in rectal temperature (TREC) and HR between trials and over time. Bonferroni post-hoc corrections were used when appropriate. Paired samples t-tests examined changes in the number of boxes lifted and time between trials to measure productivity.
**Results:** Significant interactions occurred for both TREC and HR ($p < 0.05$). TREC was significantly lower in COOL compared to CON between trials at the end of RB 1 through the remainder of the trial (Figure 1, post-final exercise bout TREC: 0.49±0.30C). HR was significantly lower in COOL at the end of all 3 RB (p= < 0.001, 0.001, < 0.001, respectively), and the end of the first TW in the last exercise cycle (p=0.045). Average HR was lower (n=13, 133±24 bpm) in COOL compared to CON. Participants lifted on average 4 less boxes in the first, but 4 more boxes in the third BL activity in COOL compared to CON (n=14 p=0.010, p=0.001, respectively). Overall, participants were able to lift on average 0.48±7.5% more boxes during COOL. During the timed 25-repetition BL activity, participants were 20±33 seconds faster in COOL compared to CON (n=13, p=0.011).
**Conclusions:** COOL resulted in significantly lower thermal strain compared to CON throughout the trial. Additionally, there was a 12% increase in productivity (# of boxes lifted) in a 30-minute period. These findings suggest that implementing a full body cooling strategy may be considered an effective solution to protect the health, safety, and productivity of laborers and other populations.

Mission is a corporate partner of the Korey Stringer Institute. This study was funded by Mission.

**Figure 1. Average $T_{REC}$ Values Between CON and COOL During Trials**



## Perceptual Heat Strain and Environmental Symptoms Across Three Consecutive Days of Heat Stress

Pryor RR, Kozlin M, Wheelock B, Przybysz JT: University at Buffalo, Buffalo, NY

**Context:** Exacerbated heat strain across consecutive exercise days can occur, impacting individuals undergoing heat acclimatization. We tested the hypothesis that perceptual heat strain and environmental symptoms are exacerbated on the second, but not third consecutive day of exercise in heat.

**Methods:** A convenience sample of 15 participants (7 females, age: 27±6 y, body fat: 16.7±9.3%) completed this repeated measures laboratory study, consisting of 3 consecutive days (Day 1, Day 2, Day 3) of 4 h of high-intensity exercise (metabolic heat production: 395±10 W) and rest (work:rest ratio=45:15 min) in heat (36.3±0.8°C, 21±5% relative humidity). Heat strain perceptions were assessed on Likert scales of thermal sensation (TS) (0=unbearable cold, 9=unbearably hot), thermal comfort (TC) (1.0=comfortable, 4.0=very uncomfortable), rating of perceived exertion (RPE) (0=extremely easy, 10=extremely hard), and fatigue (0=no fatigue at all, 10=completely fatigued). An environmental symptoms questionnaire (ESQ) assessed symptoms of heat strain. Repeated measures analysis of variance and t-tests were used to compare responses, with $p \leq 0.05$.

**Results:** Resting TS ($p=0.40$) and TC ($p=0.83$), and maximum TS ($p=0.17$) and TC ($p=0.40$) were not different among days. On Day 1, TS was greater during hours 3 and 4 compared to hours 1 and 2 (all $p > 0.05$), but was not different across time on Day 2 (all $p > 0.05$) or Day 3 (all $p > 0.05$). On Day 1 and Day 2, TC increased (became less comfortable) from hour 1 (1.8±0.6, 2.0±0.8) to hour 2 (2.1, $p=0.03$; 2.3, $p=0.01$) and was maintained through the end of exercise (all $p > 0.05$) while on Day 3 TC was maintained through hour 2 ($p=0.20$) before increasing at hour 3 (2.3±0.9, $p=0.03$). Females reported no differences in maximum RPE (Day 1: 6.9±1.5, Day 2: 7.0±1.7, Day 3: 7.0±1.5, all $p > 0.05$), while males reported no difference in RPE between Day 1 (5.3±2.3) and Day 2 (6.0±2.0, $p=0.10$) but greater maximum RPE on Day 3 (6.3±2.2, $p=0.01$) compared to Day 1. There was no difference in resting fatigue between Day 1 (0.2±0.4) and Day 2 (0.5±0.6, $p=0.06$) and greater resting fatigue on Day 3 (1.1±1.0) compared to Day 1 ($p < 0.01$). Change in fatigue was not different among days for males (all $p > 0.05$). Change in fatigue for females was similar between Day 1 (+4.4±2.4) and Day 2 (+4.0±2.6, $p=0.51$) and smaller on Day 3 (+3.3±2.1, $p=0.01$) compared to Day 1. End of exercise ESQ was not different among days ($p=0.82$).

**Conclusions:** ATs overseeing heat acclimatization must be aware of perceptual responses to heat stress. Contrasting our hypothesis, TS, TC, and ESQ were not different across consecutive days of exercise in heat. Males report greater RPE and females report a smaller increase in fatigue on the third day of exercise.

This project was funded by the National Institute for Occupational Safety and Health (NIOSH) and the Centers for Disease Control and Prevention (CDC) (1K01OH012016-01A1).

## Body Bag Cooling Effectiveness on Treating Exertional Hyperthermia

Zashin DO, McDermott BP, Morris A, Zhao X: University of Arkansas, Fayetteville, AR

**Context:** Research suggests that ATs lack compliance with EHS management and do not adopt gold-standard treatment for EHS. Body bags filled with ice and water (BB) may offer an alternative method of cold-water immersion (CWI) that is more portable and accessible than rigid cold tubs. Anecdotally, this treatment has been used in ambulances and at mass participation events for exertional heat illness treatment. The purpose of this study was to determine whole-body cooling rates when using BB as partial CWI to treat exertional hyperthermia.

**Methods:** Nine (8 male) participants (24 ± 4y, 175 ± 7cm, 83.6 ± 21.6kg) completed two randomized, crossover trials one week apart. Trials were completed on outdoor recreational turf fields and included of a self-paced 400-m warm-up, 1609-m run, and 100-m sprints until core temperature reached 38.9°C or volitional exhaustion. Following exercise, participants were cooled for a maximum of 30-min lying supine in the shade (control; CON) or in BB that were filled with 20 gallons of ice-water and oscillated continuously. Following cooling, patients sat upright for 15-minutes for a recovery period. Rectal temperature (Trec) and heart rate (HR) were taken following each exercise protocol, every minute of cooling, and every 5 minutes of recovery. Thermal and thirst sensation were assessed every set of sprints and at the first and last minute of cooling and recovery. Rating of perceived exertion (RPE) was assessed after each exercise protocol and set of sprints. Data were analyzed using repeated measures ANOVA or paired t-tests where appropriate with alpha set at $p < .05$.

**Results:** WBGT between trial days was not significantly different (day 1: 28.70 ± 1.23°C; day 2: 28.17 ± 0.83°C, $p = 0.726$). There was no difference in maximum Trec (BB: 39.19 ± 0.47°C; CON: 39.11 ± 0.43°C; $p = 0.448$), HR (BB: 183 ± 13bpm; CON: 190 ± 9bpm; $p = .213$), RPE (BB: 18 ± 2; CON: 18 ± 2; $p > .999$), Thirst ($p = .617$), or thermal sensation ($p = 0.729$) during exercise. Fluid consumed ($p = .404$), body mass changes ($p = .898$), 400-m run times ($p = .186$) and 1609-m run times ($p = .174$) were no different between trials. Whole-body cooling rate for BB was 0.102 ± .04°C/min; whereas, CON cooling produced a cooling rate of 0.040 ± .02°C/min ($p = .002$). Total cooling time was significantly faster with BB (13.2 ± 5.8min) compared to CON (27.6 ± 4.2min; $p = .002$). Thermal sensation was significantly lower throughout cooling in BB versus CON ($p < .001$).

**Conclusions:** BB cooling provides acceptable cooling rates for lowering Trec and treating exertional hyperthermia. In settings where full body CWI is not feasible, partial CWI cooling via BB offers an effective alternative.

## Exertional Heat Stroke Management: An Analysis of Recommendations From Professional Organizations

Grace A, Marcelino M, Szymanski MR, Eason CM, Stearns RL, Casa DJ: Korey Stringer Institute, Department of Kinesiology, University of Connecticut, Storrs, CT

**Context:** Exertional heat stroke (EHS) is an exertional heat illness characterized by an internal body temperature >40.5°C and central nervous system (CNS) dysfunction. Rapid recognition of EHS followed by initiation of rapid cooling are key to survival without complications. Cold water immersion (CWI) has the highest reported rate of cooling when used within 30 minutes of collapse. CWI provides a 100% survival rate from EHS when combined with the concept of cool first, transport second (CFTS). Cooling to 39.0°C before removing is the best way to ensure adequate treatment. The purpose of this grounded theory study was to evaluate recommendations made in consensus, position, and roundtable documents and determine if they agree on these key items to appropriate EHS treatment.

**Methods:** A search was performed on AcadmicSearchPremier, PubMed, Scopus, and SportDiscus to find, then analyze consensus statements, position statements, and roundtable documents that discuss EHS and make definite recommendations for key treatment items, including CWI as standard of care, an appropriate alternative cooling modality with a cooling rate over 0.15°C/min, inclusion of the concept of CFTS, and what temperature to remove from CWI. If clear recommendations were not provided, the publication was not considered to make a recommendation in that area. If there were multiple documents from a single organization, only the most current position statement was considered for analysis. Four independent reviewers read through each document to find if the key treatment items were included. Disagreements were resolved by majority rule. If tied, a discussion was held until an agreement was reached.

**Results:** The search resulted in 624 publications. After removing all publications that were not consensus, position, or roundtable documents with the purpose was to make a recommendation for treatment of EHS, only 11 publications remained. The results of the analysis by the reviewers are found in Table 1. CWI as primary cooling method was supported by 9 of the 11 (82%) documents. "CFTS" was recommended by 10 publications (91%). All publications (100%) supported the temperature of 39.0°C for the point to cease cooling, though one (9%) said CNS function return to normal was an appropriate indicator. Five of the 11 (45%) documents either did not make a recommendation for or did not recommend an appropriate alternative cooling modality. Three documents (27%) had all four recommendations in place.

**Conclusions:** Publications are in favor of CWI and "CFTS," provide recommendations on when to remove from cooling, and establish effective alternatives to CWI. The documents agreed that CWI, "CFTS," and the temperature threshold of 39.0°C to cease cooling should be utilized, while alternative appropriate cooling modalities were not always recommended. Clinicians should consider these recommendations when developing their emergency action plans and preparations for emergency EHS care, as well as recognize the items with overwhelming support from the available literature.

This study has no financial disclosers. The authors are employed at the Korey Stringer Institute and many have had authorship on the publications included in the analysis.

**Table 1. Exertional Heat Stroke Recommendations for Cold Water Immersion, An Appropriate Alternative, "Cool First-Transport Second," and Appropriate Removal Temperature by Professional Organizations**

| Title of Document (Year of Publication) | CWI | Alternative | "CFTS" | Removal Temp |
|---|---|---|---|---|
| 2020 International Consensus on First Aid Science with Treatment Recommendations (2020) | Y | Y | N | 39.0°C |
| ACSM Expert Consensus Statement on Exertional Heat Illness: Recognition, Management, and Return to Activity (2023) | N | N | Y | 38°C or CNS function to normal |
| Consensus Statement- Prehospital Care of Exertional Heat Stroke (2018) | Y | Y | Y | 38.6°C |
| Expert Consensus on the Diagnosis and Treatment of Heat Stroke in China (2020) | N | N | Y | 38.5°C |
| National Athletic Trainers' Association Position Statement: Exertional Heat Illnesses (2015) | Y | Y | Y | 38.9°C |
| National Athletic Trainers' Association Position Statement: Preventing Sudden Death in Sports (2012) | Y | Y | Y | 38.9°C |
| Preventing Catastrophic Injury and Death in Collegiate Athletes: Interassociation Recommendations Endorsed by 13 Medical and Sports Medicine Organisations (2019) | Y | N | Y | 38.9°C |
| Roundtable on Preseason Heat Safety in Secondary School Athletics: Prehospital Care of Patients with Exertional Heat Stroke (2021) | Y | N | Y | 38.9°C |
| The Inter-Association Task Force for Preventing Sudden Death in Secondary School Athletics Programs: Best-Practices Recommendations (2013) | Y | Y | Y | 38.9°C |
| The Inter-Association Task Force Document on Emergency Health and Safety: Best-Practice Recommendations for Youth Sports Leagues (2017) | Y | N | Y | 38.9°C |
| Prehospital Management of Exertional Heat Stroke at Sports Competitions: International Olympic Committee Adverse Weather Impact Expert Working Group for the Olympic Games Tokyo 2020 (2021) | Y | Y | Y | 39.0°C |
| **Percent with Recommendation Items (n=11)** | 82% (n=9) | 55% (n=6) | 91% (n=10) | 100% (n=11) |

## Perceptions of Collegiate Marching Band Artists Completing a Heat Acclimatization Protocol

Liptrap HA, Ballenger TL, Uriegas N, Kelly MR, Torres-McGehee TM, Yeargin SW, Emerson DM: University of South Carolina, Columbia, SC

**Context:** Participating in a heat acclimatization protocol is known to decrease EHI risk. Despite the physical demands of marching and wearing traditional uniforms, no established acclimatization guidelines exist for marching bands (MB). The purpose of this study was to understand the perceptions of collegiate MB artists completing a heat acclimatization protocol.

**Methods:** This was a randomized control study using a convenient sample of non-heat acclimatized collegiate MB artists (n=16, mean age=19.5±0.9 years, height=170.8±9.1 cm, weight=81.6±17.2 kg). Participants were randomly assigned to a condition: 1) control, 2) mock, or 3) uniform. Participants completed a 10-day acclimatization protocol beginning day one of MB camp. The control group wore athletic clothing (shorts, t-shirt). The uniform group gradually increased the number of uniform pieces (bibbers, jacket, shako/hat, gloves). The mock group used participants' clothing (athletic pants, jackets, hats) to mimic uniform heat strain. To maintain acclimatization, participants wore the full uniform/mock clothing one day during a normal rehearsal week. To assess MB artists' perceptions, we administered a series of questionnaires before MB camp, on protocol days 5 and 10, and after the second game day performance. Questions asked about wearing full uniforms in hot weather, EHI symptoms, protocol components (eg, adding uniform and mock clothing), and game preparedness. After the second game, participants completed a final survey about their experience and how the protocol prepared them for game day. Statistical analysis included descriptives and frequencies for each survey question. Kruskal-Wallis tests determined differences in Likert scores (1=strongly agree to 5=strongly disagree) between groups.

**Results:** WBGT was > 90°F on 6/10 days, the 10-day average=82.8±5.6°F, and max=93.3°F. Game day WBGT (mean=71.7±2.2°F) was significantly cooler than all rehearsals (83.5±4.2°F, $F(2)=9.4$, $P < .001$). Prior to day 1, all participants believed the acclimatization protocol would improve MB activity performance. Table 1 presents mean and median scores for all Likert questions at the end of the study. When asked if wearing the uniform/clothing on one rehearsal day prepared them for the demands of game day, a significant difference occurred between conditions; the uniform group indicated strong agreement and the mock group somewhat agreed (Table 1). Nine participants self-reported mild EHI symptoms (headache, dizziness) throughout the study (Table 1); no participants reported EHI symptoms on game day.

**Conclusions:** To prepare MB artists for the added strain of wearing full uniforms, we developed a heat acclimatization protocol to gradually introduce traditional MB uniforms or clothes that mimicked the uniform's thermal strain. Artists somewhat strongly to strongly agreed that wearing the mock clothing/uniform prepared them for game day and that they would be willing to wear clothing to improve heat tolerance/acclimatization. Heat related symptoms were minimal and provided feasibility support for the heat acclimatization protocol.

**Table 1. Self-reported EHI symptoms and Likert Scores for All Participants**

| Number of individuals self-reporting EHI symptoms during 10-day protocol N (%) | | Incidences of EHI symptoms throughout study | | Number of individuals who sought care or adjusted protocol due to EHI symptoms N (%) | |
|---|---|---|---|---|---|
| Total (n=16) | 9 (56.3) | Total | 14 | Total | 3 (18.8) |
| Control (n=5) | 2 (40.0) | Band camp | 8 | Control | 0 (0.0) |
| Mock (n=4) | 4 (100.0) | 1st week rehearsal | 4 | Mock | 1 (25.0) |
| Uniform (n=7) | 3 (42.9) | 2nd week rehearsal | 2 | Uniform | 2 (28.6) |
| **Level of agreement with the following statements at end of study:[1]** | | | | **Mean Score ± SD** | **Median Score** |
| Would like to wear full, traditional uniform only if temperatures below certain degree (eg., <90°F) | | | | 1.6 ± 1.1 | 1.0 |
| Would like to wear alternative uniform if temperatures above certain degree | | | | 1.4 ± 0.9 | 1.0 |
| Willing to wear clothing more days if it improves heat tolerance/acclimatization | | | | 2.1 ± 1.3 | 2.0 |
| Hated wearing clothing/uniform during rehearsals | | | | 2.5 ± 1.2 | 2.5 |
| Would not wear additional clothing during rehearsal even if it helps for gameday | | | | 3.8 ± 0.9 | 4.0 |
| Wearing clothing/uniform during 10-day rehearsals prepared me for gameday | | | | 1.1 ± 0.4 | 1.0 |
| Wearing clothing/uniform on one rehearsal day before game prepared me for gameday | | | | 2.6 ± 1.5 | 2.0[2] |
| Band camp prepared me for heat and physical demands of gameday | | | | 1.5 ± 0.7 | 1.0 |
| Regular, school-year rehearsals prepare me for heat and physical demands of gameday | | | | 2.0 ± 1.2 | 2.0 |

[1]Based on 5-point Likert scale: 1=strongly agree, 2=somewhat agree, 3=neither agree or disagree, 4=somewhat disagree, 5=strongly disagree
[2]Significant difference between mock (2.0) and uniform (1.0, $X^2(1)=4.507$, $p=0.034$)

# Free Communications, Rapid Fire Presentations: Beyond the Finish Line: Addressing Social Determinants of Health and Boosting Health Literacy in Athletic Training

Thursday, June 27, 2024; 9:00 AM-9:55 AM; Room 271-273

Moderator: Brittany Ingram, MA, LAT, ATC

### Professional Program Faculty Experiences Integrating Patient-Centered Care Topics Into Athletic Training Curriculums

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**Context:** Health literacy (HL), the social determinants of health (SDH), and the International Classification of Functioning, Disability, and Health (ICF) are recent additions to the Commission on Accreditation of Athletic Training Education (CAATE) content standards for professional athletic training programs (P-ATP) as components of patient-centered care (PCC). It is unknown how the topics are being integrated into curricula. The purpose of our study was to explore faculty experiences integrating PCC components into their teaching and assessments of learning.

**Methods:** We completed a grounded theory investigation of P-ATP's faculty's experiences teaching and assessing components of PCC. We content validated a researcher-developed semistructured interview guide via expert review (n=2) and pilot testing (n=3). We used criterion sampling and sent recruitment emails to program directors of CAATE-accredited P-ATPs through Qualtrics and asked them to forward it to all faculty. Participants (n=15, age=38.00±7.81 years, educator experience=15.67±7.07 years, 13 women, 13 White) volunteered to complete video-recorded interviews via Zoom. We reviewed transcripts for accuracy. Two members of the research team read the finalized transcripts multiple times to develop themes using open, axial, and selective coding procedures. Data saturation occurred upon completion of the 15th interview for general themes regarding faculty experiences teaching PCC components. We established data trustworthiness via member checking, multianalyst triangulation, and peer review. For member checking, we provided participants with their transcript and asked them to confirm accuracy. Two members of the research team coded the data independently and met to negotiate the coding scheme for multianalyst triangulation. Finally, a peer with extensive training in qualitative data analysis reviewed a coded transcript and verified the authenticity of the presentation of the results.

**Results:** Three themes emerged following data analysis. First, participant comfort level in teaching the various PCC topics depended on prior experiences. Participants who had extensive experiences with PCC topics believed they had adequate preparation for teaching the topics while those who did not have expertise felt they needed targeted professional development related to PCC to teach and assess the content. Participants noted a need for authentic learning opportunities (e.g. simulations, standardized patients, case studies, etc.) for students to grasp PCC ideals and challenges associated with clinical integration. Examples of authentic learning challenges included a disconnect between didactic and clinical messaging and/or integration, a lack of learning experiences with diverse patients, and challenges associated with teaching PCC constructs due to faculty identity. Participants noted time as a barrier to integrating PCC topics into their classes because curricula are full, leaving little time for developing content expertise, integrating PCC into class activities, and developing learning assessments.

**Conclusions:** Professional development is needed for faculty who teach PCC content depending on their previous clinical, research, and teaching experiences. Professional development should focus on incorporating authentic learning opportunities with limited resources to improve student buy-in. Clinical opportunities should be selected carefully to ensure PCC cohesion between clinical and didactic education. Collaborating with community partners who represent diverse populations may help build authentic teaching and clinical practice opportunities. Faculty and clinicians with diverse backgrounds and experiences teaching PCC topics may be helpful with preceptor training, guest lectures, and course development since participants wondered if they were the appropriate people to teach some topics due to their social and personal characteristics. Finally, faculty should be provided with time to develop course content and assessments related to PCC as the components should be valued.

## Differences in Patient-Reported Outcomes Across Social Determinants of Health for People With Ankle Sprain History

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**Context:** People with a history of ankle sprain have decreased self-reported ankle function, poorer health-related quality of life, and greater injury-related fear compared to people without a history of ankle sprain. It is unclear how these outcomes are influenced by personal characteristics representative of the social determinants of health (SDOH). The purpose of this analysis was to compare scores on patient-reported outcome instruments (PROs) in people with a history of ankle sprain across various personal characteristic groups. We hypothesized participants who reported less than full-time employment, lower socioeconomic status, living in non-suburban areas, and lower education will have worse scores on PROS.

**Methods:** Seventy-three participants with a history of ankle sprain (age 30.9±7.7 years) participated in this survey study. Participants completed a demographics questionnaire that determined ankle sprain history, age, gender, biological sex and personal characteristics that included: employment status, socioeconomic status, community description, and highest education obtained. The subcategories for each of the personal characteristics can be found in Table 1. Participants also completed the following valid and reliable PROs: the modified Disablement in the Physically Active Scale (mDPA), the Fear-Avoidance Belief's Questionnaire (FABQ), and the Foot and Ankle Disability Index (FADI) to assess disablement, injury-related fear, and self-perceived ankle function, respectively. Higher scores on the mDPA-Physical Summary Component (mDPA-PSC), mDPA-Mental Summary Component (mDPA-MSC), FABQ-Work, and FABQ-Physical Activity (FABQ-PA) and lower scores on the FADI-Sport, FADI-Pain and FADI Activities of Daily Living (FADI-ADL) represented poorer outcomes. Descriptive statistics (median [interquartile range]), independent samples Kruskal-Wallis tests and, when indicated, post-hoc pairwise comparisons were performed. Alpha was set a priori $p \leq 0.05$.

**Results:** Descriptive statistics and the results of the Kruskal-Wallis tests can be found in Table 1. There was a significant difference in PROs based on employment status (Table 1). Part-time employment had worse FADI-ADL (p=0.003), FADI-Pain (p=0.008), FABQ-Work (p=0.017), mDPA-MSC (p=0.012) and mDPA-PSC (p=0.011) scores compared to students and worse FADI-ADL (p=0.013), FABQ-Work (p=0.007), mDPA-MSC (p=0.041) and mDPA-PSC (p=0.031) scores compared to full-time employees. Doctorate degree had lower FABQ-Work and FABQ-PA scores compared to high-school graduate (p=0.003, p=0.005), associate's degree (p<0.001, p=0.002), and bachelor's degree (p<0.001, p=0.002). Master's degree had lower FABQ-Work scores compared to bachelor's degree (p=0.015) and associate's degree (p=0.008). Doctorate degree had lower mDPA-MSC scores compared to bachelor's degree (p=0.014) and associate's degree (p=0.018), while master's degree had lower mDPA-MSC scores compared to bachelor's degree (p=0.024) and associate's degree (p=0.038).

**Conclusions:** Our results demonstrated certain patient-characteristics associated with SDOH may be related to PRO scores in people with a history of ankle sprain. Interestingly, employment status and education appeared to influence ankle-specific PRO scores along with general quality of life and fear-avoidance. Future research should consider patient-characteristics when determining the effectiveness of intervention strategies across multiple PROs.

**Table 1. Descriptive statistics (median[interquartile range]) and results of the Kruskal-Wallis tests for each of the patient-reported outcome instruments for each of the patient characteristic groups. (Participant characteristic groups with 5 or less participants were removed from the analysis.)**

| | mDPA-PSC | mDPA-MSC | FABQ-Work | FABQ-PA | FADI-Sport | FADI-Pain | FADI-ADL |
|---|---|---|---|---|---|---|---|
| **Employment** | **p=0.032** | **p=0.038** | **p=0.018** | **p=0.132** | **p=0.140** | **p=0.030** | **p=0.009** |
| **Other (n=2)** | NR | NR | NR | NR | NR | NR | NR |
| **Unemployed (n=3)** | NR | NR | NR | NR | NR | NR | NR |
| **Student (n=12)** | 12.5 [21] | 5 [6] | 3.5 [10] | 14.5 [10] | 78.1 [24.2] | 96.9 [12.5] | 92.6 [ 13.9] |
| **Part-Time (n=11)** | 24 [15] | 8 [6] | 21 [17] | 15 [10] | 53.1 [41.3] | 75.0 [31.3] | 63.6 [ 14.8] |
| **Full-Time (n=45)** | 14 [19] | 5 [8] | 6 [17] | 11 [10] | 81.3 [34.4] | 87.5 [31.3] | 92.0 [ 27.8] |
| **Socioeconomic Status** | **p=0.669** | **p=0.447** | **p=0.968** | **p=0.624** | **p=0.718** | **p=0.754** | **p=0.709** |
| **Low (n=16)** | 18 [21] | 4.5 [8] | 7.5 [20] | 15 [15] | 75.0 [32.0] | 90.6 [12.5] | 89.8 [21.6] |
| **Middle (n=54)** | 15.5 [24] | 5 [7] | 7 [19] | 12 [12] | 75.0 [39.0] | 87.5 [31.3] | 84.7 [30.4] |
| **High (n=3)** | NR | NR | NR | NR | NR | NR | |
| **Community Description** | **p=0.084** | **p=0.096** | **p=0.698** | **p=0.797** | **p=0.139** | **p=0.531** | **p=0.097** |
| **Rural (n=8)** | 17.5 [28] | 5.5 [11] | 4 [22] | 12 [7] | 65.6 [46.9] | 84.4 [40.6] | 88.6 [41.4] |
| **Suburban (n=31)** | 12 [17] | 3 [8] | 6 [13] | 13 [15] | 91.6 [21.9] | 93.8 [25] | 93.2 [18.2] |
| **Urban (n-34)** | 21 [19] | 6 [5] | 12.5 [21] | 12 [13] | 68.8 [50.8] | 87.5 [32.8] | 77.3 [34.4] |
| **Education** | **p=0.005** | **p=0.026** | **p<0.001** | **p=0.008** | **p=0.101** | **p=0.415** | **p=0.097** |
| **High School/GED (n=16)** | 23.5 [22] | 4.5 [10] | 7.5 [21] | 15 [11] | 65.6 [30.5] | 87.5 [28.1] | 83 [26.7] |
| **Associate's Degree (n=8)** | 18.5 [15] | 8.0 [8] | 16.5 [19] | 16 [10] | 62.5 [37.5] | 81.3 [21.9] | 79 [25.9] |
| **Bachelor's Degree (n=27)** | 21 [28] | 7 [6] | 13 [21] | 14 [14] | 75.0 [59.4] | 87.5 [43.8] | 84.1 [39.8] |
| **Master's Degree (n=15)** | 11 [13] | 4 [6] | 0 [13] | 11 [7] | 81.3 [28.1] | 87.5 [25] | 92 [17] |
| **Doctorate (n=7)** | 9 [12] | 2 [4] | 0 [0] | 3 [10] | 87.5 [31.3 | 93.8 [12.5] | 95.5 [10.2] |

## The Influence of Web-Based Continuing Education Specific to Documentation on Clinical Practice Behavior Changes: A 6-Month Follow-Up Investigation

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**Context:** An abundance of research regarding clinical documentation in athletic training has indicated that athletic trainers (ATs) desire more continuing education (CE) opportunities to enhance their documentation skills. Recently, researchers developed two web-based CE opportunities and found that both opportunities increased ATs' knowledge and confidence in clinical documentation. While improvements in knowledge and confidence are important outcomes of any CE activity, little is known about whether ATs effectively translate new knowledge gained to actual clinical practice behavior changes. Therefore, we aimed to explore ATs' perceived clinical documentation behavior changes 6 months after completing the web-based CE opportunities.

**Methods:** A consensual qualitative research design and purposeful sampling were used for this study. Six months after completing one of two CE opportunities regarding clinical documentation (a passive web-based CE [PAS] or an active personalized learning pathway CE [PLP]), participants from both groups were invited to participate in a follow-up interview. A 5-item, semi-structured follow-up interview guide was used; interview questions were adopted from a previously validated interview guide developed by the research team. The follow-up interview guide was piloted with the first participant from each group; no changes were deemed necessary and both pilot interviews were included in final analyses. All interviews were conducted individually, via Zoom, with the principal investigator until saturation was reached. In total, 26 ATs (12 PAS, 14 PLP; 11 men, 15 women; average age=36.8±9.3 years; AT experience=12.9±8.8 years) from 7 settings across 20 states were interviewed. Following transcription, the data were coded into themes and categories by a 3-person research team; the team met regularly to ensure consensus throughout a 3-phase process. Multi-analyst triangulation, internal, and external auditing were strategies employed to ensure trustworthiness of the data.

**Results:** Three predominant themes emerged regarding ATs' perceptions of clinical documentation 6 months following the CE activities. Participants discussed perceived behavior changes including enhanced electronic medical record (EMR) use, timely and diligent documentation habits, more secure communication procedures, and enhanced consistency and staff onboarding procedures. However, perceptions differed among ATs depending on their employment setting. While subtle differences were noted across PAS and PLP groups, all participants discussed the value of the CE activities, detailing specific key content they perceived to be impactful and highlighting general benefits such as refreshed knowledge and documentation strategies. Participants also appreciated the resources provided with each CE opportunity and discussed the benefit of having these resources for the future. Despite the perceived behavior changes, our participants also discussed ongoing barriers affecting their clinical documentation behaviors including a lack of scheduled time to focus on clinical documentation, a lack of technology and financial resources to support the purchase and maintenance of EMRs, and low staffing levels to assist with all roles and responsibilities during clinical practice. However, some participants indicated they felt well supported in their setting and did not perceive any barriers prohibiting clinical documentation behavior changes.

**Conclusions:** ATs that completed a PAS or PLP on documentation self-reported improved clinical documentation behaviors 6 months following completion of the CE opportunity. Our participants discussed increased EMR use following the CE activities, which suggests our CE opportunities may help address a profession-wide EMR use barrier previously identified in the literature. It is concerning that setting-specific differences were noted among participants. As ATs, documentation behaviors should be consistent regardless of setting since true clinical documentation is focused on the patient encounter itself, not the setting where the care is provided. Regardless, our participants expressed behavior changes still occurred despite organizational infrastructure-related barriers. Our findings focus on ATs' self-reported clinical documentation behaviors; future research should explore if actual documentation behavior changes occur following the completion of CE activities specific to clinical documentation.

## Social Determinants of Health and Concussion Care Seeking in Secondary School Athletes: A Preliminary Analysis

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**Context:** As many as 50% of secondary school athletes with suspected concussions do not seek care for various reasons. While studies have examined factors that influence concussion care seeking and provide a framework for understanding this complicated behavior, they have not considered broader social and contextual factors; including social determinants of health (SDH), the conditions in which we live, work and play. The purpose of this preliminary analysis was to determine which SDH domain(s) (economic stability, education, health and health care, neighborhood and built environment, and social and community context) were associated with concussion care seeking intentions and behavior among secondary school athletes.
**Methods:** Using a cross-sectional study design, a convenience sample of secondary school athletes completed a validated 39-item survey encompassing the SDH domains with sections of concussion care seeking intentions (indirect and direct) and behavior (indirect and direct) which is part of a larger study. Indirect items list a variety of signs and symptoms associated with concussion and ask the participant's care seeking intentions and behavior, whereas direct measures ask specifically if the participant would intend or has sought care for a suspected concussion. Items in each SDH domain were summed, while indirect and direct care seeking intentions were averaged. Higher SDH domain and care seeking intentions (indirect and direct) scores indicate more favorable SDH and care seeking intention beliefs. Responses to indirect and direct care seeking behavior items were used to categorize participants as "care seekers" or "non-care seekers." Four separate multivariable regressions were completed to better understand associations between SDH domains and care seeking intentions (two linear regressions) and behavior (two logistic regressions).
**Results:** The survey completion rate was 86.6% (n=116/134; age=16.3±1.0 years; males=43/134, 32.1%; females=74/134, 55.2%; female to male=1/134, 0.7%, other=2/134, 1.5%; prefer not to respond=1/134, 0.7%; missing=13/134, 9.7%). In the overall model, SDH domains were associated with direct care seeking intentions (F5,122=2.92, p=0.02, R2=0.12), however no individual variables were significantly related (all p-values$^3$0.12). For direct care seeking behavior, better health and healthcare decreased the odds of being a non-care seeker by 55% (b=-0.81, odds ratio=0.45, p=0.011, Nagelkerke's R2=0.31). SDH domains were not associated with indirect care seeking intentions (p=0.34), nor indirect care seeking behavior (p=0.54).
**Conclusions:** Our preliminary analysis indicates that athletes who have access to healthcare and higher health literacy were more likely to seek care for a suspected concussion. Clinicians should aim to understand the overarching well-being of each patient, recognizing that SDH, especially access to healthcare and health literacy, may play a role in individuals' decision to disclose a concussion. These findings suggest that secondary school athletes may benefit from additional education regarding concussion disclosure and resources provided by the school's athletic trainer to assess and manage suspected concussions.

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## Health Literacy Disparities and Required Concussion Education Among Adolescents in Rural and Urban Communities

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**Context:** The Alabama High School Athletic Association (AHSAA) requires athletes and their parent/guardian to sign a concussion handout annually. This handout describes concussive signs and symptoms, the effects of second impact syndrome, and next steps for a suspected concussion. Based on reading comprehension, this form scores at 10.4 correlating to a 10th-grade reading level using the Flesch-Kincaid Grade Level. This handout is the only piece of state-required concussion education for high school athletes and serves as a primary prevention strategy for participating athletes, especially in rural communities facing inequitable health resources. The purpose of this study was to assess health literacy scores among urban and rural communities within Alabama and compare the results to the reading level of the state-mandated concussion education requirement.

**Methods:** A cross-sectional design was utilized and a total of 127 Black / African American high school football athletes from rural (n=68) and urban (n=59) communities in Alabama participated. The Rapid Estimate of Adolescent Literacy in Medicine (REALM-Teen) was administered to participants to evaluate health literacy. The REALM-Teen is a valid, reliable, and easy-to-administer tool that screens youth in grades 6-12 under three minutes. Each participant was administered the REALM-Teen individually with a trained researcher; having each participant read the 66 health terms aloud. REALM-Teen scores range from 0-66 and are tabulated into a health literacy raw score correlating to a grade-specific reading level. REALM-Teen score totals were used for all statistical analyses. A Mann-Whitney U test was used to determine score differences based on rurality. Statistical significance was set a priori ($p \leq .05$).

**Results:** The total raw REALM-Teen median score was 57 (range 32-66), with 15 participants (11.8%) scoring at a 4th-6th grade reading level, 81 participants (63.8%) scoring at a 7th-8th grade level, and 31 participants (24.4%) scoring at a 9th-12th grade reading level. Statistically significant differences were observed in rural versus urban communities with a rural median score of 55 (range32-66) and an urban score of 59 (35-66). There were statistically significant differences between participants in rural and urban settings for REALM-Teen raw scores (p=0.004), with those in urban settings having better health literacy.

**Conclusions:** Health literacy is essential for individuals to obtain, process, and understand basic health information to make appropriate and safe health decisions. Most participants scored below the appropriate reading level to understand basic concussion information as mandated by the ASHAA. Rural communities scored below their urban counterparts indicating the need for greater primary and secondary prevention approaches across communities where health literacy concerns persist. Individuals and communities with lower health literacy have the potential to struggle understanding medical terminology and written instructions regarding patient care for concussion. These findings emphasize the need for equitable concussion education materials that are required by state legislation.

## Access to Athletic Training Services in U.S. Public High Schools Based on Socioeconomic Status and Race/Ethnicity Demographics

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**Context:** Extensive research in health care demonstrates disparities in access based on patient socioeconomic status (SES) and race/ethnicity. Similarly, research has shown significant differences in access to athletic training services (AT access) in the secondary school setting based on school SES. However, these studies have been limited to specific states and the relationship between AT access and race/ethnicity has not been explored. To fully appreciate and address inequities in AT access, the objective of this study was to investigate differences in AT access based on SES and race/ethnicity on a national level.

**Methods:** We conducted a cross-sectional database study using secondary analysis. Data were collected from open-access databases including the National Center for Education Statistics (NCES), Athletic Training Location and Services (ATLAS), and US Census Bureau. The NCES provided school location, race/ethnicity demographics per school, total number of students, and the percentage of students eligible for free or reduced lunch (%FRL). The ATLAS database provided AT access data divided into full time (FT-AT), part time (PT-AT), and no access (no-AT). Data collected from the Census Bureau included county median household income (MHI). All public schools across the United States with complete data in both NCES and ATLAS were included in this study (n=10,983) while private schools and schools with incomplete or missing data were excluded. Descriptive data were summarized by measures of central tendency. A one-way ANOVA was used to compare schools with AT access (FT-AT, PT-AT, no-AT) on their SES and race/ethnicity characteristics (MHI, %FRL, percentage of white students, percentage of nonwhite students). A Bonferroni pairwise comparison was used for variables that had significant main effects.

**Results:** Across all schools included in the study, 43.8% had no-AT (n=4,812), 23.5% had PT-AT access (n=2,581), and 32.7% had FT-AT access (n=3,590). There were significant differences between school characteristics based on AT access for MHI ($p<.001$), %FRL ($p<.001$), percentage white ($p<.001$), and percentage non-white ($p<.001$). Table 1 summarizes post-hoc differences. Schools with FT-AT had higher county MHI and lower percentage of students eligible for %FRL compared to schools with part-time or no AT access. Schools with no-AT had a significantly higher percentage of nonwhite students (46.0%) compared to schools with a FT-AT (31.3%) ($p<.001$). However, there were no significant differences between FT-AT and PT-AT based on race/ethnicity demographics ($p\geq.13$).

**Conclusions:** Schools with higher SES had greater AT access than those with lower SES levels. We found schools with a higher percentage of nonwhite students were more likely to have no AT access, further demonstrating that health care disparities extend to athletic health care as well. To increase AT access, future initiatives should address the inequities in counties of lower SES and schools with larger nonwhite populations.

## Exploring Educational Opportunities Related to Social Determinants of Health Provided by Professional Graduate Athletic Training Programs

Jones BC, Welch Bacon CE, Snyder Valier AR, Picha KJ: A.T. Still University, Mesa, AZ

**Context:** Curricular standards require athletic training students to receive education on social determinants of health (SDH), including their impact on health and well-being of patients. However, there is no guidance on how to incorporate the concepts into athletic training education and limited literature describes the methods and techniques that professional graduate athletic training programs (ATPs) use when teaching students about the SDH. Greater understanding of current opportunities and challenges associated with teaching SDH should inform effective curricular approaches that would benefit the athletic training education community. Therefore, the purpose of this study was to explore SDH-related educational opportunities provided to students in professional graduate ATPs.
**Methods:** This study used a consensual qualitative research (CQR) design. A convenience sampling strategy was used to recruit current program faculty of ATPs that had graduated at least 1 cohort of students at the time of study and who indicated interest in participating through a brief screening questionnaire. Virtual focus group interviews, via Zoom, averaging 45-60 minutes in length, were scheduled for participating ATPs. An interview guide was developed by the research team and reviewed by methodological experts for face and content validity. The semi-structured interview guide consisted of 10-items that explored SDH content delivery strategies in didactic and clinical education learning environments, assessment strategies, perceived program strengths and weaknesses, university support, and intention to change delivery in the future. Each focus group was transcribed, proofed for accuracy and to deidentify data, and checked by participants for accuracy and clarity. The CQR analysis process consisted of several phases including initial codebook development, codebook finalization, coding of transcripts, and frequency counting of themes across transcripts. Three investigators were data coders and 1 was an internal auditor. Consensus was achieved across all phases.
**Results:** Data saturation was achieved following the completion of 6 focus groups (11 program faculty from 6 ATPs, range = 1-3 faculty/focus group; 3 males, 8 females, all white). Four themes emerged from data analysis: current educational practices, perceived strengths, perceived, and needs. Participants discussed current practices and content delivery strategies they implement to address SDH content across their curriculum including both didactic and clinical education approaches. Though faculty discussed implementing this educational content early in the program and weaving it throughout other courses, most participants could not identify a concrete assessment strategy for measuring students' knowledge of SDH. Participants also noted students were exposed to SDH at clinical sites that were in lower socioeconomic communities, albeit no tracking methods to confirm SDH exposure were discussed. Participants also discussed their perceived strengths of integrated SDH across the curriculum and with multiple exposures, but barriers, such as preceptor knowledge and buy-in during clinical experiences or self-reported knowledge barriers of SDH, exist. Finally, participants discussed future needs to help incorporate SDH content across the curriculum, including validated patient cases and real-time examples in athletic training practice. University support of interprofessional education opportunities were a perceived strength to support SDH concepts.
**Conclusions:** While our results suggest that most graduate professional ATPs are incorporating SDH in their programs, with appropriate frequency and diverse methodologies, difficulty in establishing and implementing effective assessment methods was a common theme across programs. Additionally, programs expressed a reliance on organic exposure to SDH in patient cases during clinical experiences, such as clinical experiences in lower socioeconomic communities, which may result in an over-estimation of SDH exposure. Programs may benefit from use of tracking systems to capture experiences and ensure a variety of exposures for students. Further, supporting programs with validated tools and resources to screen for SDH and evaluate learning over time with reliable assessments would fill a gap that programs expressed.

A.T. Still University's internal grants program funded this study.

# Free Communications, Rapid Fire Presentations: Understanding the Complexities of the Upper Extremity: A Case Study Session

Thursday, June 27, 2024; 10:25 AM-11:20 AM; Room 271-273

Moderator: Natalie Myers, PhD, ATC

### Carpometacarpal Bossing in a Collegiate Baseball Player: A Case Report

Trail LE, Galbraith RM, Wang A, Castles S, Warner BJ, Cage SA: The University of Texas at Tyler, Tyler, TX; UT Health East Texas, Tyler, TX; University of Texas Health Science Center, Tyler, TX; Grand Canyon University, Phoenix, AZ

**Background:** A 22-year-old male collegiate baseball middle infielder reported to the athletic training staff complaining of pain and stiffness in the dorsal aspect of his right wrist. Physical examination revealed a tender protuberance of the dorsal aspect of the scaphoid and trapezium. The patient stated he had noticed the protuberance approximately three days prior to seeking care. The patient also exhibited a decrease in active range of motion with wrist extension, and a decreased grip strength. Initial point of care ultrasound assessment did not reveal any observable edema in the protuberance or surrounding structures. Given the extent of the patient's symptoms and the inability to come to a conclusive diagnosis in the absence of more advanced imaging, the patient was referred to the team physician.

**Differential Diagnosis:** Ganglion Cyst, Osteophyte, Dorsal Wrist Impingement.

**Intervention & Treatment:** A second point of care ultrasound and initial x-ray did not reveal any new clinical findings. As such, the team physician ordered an MRI for further evaluation. MRI findings revealed complete bridging second carpometacarpal boss. With the new clinical finding, the patient was referred to an orthopedic hand and wrist surgeon for further evaluation and consultation. During the clinic visit, the patient consented to excision of the excess bone mass and resurfacing of the underlying bony tissue. While performing the ostectomy, the surgeon noted that there was no visible joint line between the second metacarpal and trapezium. A successful ostectomy and resurfacing was performed without incident. One week following surgery, the patient began gentle active range of motion exercises for the wrist and hand. Two weeks post-surgery, the patient's range of motion and pain had improved to the point where grip strengthening exercises could be initiated using light density theraputty. At 17 days post-surgery the patient began wrist strengthening exercises with a two pound weight in the flexion, extension, and ulnar deviation motions. Week five the patient began a return to throwing program that progressed over the next four weeks, at which point the patient was cleared for all fielding drills during practice. Week six the patient began hitting drills using a light weight bat. By week eight the patient was able to take part in hitting drills using a light weight bat without further recurrence of symptoms. Over the next two weeks, the patient began to gradually increase the frequency and volume of hitting drills. Week 11 the patient was cleared to hit off live pitching. Throughout the return to play process, the patient reported occasional pain and stiffness in his wrist. These symptoms were treated with over-the-counter oral naproxen, topical diclofenac, and instrument assisted soft tissue mobilization. The patient was counseled that he would continue daily therapeutic exercise for the remainder of the semester before transitioning to a maintenance program with less frequent sessions during the playing season.

**Uniqueness:** While there is variance in the reported prevalence of carpal bossing, the highest reported prevalence rate is 19%. Only approximately 1% of patients report symptoms related to carpal bossing. The patient in this case reported both decreased range of motion and grip strength. Additionally, many patients develop wrist extensor tendon pathologies related to the presence of the bony protuberance. In this case, the patient reported symptoms and diagnostic imaging did not reveal any pathology of the wrist extensor tendons.

**Conclusions:** Many uncommon or rare pathologies have the potential to mimic the symptomatology of more common pathologies. Thorough and holistic evaluations of pathologies is critical for accurate diagnosis. By obtaining an accurate diagnosis, clinicians and patients are put in the best possible position for optimal outcomes.

**Winner of the Early Career Category**

**Anterior Bundle of Ulnar Collateral Ligament Tears Beyond the Pitcher's Mound - A Football Player's Paradox**

Hughes J, Rodriguez K, Stavitz J: Kean University, Union, NJ, and Roselle Park High School, Roselle Park, NJ

**Background:** Over the past three decades, Ulnar Collateral Ligament (UCL) injuries have gained notoriety predominantly within the baseball community. Notably, in throwing sports, the mechanism of injury predominantly results from repetitive microtrauma, engendered by the incessant valgus load on the elbow. However, the etiological narrative differs significantly for athletes involved in non-throwing contact sports. Herein, UCL injuries often originate from sudden, traumatic elbow loads. Our case study delves deep into an intriguing instance of a high-grade UCL tear in a non-throwing contact athlete, a realm less explored, yet equally critical.
**Patient:** We present a case involving a seventeen-year-old male high school football prodigy, who sustained a high-grade tear of the UCL in his dominant right elbow. With no prior injuries associated with this joint, this two-way player (who adeptly plays both offense and defense) faced a unique injury mechanism. While attempting to break his fall with an outstretched arm during an offensive play, an adversary forcefully collided posteriorly and laterally into the young athlete's elbow. This resulted in a combined force of hyperextension and valgus before ground impact. Subsequent to the trauma, the athlete, despite not experiencing any audible cues from the injury, reported sensations of numbness and diminished strength in the afflicted arm.
**Intervention & Treatment:** A comprehensive on-field examination identified focal tenderness around the antecubital fossa and indicated specific strength deficits. Alarmingly, the Valgus test was positive. Radiological evaluations, including an emergency x-ray, revealed potential bony anomalies, warranting further Magnetic Resonance Imaging (MRI) investigations, which conclusively diagnosed a high-grade UCL tear.
**Outcomes or Other Comparisons:** While UCL injuries have become synonymous with baseball, particularly pitchers, our study emphasizes that these injuries can manifest in contact sports via distinct etiological pathways. While chronic valgus loads are the culprits in throwing sports, the causative agents in contact sports are abrupt and traumatic valgus forces. Hence, in cases where UCL injuries are suspected, timely MRI referrals are paramount. The intricacies of UCL injuries in non-throwing contact sports cannot be underscored enough. These athletes predominantly exhibit acute-onset ulnar-sided elbow pain. As clinicians, it is imperative to conduct a meticulous history and physical examination. This encompasses a thorough evaluation of the injured site and its contralateral counterpart to discern any discrepancies and guide subsequent clinical decisions.
**Conclusions:** Non-throwing athletes presenting with UCL injuries necessitate a keen clinical eye.
**Clinical Bottom Line:** A rigorous assessment, spanning from history to physical examination, including strength, motion, and sensory evaluations, is the keystone. Benchmarking against the contralateral extremity offers invaluable insights, ensuring holistic care.

## Lacertus Syndrome in a Collegiate Division II Men's Tennis Athlete: A Level 4 CASE Report

Richardson LN, Lopez RM, Wilson BB, Tritsch AJ, Cohen GW: University of South Florida, Tampa, FL, and P.T. Solutions, Tampa, FL

**Background:** A 24-year-old, left-handed Division II Men's Tennis player presented to the athletic trainer complaining of muscular weakness during pronation of the left wrist and pain around the medial aspect of the left elbow during activity. The patient reported numbness and weakness in the third, fourth, and fifth digits of the left hand occurring toward the end of practices and matches. The patient presented with swelling over the medial aspect of the left elbow and decreased range of motion during supination when compared bilaterally. The patient had a previous history of similar pain and weakness three years prior; however, no numbness was present.
**Differential Diagnosis:** Thoracic outlet syndrome (TOS), ulnar nerve entrapment, pronator teres syndrome, and lacertus syndrome.
**Intervention & Treatment:** Initial treatment consisted of manual therapy and stretching of the shoulder musculature to mitigate symptoms of possible TOS, along with manual therapy of the elbow. After symptoms progressed, therapeutic exercises for wrist and forearm strengthening, endurance, and manual therapy of the flexor musculature were included. After two weeks of ineffective conservative management, the patient was referred to the team physician for further evaluation. Physician evaluation found a positive Allen's Test, negative Neer's Impingement, Hawkins Kennedy, Cross Body Adduction, Napolean, and O'Brien's. Initial x-ray of the shoulder was unremarkable, but elbow x-ray revealed a possible physeal scar or stress fracture. The patient was referred to a vascular surgeon for further evaluation and MRI of the cervical spine, shoulder, and elbow. The MRI of the cervical spine was unremarkable. The shoulder MRI revealed mild supraspinatus and infraspinatus tendinopathy without a discrete tear. The elbow MRI revealed edema within the flexor musculature; however, the ulnar nerve appeared normal. Based on the onset of symptoms, relief with rest, and imaging results, the patient was diagnosed with lacertus syndrome (LS), a chronic exertional compartment syndrome of the forearm, which can include compression of the median nerve. Following the diagnosis, rehabilitation exercises that involved repetitive motions at the forearm were removed to avoid aggravation. Therapeutic interventions included forearm dry needling and manual therapy such as massage, instrument-assisted soft tissue mobilization, and cupping. The patient's forehand technique was adjusted to limit pronation in their swing. Over eight weeks, the patient progressed from light hitting at practice to doubles only in matches and then to full return to play (RTP). The criteria for the patient to progress at each stage in their RTP protocol was pain-free activity and no decrease in sensation or strength. The patient denied any symptoms of numbness or weakness throughout the remainder of the season but occasionally reported forearm tightness toward the end of matches. The patient was able to finish the season with new forehand mechanics and continued dry needling and manual therapy treatments.
**Uniqueness:** This case uniquely diagnoses a condition with little prevalence and familiarity. Median nerve entrapment (MNE) is commonly seen in the carpal tunnel, however only 7-10% of MNE occur proximally. In patients presenting with TOS symptoms and pronator teres syndrome, LS is not often diagnosed. The majority of LS literature analyzes the outcomes of surgical interventions. This case provides clinicians with conservative management options.
**Conclusions:** Two key features led to the LS diagnosis: weakness and numbness in the wrist and hand only present after repetitive pronation, and imaging that revealed edema around the lacertus fibrosus. Differential diagnoses often exclude LS; however, athletic trainers should consider LS in patients presenting with delayed onset of symptoms during activity that demands repetitive wrist and forearm pronation and wrist flexion. Athletic trainers should consider conservative management such as dry needling, manual therapy, and altered mechanics to treat LS in adult athletes.

## Parsonage-Turner Syndrome in Collegiate Football Athlete: A Case Study

Hunt SL, Robinson NZ, Amaria NY, Johnson PD: University of Michigan, Ann Arbor, MI

**Background:** An 18-year-old, white, male football long-snapper was diagnosed with mononucleosis at the beginning of June 2023. Nine days after the diagnosis, the athlete woke up with: significant shoulder pain on the dominant right side; a significant decrease in AROM with shoulder abduction and flexion; and a decrease in strength with shoulder abduction and external rotation. He had no known mechanism of injury during this period of illness and rest. The shoulder pain gradually dissipated over 7 days. Three weeks later, the athlete recovered from mononucleosis and had no shoulder pain. As he gradually returned to regular weight room activity, significant shoulder weakness limited his ability to do upper body exercises. He was referred to an orthopedic surgeon, where Parsonage-Turner Syndrome (PTS) was discussed as a potential cause of the weakness. Electromyography (EMG) was ordered to further evaluate.

**Differential Diagnosis:** Rotator cuff pathology, labral tear, capsulitis, nerve root injury, cervical disc injury/compression, thoracic outlet syndrome, neuropathy, neuralgic amyotrophy/PTS.

**Intervention & Treatment:** At the acute onset of shoulder pain, treatment started with anti-inflammatory and pain modulation therapy. Once the strength deficit was identified, the weakness was addressed with rotator cuff activation, scapular stabilization, and closed kinetic chain exercises. EMG yielded evidence of acute denervation localized to the suprascapular nerve, confirming PTS as the diagnosis. A hand-held dynamometer was utilized weekly to track strength in external rotation and shoulder abduction. Grip strength was also documented. Recovery and rehabilitation continued in order to limit the dysfunction from weakness and minimize supraspinatus and infraspinatus atrophy.

**Uniqueness:** This case is unique due to the low incidence rate of 1.64/100,000 people. The mechanism for PTS is thought to be caused by an autoimmune response following illness or various environmental factors. Other possible onsets of PTS include vaccinations, infections, medical procedures, or demanding exercise. Another unique factor to this case is the slow recovery rate, as average recovery time can range from 6-12 months with some documented cases lasting up to three years.

**Conclusions:** PTS is rare and not fully understood. Further research is needed to understand this disease's mechanisms of injury, list of symptoms, and how to minimize the recovery time. The rarity of this disease causes it to be unrecognized and impede a diagnosis, delaying the treatment to the patient. Initially, when treating the athlete, pain control is priority, followed by maintenance of the athlete's strength to prevent atrophy and dysfunction. Another factor to consider when treating these patients is to monitor mental health, as it can be challenging to predict when their strength may return to normal.

**Redefining Stability: Solving Posterior Shoulder Instability With Distal Tibial Allograft: Type 3 CASE Study**

Couch KL, Schmitz JN, DelNegro SE, Martin BM, Provencher MT: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** Posterior glenohumeral instability is rare in comparison to its anterior counterpart- making up only 2-10% of shoulder instability cases.1 It commonly affects the young, athletic population due to repetitive posterior dynamic loading activities.1-3 Arthroscopic soft tissue stabilizing procedures, such as a reverse Bankart repair, are indicated for isolated capsulolabral injuries, with a satisfaction rate up to 90%.4 However, posterior instability with glenoid bone loss (GBL) greater than or equal to 20% have poor outcomes if treated with isolated capsulolabral repair- with recurrent instability rates as high as 10%.5-7 Bony augmentation procedures, in conjunction with soft tissue repairs, have become more prominent for the treatment of glenohumeral instability with GBL.1,3,6-18, The Latarjet technique has been the gold standard for treatment of anterior shoulder instability with GBL.10-13 Best practices for posterior instability bony augmentation procedures remain unclear. Distal tibial allograft (DTA) provides a bone and cartilage solution for glenoid bone defects associated with instability.13-16 This type 3 CASE study elaborates on the treatment of posterior glenohumeral instability associated with GBL treated with DTA- a complicated orthopedic problem which should be thoroughly understood by the athletic training profession.

**Patient:** An active 40-year-old male presented with acute on chronic posterior left shoulder pain with history of posterior instability. The patient complained of the inability to bench press heavy weights, perform heavy overhead activities, and worsening pain in the last year. Conservative treatments including physical therapy and steroid injections showed trivial improvement. Physical examination revealed tenderness in the posterior glenohumeral joint and bicipital groove, pain at end range forward flexion, and minimal shoulder MMT deficit. Positive tests included posterior load and shift with pain, and Speeds. MRI indicated posterior GBL with cystic formation and glenoid concavity loss. CT scans revealed 20% posterior GBL. Surgical options discussed with the patient included posterior bony augmentation with DTA or posterior capsulolabral repair.

**Intervention & Treatment:** The patient underwent left shoulder arthroscopic posterior stabilization with DTA, posterior Bankart repair, shoulder arthroscopy with debridement and platelet rich plasma injection. A custom cut DTA graft was utilized for posterior GBL. An abduction sling was utilized for the first 6 weeks, with rehabilitation emphasizing early elbow and wrist motion while limiting passive external and internal rotation. Due to the patient's level of GBL, which has been shown by Nacca et al. as a critical level, the evaluating surgeon recommended posterior stabilization procedure with a DTA for bony augmentation.5 Multiple types of autografts and allografts have been utilized as posterior bone blocks; however, current literature lacks a gold standard for posterior bony augmentation.11,17-19

**Outcomes or Other Comparisons:** The patient reported decreased pain 2 weeks post-operatively, and repeat radiographs were obtained, showing a well centered humeral head and a well-fixated posterior bone block. The patient continues to progress in his rehabilitation. Current literature supports positive short-term outcomes (minimum 12 months), but mixed mid (48 months-10 years) to long-term (10+ years) reported outcomes due to high recurrent instability rates in multiple studies.20-22 **Conclusions:** Posterior instability with associated GBL requires detailed evaluation and thorough knowledge of the impact of osseous legions on surgical options, due to its vague clinical presentation.3,22 It poses a risk to the young athletic population, as a result of repetitive posterior loading.1-3 If not treated adequately, it can lead to recurrent instability, and further GBL.12,13,17,23

**Clinical Bottom Line:** Posterior glenoid instability with associated GBL is a complex orthopedic pathology. Athletic trainers should understand the risks associated with inadequate treatment of posterior instability with bone loss, and potential long-term effects, to ensure positive outcomes. DTA is an effective surgical option to restore glenohumeral stability, decrease rates of re-current instability, and increase overall patient reported outcomes.

## Anterior Shoulder Instability With A Distal Tibial Allograft: A Level 3 Clinical Case Study

Czarnecki BS, Martin BM, Provencher MT: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** Since1954 the Latarjet procedure has been the gold standard in treating recurrent anterior glenohumeral instability with associated bone loss1. A Latarjet involves transferring the coracoid process and its attached conjoint tendon to the anterior glenoid rim. An alternative technique is using a distal tibial allograft (DTA). A DTA procedure involves harvesting a segment of cadaveric bone tissue from the distal tibia and attaching it to the anterior glenoid rim. Recent literature supports that a distal tibial allograft reconstruction results in a clinically stable joint with similar clinical outcomes as the Latarjet procedure2. As DTAs gain popularity there is a necessity to discuss the factors of surgical decision making between the two techniques, especially regarding revisions. This level 3 CASE study follows a revision DTA to address a failed Latarjet.

**Patient:** A 29-year-old male presents for evaluation of his right shoulder. He has a past medical history of chronic and recurrent anterior subluxations of the glenohumeral joint. Symptoms began after a snowboarding accident 10 years ago and this was addressed surgically with a labral repair and Latarjet. One year ago, he was involved in another snowboarding accident which increased his symptoms. He reports frequent subluxations, instability, and the feeling of slipping. Physical exam reveals significant apprehension, positive relocation, and positive surprise test. Radiographs, CT, and MRI demonstrate a small Hills Sachs lesion, labral tear, and 30% anterior glenoid bone loss. This presentation is consistent with anterior shoulder instability and associated glenoid bone loss compared to the literature1.

**Intervention & Treatment:** Due to the significant glenoid bone loss and ongoing instability, he was recommended for a distal tibial allograft and remplissage. Postoperatively he reported no complaints and progressed well. In rehabilitation he progressed from PROM to AROM, strengthening, proprioception, and will eventually complete functional activities before returning to sports at the approximate 6-month mark.

**Outcomes or Other Comparisons:** The patient continues to progress without complications, reports no recent instability, and looks forward to returning to snowboarding. His continued progress provides a positive prognosis in favor of distal tibial allograft for revision. The literature shows that at an average 4 year follow up, DTA reconstruction for recurrent anterior shoulder instability results in a clinically stable joint with similar clinical outcomes and recurrence rates compared to open Latarjet1.

**Conclusions:** Revision surgery after a failed Latarjet procedure is a rare and challenging surgical problem, data shows failure rates of 7.6%3. It is a challenge due to the clinically low instance of Latarjet failure, and subsequent decision making to address the revision technique. While the outcomes of Latarjet have been clinically significant, it has been shown that DTA reconstruction results in a stable joint with similar outcomes and is favorable for revisions. It is advantageous for a revision due to the glenoid bone loss being augmented while the anatomy and stability are restored. Graft-site morbidity is minimized, there is sufficient cartilage interface for glenohumeral articulation, and a capsular repair to allograft is allowed4. Conversely, allograft availability is variable, and allograft is difficult to acquire in some circumstances. The procedural cost is also increased when using allograft. There are other surgical techniques such as soft tissue repair/reconstruction, talus, and iliac crest autograft, which do not have as strong clinical outcomes as a DTA5.

**Clinical Bottom Line:** This promising presentation in a young snowboarder highlights the need for longer term studies to determine if the outcome results are maintained. Factors such as indication, graft availability, cost, and patient goals all play a role in surgical decision making when faced with shoulder instability. Revision cases will likely have better outcomes with a DTA compared to alternative techniques.

## Entrapment of the Suprascapular Nerve at the Suprascapular Notch With a Parsonage-Turner Presentation: Type 4 Clinical CASE Study

Sume NE, Powers ME, Gildard MJ: Marist College, Poughkeepsie, NY

**Background:** A 21-year-old male Division III basketball player, who was also a competitive swimmer through high school, complained of extreme pain radiating down the back of his left arm upon waking one morning. Two days prior to symptom onset, the patient participated in a 2.83 km swim. The pain continued for approximately two weeks, resulting in decreased function and difficulty sleeping at night. Once the pain began to subside, the patient noticed a significant decrease in strength. At that time, the patient was referred to an orthopedic specialist. The physician originally suspected a rotator cuff or labral tear. However, magnetic resonance image ruled out both conditions. The physician then suspected Parsonage-Turner Syndrome and ordered electromyography (EMG), which also returned negative. The patient was told that the weakness could last months, years, or the rest of his life. Shortly after the patient began conservative treatment. The patient saw a neurosurgeon approximately three months after the onset of symptoms. The neurosurgeon suspected that the first EMG was done too early and may not have been valid. The patient returned for a second EMG, and the results showed minimal activity from the suprascapular nerve. The neurosurgeon suspected that the suprascapular nerve was being entrapped at the spinoglenoid notch and recommended surgery.
**Differential Diagnosis:** Rotator cuff strain, cervical disc disease, labral disorder, impingement
**Intervention & Treatment:** The patient began rehabilitation with his athletic trainer three weeks after the onset of symptoms. The goal of rehabilitation was to strengthen the scapular and glenohumeral musculature. Four months after the start of rehabilitation, the patient underwent a neuroplastic procedure to decompress the suprascapular nerve. One week following surgery, the patient continued to perform rehabilitation with the athletic trainer. . This consisted of isometric strengthening and progressed to proprioceptive neuromuscular facilitation, neural glides, and isotonic strengthening. Three weeks after the surgery the patient was given clearance by the physician to return to practice and game competition.
**Uniqueness:** Suprascapular nerve entrapment (SSNE) is a rare condition that commonly affects overhead athletes or laborers. It accounts for 1-4% of shoulder pathologies in the general population and is typically a result of compression or traction lesions in the spinoglenoid notch. Patients commonly complain of muscle weakness, atrophy, and sharp or burning pain on the posterolateral shoulder that can radiate distally to the digits. Patients will also experience significant decreases in shoulder external rotation and abduction range of motion. The onset of symptoms are mostly insidious, with few patients recalling a traumatic history prior to symptoms. Repetitive protraction, cross-body adduction, and internal rotation motions can increase the chances of developing SSNE.
**Conclusions:** This case study serves to highlight a rare condition that should be considered when patients present with insidious shoulder pain. The rarity of the condition often leads to delayed diagnosis by months or years. Our patient was originally misdiagnosed with Parsonage-Turner Syndrome. After follow-up testing the correct diagnosis was made and the patient was able to make a full return to competition. It is essential to include SSNE in a differential diagnosis when a patient presents with a sudden onset of posterolateral shoulder pain. A thorough history and diagnostic imaging are needed to rule out other pathologies. Nerve conduction velocity (NCV) studies and EMG testing have been appraised as the gold standard to diagnose SSNE.

### The Effect of Generalized Vs. Individualized Rehabilitation on Pain Reduction in Patients With Patellofemoral Pain Syndrome: A Critically Appraised Topic

Hartnett RA, Tierney RT, Mansell JL, Russ AC: Temple University, Philadelphia, PA

**Context:** People with Patellofemoral Pain Syndrome (PFPS) often experience lingering knee pain that may not completely resolve. Most rehabilitation programs address general knee joint weakness and flexibility, but assessing individual risk factors may lead to greater reduction in pain. In patients with PFPS, does an individualized rehabilitation program based on patient-specific risk factors reduce pain better than a generalized rehabilitation/strengthening program?
**Methods:** PubMed, Sage Journals Online, Oxford Journals Online, and Medline were searched in June of 2023 using the Boolean phrases: Patellofemoral pain AND individual AND pain, patellofemoral pain AND individual AND treatment, patellofemoral pain AND individual AND targeted, and patellofemoral pain AND protocol. Articles were included that specifically answered the research question and were published in the last 10 years. Studies that examined only at patients with osteoarthritis were excluded. The PEDro Scale and Strobe Checklist were used to assess validity. Pain was the primary outcome and was reported using means and standard deviation or median Visual Analog Scale (VAS) scores pre- and post-intervention. When provided, 95% Confidence Intervals (CI) and Cohen's d were included.
**Results:** The search returned 57 articles and 3 were selected. In Halabchi et al (randomized control trial) 60 participants were split into intervention (routine exercises plus modification of identified risk factors; n=30) and control (routine exercises; n=30) for a 12-week program. Intervention group pain scores significantly improved (-14.9; 95% CI -5.86, -23.93) compared to control (-6.82; 95% CI -2.54, -11.10, p=0.002). In Keays et al (cohort) all patients followed a general program for 2-weeks followed by a 2-week individualized program. All patients experienced significant improvement following the general program (VAS pre=3.72+2.28, post=1.33+1.69, $p<0.001$, Cohen's d=1.11) and continued significant improvement with the individualized program (VAS pre=1.33+1.69 post=0.49+1.05, $p<0.001$, Cohen's d=0.72). In Yosmaoglu et al (cohort) all patients (n=61) received a standard multimodal treatment for 6 weeks. Afterwards, 40 patients were classified as not responding to treatment. Those 40 participants then completed 6 weeks of targeted interventions where pain was significantly improved (median pre=4.4, post=1.8, $p<0.001$). Halabchi et al scored a 7/10 (PEDro), while Keays et al and Yosmaoglu et al scored 20/22 and 19/22 (STROBE).
**Conclusions:** The findings of these 3 studies support the use of an individualized rehabilitation program based on patient-specific risk factors to reduce pain in patients with PFPS. Although the effect size for the control in Keays et al was larger than the individualized, all participants completed both protocols without randomization. More randomized control trials are needed to directly compare the 2 interventions. Individualized rehabilitation programs are effective at reducing pain in patients with PFPS when compared to generalized programs. Clinicians should evaluate individual risk factors for PFPS to design an appropriate rehabilitation program for each patient.
SORT B

## Associations Between Ankle Compressive Joint Contact Force and Structural Changes in Those With Chronic Ankle Instability

Jang J, Franz JR, Pietrosimone BG, Lin FC, Blackburn JT, Tennant JN, Wikstrom EA: University of Texas - El Paso, El Paso, TX, and University of North Carolina at Chapel Hill, Chapel Hill, NC

**Context:** Chronic ankle instability (CAI) contributes to the early onset of ankle joint degeneration. Musculoskeletal modeling has revealed that patients with CAI exhibit altered ankle joint contact force (JCF) profiles during walking compared to uninjured controls. Altered ankle JCF profiles could contribute to deleterious mechanical changes within the talar cartilage. However, musculoskeletal modeling is not readily accessible to clinicians, necessitating finding CAI-related clinician-oriented outcomes that are associated with altered ankle JCF. Identifying such associations could improve our ability to identify those more likely to develop cartilage degeneration and deploy interventions to mitigate it. Rearfoot varus position is a measure of readily observable structural alignment that is clinically accessible and known to be altered in those with CAI. Therefore, the purpose of this study was to quantify the relationship between ankle JCF and rearfoot varus in patients with CAI.

**Methods:** Twenty-one patients with CAI (22.6 ± 4.2 years, 71.7 ± 12.1 kg, 171.6 ± 8.3 cm, 4.2 ± 3.3 ankle sprains, 4.5 ± 6.3 giving was episodes within the past 6 months, an IdFAI score of 23.5 ± 4.5, a FAAM-ADL score of 82.8 ± 6.7%, and a FAAM-Sports of 66.8 ± 10.2%) volunteered to participate. Participants completed a 2-min gait assessment at their self-selected speed on a force-measuring treadmill. Measured kinematics and ground reaction forces drove a generic lower-extremity musculoskeletal modeling in OpenSim to estimate ankle JCF (Rajagopal model). Variables included the peak, impulse, and loading rate for compressive, posterior shear and lateral shear JCF. Rearfoot varus was captured during weight bearing and non-weight bearing conditions. We used publicly available image processing software to assess rearfoot alignment by measuring the angle formed between lines that bisected the lower leg and the calcaneus. Pearson correlations assessed associations between JCF variables and rearfoot varus outcomes with an a priori alpha level of 0.05 for statistical significance.

**Results:** As rearfoot varus increased, compressive and lateral shear JCF decreased, while the posterior shear JCF increased. Rearfoot varus during weight bearing was associated with peak compressive JCF ($r = -0.47$, $p = 0.031$). Rearfoot varus during non-weight bearing was associated with peak posterior JCF ($r = 0.55$, $p = 0.01$) and posterior JCF loading rate ($r = 0.52$, $p = 0.016$). Rearfoot varus during non-weight bearing was also associated with peak lateral JCF ($r = -0.48$, $p = 0.027$) and lateral JCF impulse ($r = -0.53$, $p = 0.013$). No other statistically significant associations ($p>0.05$) were identified.

**Conclusions:** Our finding suggests that altered structural alignment, specifically rearfoot varus, may be a mechanism for altered ankle JCF in those with CAI, which in turn may precipitate mechanical changes in ankle joint cartilage.

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## Associations Between Walking Biomechanics and Talar Cartilage Behavior Following Loading in Individuals With Chronic Ankle Instability

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**Context:** A clear link has been made between chronic ankle instability (CAI) and subsequent ankle joint degeneration. Those with CAI have deleterious changes in cartilage composition and greater cartilage deformation following a standard loading protocol relative to uninjured controls. Also, walking and landing biomechanical variables are associated with composition and deformation outcomes in those with CAI. However, no study has determined if walking biomechanics are associated with talar cartilage recovery post-loading in individuals with CAI. Therefore, we quantified associations between walking GRF outcomes and cartilage deformation and recovery following both static and dynamic loading protocols in individuals with CAI.

**Methods:** A multi-session cross-sectional design with 36 individuals with CAI (Age: 22.6±4.3 years, number of ankle sprains: 3.8±2.7, Foot and Ankle Ability Measure-Sport: 66.9±11.6%) was completed. Inclusion criteria followed International Ankle Consortium guidelines. Participants walked barefoot on a 12-m walkway with an eight-camera motion capture system (120 Hz) that recorded ground reaction forces at 1200 Hz on force platforms mounted flush with the floor. Variables of interest included the loading phase peak vGRF, time to 1st (loading) and 2nd (push off) peak vGRF, and 1st and 2nd vGRF loading rate. Ultrasonographic (US) images of talar cartilage were captured using a 12 MHz linear probe following consistent patient and probe positioning. After a 45-minute off-loading period, to minimize the influence of prior physical activity on cartilage thickness, images were taken before (Pre), immediately after (Post), 15-minutes after (P15), and 30-minutes (P30) after each loading protocol. The loading conditions included a static protocol where participants stood on one leg for 2 minutes and a dynamic protocol where participants performed sixty 60cm single-leg forward hops. Deformation was calculated as the Pre-to-Post change in cartilage thickness (mm) following the loading protocols. Recovery was calculated as cartilage thickness changes at the P15 and P30 time points relative to the Post assessment. Spearman-rho correlations were conducted and an a priori alpha level of 0.05 was used to determine statistical significance.

**Results:** Less (worse) cartilage recovery at P15 following the dynamic loading protocol (Mean±SD: 0.046±0.09 mm) was significantly correlated with faster times to the 1st (Mean±SD: 0.20±0.03s; $r= -0.346$, $p=0.038$) and 2nd peak vGRF while walking (Mean±SD: 0.55±0.05s; $r = -0.361$, $p= 0.031$). No other significant associations ($p>0.05$) were observed between walking biomechanics and cartilage deformation ($p>0.05$) or cartilage recovery ($p>0.05$) following the static and dynamic loading protocol.

**Conclusions:** Shorter times to the 1st and 2nd peak vGRF while walking were significantly associated with less cartilage thickness recovery in the first 15 minutes following a dynamic loading protocol. This result suggests that aberrant walking biomechanics in those with CAI may hinder cartilage recovery after a standardized dynamic loading protocol.

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**Associations Between Clinical Dynamic Balance and Talar and Subtalar Cartilage Composition in Those With Chronic Ankle Instability**

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**Context:** Individuals with chronic ankle instability (CAI) and worse balance demonstrate deleterious changes in talar and subtalar cartilage composition and composition variability, which may indicate early osteoarthritis development. Postural control outcomes captured from a research-grade force plate associate with ankle cartilage composition in those with CAI. However, it remains unknown if clinician-oriented measures, such as the Star Excursion Balance Test (SEBT) are robust enough to capture this relationship and provide further insight regarding potential therapeutic targets to help slow ankle degeneration in those with CAI. Therefore, this study aimed to quantify the relationship between SEBT scores and cartilage composition using means and variability of T1ρ MRI relaxation times within the talar and subtalar cartilage in those with CAI.

**Methods:** Thirty-seven individuals with CAI (11M; 22.6±4.2 years, 171.5±9.2 cm, 71.8±12.2 kg) volunteered to participate in this cross-sectional study. Inclusion criteria followed International Ankle Consortium guidelines. Participants completed three trials of the anterior (A), posterior-medial (PM), and posterior-lateral (PL) reach directions of the SEBT following four practice trials of each direction. Reach distances were normalized to leg length (LL) and averaged across the three trials. Participants were then non-weight bearing for 30 minutes prior to undergoing a T1ρ MRI scan (Siemens Magnetom TIM Prisma 3T scanner within a high-resolution knee coil) in a plantarflexed position. The overall Talar dome and the posterior articulation of the subtalar joint were the regions of interest for this investigation. The mean T1ρ value as well as the coefficient of variation (CoV) of the T1ρ values in the regions of interest were calculated and represent proteoglycan density within the cartilage. Pearson correlations were run to determine associations between SEBT scores and compositional outcomes with $p \leq 0.05$ determining statistical significance.

**Results:** Less (worse) SEBT-PM reach distance (84.7±10.0%LL) was associated with greater Subtalar T1ρ CoV (55.8±19.2ms ; r=-0.350, p=0.04). No other significant associations were identified between SEBT-PM and the Talar T1ρ mean, Subtalar T1ρ mean, or the Talar T1ρ CoV (r range: 0.012 to -0.210, p value range: 0.226 to 0.946). The SEBT-A (65.5±5.9%LL) did not have significant associations with any compositional outcome (r range: -0.015 to 0.189, p value range: 0.43 to 0.93). Similarly, the SEBT-PL (76.4±11.6%LL) did not have significant associations with any compositional outcome (r range: 0.117 to -0.250, p value range: 0.15 to 0.50).

**Conclusions:** Worse SEBT-PM reach distances, like worse static postural control measures, was significantly associated with greater (worse) Talar T1ρ values in those with CAI. However, the cumulative data illustrates normalized SEBT reach distances, clinician-oriented measures, have minimal associations with Talar and Subtalar T1ρ values in those with CAI. Research grade measures of postural control may be more predictive of joint degeneration.

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## Associations Between T1ρ MRI and Ultrasound Based Measures of Cartilage Health in Those With Chronic Ankle Instability

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**Context:** Deleterious changes in proteoglycan density (PGD), measured via T1ρ MRI, within the talar and subtalar cartilage are present in those with chronic ankle instability (CAI). Similarly, those with CAI have greater deformation of talar cartilage thickness, measured via ultrasound (US) following standardized loading relative to uninjured controls. While MRI outcomes remain the non-invasive gold standard for assessing early degenerative changes, cartilage thickness and echo-intensity magnitude assessed via US may be viable indicators of PGD changes. Yet, no investigation has determined if US-based measures of cartilage health are associated with T1ρ values in those with CAI. This study quantify the relationship between T1ρ and US based outcomes of cartilage thickness and US echo-intensity following a standardized dynamic loading protocol in those with CAI.

**Methods:** This cross-sectional investigation included thirty-five individuals with CAI (22.6±4.2 years, 3.8±2.7 sprains, 5.4±6.7 giving way episodes, 23.5±4.03 IdFAI score). Inclusion criteria followed International Ankle Consortium guidelines. Participants completed a 30-minute unloading period prior to undergoing a T1ρ MRI (Siemens Magnetom TIM Prisma 3T scanner within a high-resolution knee coil) in a plantarflexed position. Talar and Subtalar segmentation was completed manually using ITK-SNAP software. Mean T1ρ values and T1ρ coefficient of variation (CoV) values for the overall Talar dome and posterior articulation of the Subtalar joint were calculated and are representative of PGD. Following a 45-minute unloading period on a separate test day, a 12 MHz linear US probe imaged the talar cartilage before (Pre), immediately after (Post), 15-minutes after (P15), and 30-minutes (P30) after sixty 60 cm single-leg forward hops. US-based outcomes included the Pre-to-Post change in cartilage thickness and echo-intensity as well as the recovery of cartilage thickness and echo-intensity at the P15 and P30 time points relative to the Post assessment. Pearson correlations were run to determine associations between MRI and US based outcomes with $p \leq 0.05$ determining statistical significance.

**Results:** Greater (worse) Talar T1ρ variability (40.06±20.6ms) was associated with less (worse) recovery of the echo-intensity mean at P15 (r=-0.390, p=0.021) and P30 (r=-0.360, p=0.034). Similarly, greater (worse) mean T1ρ values in the posterior Subtalar articulation (77.6±10.5 ms) was associated with less (worse) recovery of the echo-intensity mean at P15 (r -0.0383, p=0.023) and P30 (r=-0.368, p=0.030). Greater Subtalar T1ρ variability (43.8±18.1ms) was also associated with less cartilage thickness recovery at P15 (r=0.382, p= 0.023). No other statistically significant associations (p>0.05) were identified between PGD and US-based measures of cartilage health in those with CAI.

**Conclusions:** Cumulatively, the results indicate that worse recovery of US-based measures of cartilage health, particularly echo-intensity, following a standardized dynamic loading protocol could serve as a viable clinician-oriented surrogate for PGD in those with CAI when assessing for future OA risk.

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## Changes in Cartilage Composition Post-ACL Reconstruction After a Daily Step Promotion Intervention: A Pilot Study

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**Context:** Optimal knee joint loading is essential for reducing the risk of developing posttraumatic osteoarthritis following anterior cruciate ligament reconstruction (ACLR). Individuals engage in fewer daily steps post-ACLR which may result in insufficient knee joint loading linked to worse cartilage composition (i.e., lesser proteoglycan density). Adaptive daily step promotion is a feasible intervention to increase daily steps post-ACLR, but it is unclear if altering daily steps will change cartilage composition. The purpose of this study was to determine changes in tibiofemoral cartilage proteoglycan density (i.e, T1ρ relaxation times examined via Magnetic Resonance Imaging [MRI]) after an 8-week daily step promotion intervention post-ACLR.

**Methods:** Individuals with primary, unilateral ACLR who took ≤8,000 daily steps were enrolled in a pre-test post-test single-arm phase 1 clinical trial (NCT04906499). As part of the intervention, participants wore a Fitbit monitor on their wrist during all waking hours which was used to log daily steps into the ACL Goals application. Personalized text messages with a step goal based on the top 60th percentile of steps collected over the previous 10 days were automatically sent to participants daily using the ACL Goals application for 8 weeks. The 3D modulated partitioned k-space spoiled gradient echo snapshots (MAPSS) T1ρ imaging sequence which is a valid assessment of articular cartilage proteoglycan density and demonstrates strong intersession reliability were collected via MRI before and after the intervention on ACLR limb. T1ρ relaxation times of tibiofemoral cartilage were calculated via a customized MATLAB code. Post-images were registered to pre-images prior to manual segmentation which has demonstrated strong intra-rater reliability. Cohen's d effect sizes and 95% confidence intervals (CIs) were used to estimate magnitude of changes in tibiofemoral cartilage T1ρ.

**Results:** Seven participants enrolled in the study and one participant dropped out of the intervention due to lack of time. Participants who completed the intervention (n=6, 83% Female, 25.5±6.3 years old, 26.3±4.8 kg/ m2, 37.9±17.4 months post-ACLR) demonstrated average monitor wear compliance of 98%±2% and an average daily step increase of 2054±3795 steps over the intervention period. Participants also demonstrated strong effects for decreases in T1ρ relaxation times (increased proteoglycan density) of the overall medial and lateral tibial cartilage (d range=0.85-0.97), and small to moderate effects for decreases in T1ρ relaxation times in the overall medial and lateral tibial cartilage (d range=0.13-0.42; Table 1). Strong effects for decreasing T1ρ relaxation times were exhibited in the posterior lateral tibia, anterior lateral tibia, and posterior medial tibia (d range=1.11-1.38; Table 1).

**Conclusions:** Our pilot data demonstrate changes in lateral tibiofemoral cartilage health following the daily step promotion intervention post-ACLR and supports its use in future randomized controlled trials for improving cartilage composition.

The project was supported by the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health, through Grant Award Number UL1TR002489 and the Core for Clinical Research (CCCR) P30AR072580 funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases. Dr. Christopher Kuenze is a paid analyst for Inova Health, Fairfax, VA.

Table 1. Average Tibiofemoral Cartilage T1ρ Relaxation Times (mms) Pre-/Post-Intervention

| Cartilage Region | | Pre-Intervention | Post-Intervention | Cohen's *d* Effect Sizes | 95% CIs for Effect Sizes |
|---|---|---|---|---|---|
| | | Tibia | | | |
| Medial | | 54.48±3.62 | 53.38±3.03 | 0.85 | [-0.13, 1.77] |
| | Anterior | 54.41±3.35 | 53.09±2.79 | 0.55 | [-0.34, 1.39] |
| | Central | 55.37±6.48 | 55.51±7.02 | -0.07 | [-0.87, 0.74] |
| | Posterior | 53.57±3.27 | 52.03±2.29 | 1.11 | [0.04, 2.12] |
| Lateral | | 51.69±4.92 | 50.51±4.36 | 0.97 | [-0.05, 1.93] |
| | Anterior | 51.82±3.44 | 49.83±2.36 | 1.38 | [0.20, 2.51] |
| | Central | 50.81±6.03 | 50.58±5.93 | 0.17 | [-0.65, 0.97] |
| | Posterior | 53.17±5.63 | 51.49±5.50 | 1.16 | [0.07, 2.20] |
| | | Femur | | | |
| Medial | | 53.48±4.58 | 52.98±3.23 | 0.13 | [-0.68, 0.93] |
| | Anterior | 54.97±5.21 | 52.49±5.29 | 0.45 | [-0.42, 1.27] |
| | Central | 52.40±5.15 | 51.85±4.34 | 0.14 | [-0.68, 0.93] |
| | Posterior | 53.65±4.46 | 54.04±2.95 | -0.10 | [-0.90, 0.71] |
| Lateral | | 51.40±2.96 | 50.60±2.48 | 0.42 | [-0.44, 1.24] |
| | Anterior | 52.91±4.65 | 53.41±3.01 | -0.18 | [-0.98, 0.63] |
| | Central | 51.49±3.06 | 50.43±3.59 | 0.56 | [-0.33, 1.41] |
| | Posterior | 50.77±3.27 | 49.38±2.45 | 0.63 | [-0.28, 1.50] |

* Abbreviation: CIs = Confidence Intervals

# Free Communications, Rapid Fire Presentations: Optimizing the Assessment and Treatment of the Overhead Athlete

Friday, June 28, 2024; 10:25 AM-11:20 AM; Room 260-262
Moderator: Stephen Thomas, PhD, ATC

### The Bilateral Shoulder Range of Motion and Association With Acromio-Humeral Distance in Young Male Volleyball Players

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**Context:** Repetitive overhead movement may modify shoulder macrostructure and potentially result in shoulder instability. While limited internal rotation and increased external rotation have been identified as risk factors of shoulder injury and are widely reported in baseball players, little is known of similar measures in volleyball players. Further, given acromio-humeral distance (AHD) was related to shoulder muscle geometry and strength, this bony measure may partially explain shoulder range of motion (ROM). The aim of this study was to investigate the relationship of acromio-humeral distance (AHD) and shoulder range of motion in adolescent male volleyball players.

**Methods:** This was cross-sectional study in a university laboratory. Twenty young male volleyball players (1.70 ± 0.05m, 61.4 ± 9.0kg, 14.5 ± 0.9yrs) without current upper extremity injury or previous shoulder surgery were recruited. Participants underwent ultrasound imaging of acromio-humeral distance on both sides. Acromio-humeral distance was obtained from infero-lateral edge of acromion to the apex of the greater tubercle in sitting position. Shoulder internal rotation (IR), external rotation (ER), and horizontal adduction (HA) ROM were measured by using standard goniometer in supine positon with shoulder abduction 90 degree. Paired samples t-test were used to compare the differences of all measures between the dominant and the non-dominant side. The Pearson's product-moment correlations were used to analyze the relationship of shoulder ROM and AHD.

**Results:** Dominant side had a greater ER ROM (98.7 ± 9.9° Vs 85.6 ± 7.8°, $p < .001$), lesser IR ROM (29.9 ± 8.1° Vs 40.8 ± 8.8°, $p < .001$), and lesser HA ROM (7.1 ± 3.2° Vs 8.8 ± 3.7°, $p = .023$) than the non-dominant side. There was no significant difference in AHD between dominant and non-dominant side (22.9 ± 3.4 mm Vs 22.5 ± 2.3 mm, $p = .236$). The AHD was significantly negatively correlated with ER ROM ($r = -.572$, $p = .008$), but not correlated with IR ROM ($p = .697$) and HA ROM ($p = .839$) in the dominant side. There were no significant correlations between AHD and shoulder ROM measures in the non-dominant side.

**Conclusions:** Bilateral shoulder asymmetries of ER, IR, and HA ROM were found in adolescent male volleyball players. Further, volleyball players with narrower acromio-humeral distance have greater ER ROM. These findings suggest that shoulder asymmetry of ROM exists in male volleyball players and anatomical measure could impact shoulder function. Future research is required to determine if asymmetrical ROM and narrowing acromio-humeral distance could be risk factors of shoulder injury in young volleyball players.

## A Comparison of Neck Function in Collegiate Volleyball Players and Healthy College Females

Boergers RJ, Monaco JT, Calle K, Lopez G, Rodriguez Cordero Y: Seton Hall University, South Orange, NJ

**Context:** Playing volleyball requires skillful hand-eye coordination, as well as large, coordinated shoulder movements to perform overhead hitting. The neck and shoulder girdle share muscles that are responsible for performing movements associated with volleyball demands. Participation in volleyball may yield functional differences in the neck. The purpose of this study was to evaluate differences in neck strength, range of motion, joint reposition sense and motor control between collegiate women's volleyball players and active healthy college females.

**Methods:** This observational study was performed with 36 female subjects [18 volleyball (VB) (age = 19.9 ± 1.3 yrs); 18 active healthy college females (HCF) (age = 20.1 ± 1.4 yrs)] in a biomechanics lab. Subjects had no previous history of concussion, traumatic brain injury, shoulder injury, or spine injury that they were under treatment for with a medical professional within the last 3 months. We used the NeckCare System (NeckCare, Kopavogur, Iceland) to measure ROM, joint reposition sense, and motor control using the proprietary Butterfly Test. To assess strength, we used a handheld dynamometer (Vald DynaMo, New York, NY). All tests were conducted while seated in a standard chair with a back support. We measured neck ROM (deg) in flexion (FLX), extension (EXT), dominant side (DOM) and nondominant side (NONDOM) rotation (ROT), and R and L lateral flexion (LAT FLX); joint reposition sense (absolute error deg) in FLX, EXT, DOM and NONDOM ROT; neck strength (N) in FLX, EXT, and DOM and DONDOM LAT FLX; motor control via the Butterfly Test which measured Amplitude Accuracy (deg) and Directional Accuracy (%). To assess differences between the volleyball cohort and the healthy college females we used an independent samples t-tests. All alpha levels were set at 0.05 a priori.

**Results:** The VB participants had significantly more ROM in EXT (VB=71.25±13.87; HCF=55.63±9.1 p=0.001), NONDOM ROT (VB=72.28±8.32; HCF=62.83±9.19 ; p=0.003), DOM ROT (VB=73.29±7.47; HCF=63.12±6.89; p=0.001), NONDOM LAT FLX (VB=43.07±6.37; HCF=34.73±5.77; p=0.001), and DOM LAT FLX (VB=44.48±6.50; HCF=35.41±6.07; p=0.001). The VB participants also had significantly greater strength in NONDOM LAT FLX (VB=96.29±2022; HCF=79.81±15.50; p=0.01). There were no differences between groups for joint reposition sense or motor control. Additionally, those measures were similar to normative data provided by the NeckCare System.

**Conclusions:** The increased ROM for VB participants may be due to the ball tracking required to succeed at their sport. The increased strength in NONDOM LAT FLX for VB participants may be the result of the slight side bend and rotation of the head toward the NONDOM side during aiming for overhead hitting. Athletic trainers and strength and conditioning coaches should use these findings to address the demands of volleyball players in the shoulder and neck region.

## Effects of 8-Week Core Exercise Program on Trunk and Lumbopelvic Muscle Function and Baseball Pitching Biomechanics

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**Context:** Based on the evidence linking core muscle function and trunk/pelvis kinematics during baseball pitching to upper extremity injury, injury prevention programs targeting trunk and lumbopelvic muscles are implemented in baseball. However, whether strengthening the muscles improves pitching kinematics or decreases joint loading remains unknown. The purpose of this study was to investigate the effects of an 8-week intervention targeting the trunk and lumbo-pelvic muscles on muscle function and pitching biomechanics in high school baseball pitchers.

**Methods:** Twenty-seven high school baseball pitchers enrolled in the intervention group (INT), and 27 age-matched pitchers enrolled as controls. The group allocation was not randomized. Twenty-three INT pitchers and 25 control pitchers completed pre and post-tests for trunk and lumbopelvic muscle function and pitching biomechanics. The muscle function was assessed using isometric trunk and hip strength, inline-lunge medicine ball toss (test for trunk rotational power), and the Y-balance test. Marker coordinates and estimated segment mass were used to calculate peak trunk rotation velocity, peak elbow varus moment, and peak shoulder internal rotation moment during the pitching motion. High intrasession reliability has been established for all measures (ICC2,k=.837-.985). During the 8-week intervention, all participants continued to participate in their normal baseball team activities, while INT pitchers completed progressive exercises targeting stability, strength, and power of the trunk and lumbopelvic musculature twice a week. The changes (post-pre) in variables were compared between groups using independent t-tests. Correlations between changes in muscle function and pitching biomechanics among the INT pitchers were analyzed using Pearson correlation coefficients ($p<0.05$).

**Results:** The intervention resulted in significant improvements in ball velocity, trunk flexion and rotation strength, hip abduction strength, and inline-lunge toss performance, but no changes in pitching biomechanics (Table). Within the INT group, improved stride leg Y-balance was correlated with increased peak trunk rotation velocity (r=.435, p=.038), and improved trunk extension strength was correlated with increased peak shoulder internal rotation moment (r=.500, p=.015). Increased peak and mean ball velocity were correlated with increased elbow varus (r=.492-.586, p=.003-.017) and shoulder internal rotation (r=.535-.588, p=.003-.009) moments.

**Conclusions:** The intervention significantly improved trunk and lumbopelvic muscle function and ball velocity. Still, its impact on pitching biomechanics may have been obscured by the variability in the changes in pitching biomechanics or the relatively short intervention period. Pitchers who improved the dynamic balance of the stride leg through the intervention increased the peak trunk rotation velocity, possibly due to improved pelvic stability that serves as a base for trunk rotation. The peak joint moments increased in INT pitchers who increased trunk extension strength and ball velocity. Therefore, strengthening the dynamic joint stabilizers to protect the inert tissues may be necessary to counteract the risk of injury as the pitchers increase ball velocity.

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**Table:** Between group comparison of change in variables (means ± standard deviation).

| Variable | Intervention group (n=23) | Control group (n=25) | *p*-value | Effect size (d) † |
|---|---|---|---|---|
| Age (years) | 15.6 ± 1.5 | 16.0 ± 1.1 | .267 | |
| Body mass (kg) | 72.0 ± 14.3 | 76.5 ± 11.2 | .221 | |
| Height (m) | 1.76 ± 0.07 | 1.75 ± 0.12 | .908 | |
| Δ Peak ball velocity (m/s) | 0.86 ± 0.88 | 0.16 ± 0.89 | **.010** | 0.70 |
| Δ Mean ball velocity (m/s) | 0.75 ± 1.07 | -.020 ± 1.02 | **.014** | 0.57 |
| Δ Y-balance composite score (Stance leg) (% leg length) | 12.2 ± 19.5 | 1.11 ± 23.7 | .085 | 0.46 |
| Δ Y-balance composite score (Stride leg) (% leg length) | 9.41 ± 19.8 | 1.68 ± 20.1 | .186 | 0.37 |
| Δ Inline-lunge toss (throwing arm side) (m) | 1.25 ± 0.89 | 0.56 ± 0.89 | **.011** | 0.78 |
| Δ Inline-lunge toss (non-throwing arm side) (m) | 1.33 ± 0.80 | .55 ± 0.83 | **.002** | 0.99 |
| Δ Trunk flexion strength (%Body weight) | 14.0 ± 12.6 | 5.81 ± 13.7 | **.036** | 0.64 |
| Δ Trunk extension strength (%Body weight) | 10.2 ± 13.0 | 3.80 ± 12.1 | .085 | 0.51 |
| Δ Trunk rotation strength (throwing arm side) (N/Body weight) | 12.2 ± 7.62 | 3.54 ± 9.64 | **.001** | 0.95 |
| Δ Trunk rotation strength (non-throwing arm side) (%Body weight) | 12.6 ± 7.96 | 0.86 ± 9.80 | **<.001** | 1.12 |
| Δ Hip abduction strength (throwing arm side) (%Body weight) | 3.24 ± 4.49 | 0.64 ± 3.10 | **.023** | 0.75 |
| Δ Hip abduction strength (non-throwing arm side) (%Body weight) | 3.03 ± 3.92 | -0.17 ± 2.61 | **.002** | 0.96 |
| Δ Peak upper torso rotation velocity (°/s) | 39.8 ± 140.1 | 19.4 ± 111.6 | .578 | 0.14 |
| Δ Peak elbow varus moment (Nm/height/body weight) | 0.24 ± 0.39 | 0.08 ± 0.43 | .170 | 0.22 |
| Δ Peak shoulder internal rotation moment (Nm/height/body weight) | 0.25 ± 0.41 | 0.09 ± 0.42 | .193 | 0.18 |

* All variables met the assumption of normality using the Shapiro-Wilk test. Significant between differences noted in bold font.
† Effect size (d) = Cohen's d x sqrt (1-correlation coefficient).

**Neck Mobility in Healthy College Baseball Pitchers: A Descriptive Analysis**

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**Context:** Emerging evidence suggests that limited neck mobility may contribute to throwing-related arm injury in overhead athletes, but there has been little attention to neck function in baseball research and practice. Pilot data indicates that pitchers have a unique neck mobility profile compared to non-pitchers, and normative values would be useful to clinicians and researchers in interpreting the relevance of limited mobility. The purpose of this study was to describe neck mobility in healthy college baseball pitchers and examine the relationship between preseason neck mobility and injury history. We hypothesized that differences in neck mobility would be observed based on hand dominance, injury history, and pitcher role.

**Methods:** This was a cross-sectional study of 128 healthy college pitchers from 3 teams in the northeast United States and 4 teams in the southeast United States during the 2023 college baseball preseason. Age, height, weight, injury history, and hand dominance were recorded. Neck active range of motion in 3 planes of motion and the cervical flexion rotation test (CFRT) were measured by 2 research teams (1 northeast and 1 southeast). We calculated means and standard deviations for all physical measures. Neck mobility measures were classified as dominant or non-dominant according to pitching arm dominance. We assessed group differences according to hand dominance, prior arm injury, and starter/reliever position using multivariate analysis of variance.

**Results:** Two cases were missing data, so final analysis included 126 pitchers (mean age 20.5 years (1.5), height 73.2 in (2.6), weight 186 lbs, 74% right hand dominant). Neck mobility means were as follows: flexion 61° (9.9°), extension 71° (10.9°), dominant side bend 39° (9.6°), non-dominant side bend 40° (9.7°), dominant neck rotation 75° (7.8°), non-dominant rotation 77° (9.2°), dominant CFRT 54° (12.7°), and non-dominant CFRT 53° (13.5°). Right-handed pitchers had 5° less motion on the non-dominant CFRT as compared to left-handed pitchers (p=.03), and pitchers with a history of throwing-related arm injury had 4° less non-dominant neck rotation (p=.02) than pitchers without an injury history.

**Conclusions:** This study reports mean neck mobility measures for a sample of healthy college baseball pitchers. Mean measures were consistent with prior literature with the exception of a greater dominant and non-dominant CFRT. Differences in neck mobility were observed by hand dominance and injury history. Differences were small in magnitude, but in performing a complex biomechanical task like pitching, small limitations in neck rotation that alter pitching mechanics may be clinically relevant.

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## Comparing Clinical and Biomechanical Variables Based on KJOC Scores in High School and College Baseball Pitchers

Ide T, Rosen AB, Knarr BA, Wilkins SJ: University of Nebraska at Omaha, Omaha, NE

**Context:** Kerlan-Jobe Orthopaedic Clinic (KJOC) score is a valid tool to assess the functional status of overhead-athletes, but it's unknown how pitching biomechanics and shoulder characteristics would differ between pitchers with higher scores in KJOC scores and those who report lower KJOC scores. We aimed to investigate differences in kinematics and kinetics of the throwing shoulder and elbow while pitching as well as shoulder range of motion and strength ratio.

**Methods:** Cross-sectional design. We implemented clinical and biomechanical assessments for high school and college baseball pitchers from October 2022 to June 2023 in our pitching laboratory through convenience sampling. Cutoff score was set at 87 for KJOC scores to divide participants into 2 groups, high KJOC score group (HKJOC) and low KJOC score (LKJOC) group. Pitchers started with clinical assessments, including self-reported questionnaire by KJOC and shoulder range of motion and shoulder strength, followed by a 3-dimensional pitching motion analysis. Shoulder range of motion were measured using a standard goniometer with 2 certified athletic trainers, and shoulder strength was assessed by isokinetic dynamometer (Biodex Medical System, Inc., Shirley, NY). We used a 20-camera system for motion analysis (Qualisys AB, Göteborg, Sweden,) and 3 force plates (Bertec, Columbus, OH) embedded into a custom pitching mound. Independent t-tests were performed to compare the means of each key variable of pitching biomechanics and shoulder characteristics with an alpha level set at 0.05.

**Results:** A total of 47 pitchers participated in the study, with 28 pitchers scoring ≧87 on the KJOC (HKJOC- age: 18.7±2.6 years, height: 180.0±15.7cm, weight: 84.8±8.9kg), and 19 pitchers scoring <87 (LKJOC- age: 21.4±1.9 years, height: 186.6±5.8cm, weight: 93.2±9.2kg). Significant differences were found in elbow flexion torque (HKJOC: -49.1±5.2Nm, LKJOC: -69.62±2.2Nm, p<.001), total arc of the shoulder (HKJOC:169.3±11.9°, LKJOC: 162.0±15.2°p=.036), trunk rotation velocity (HKJOC: 1055.4±92.1°/s, LKJOC: 1110.3±106.4°/s, p=.033), and shoulder strength ratio between external/internal ratio (HKJOC: 60.9±6.9, LKJOC: 66.3±9.3, p=.015). There was a trend but not significant difference in elbow valgus torque (p=.054), shoulder internal rotation velocity (p=.077), and ball velocity (p=0.76). There was no significant difference in shoulder distraction force.

**Conclusions:** These findings indicate pitchers with lower KJOC scores may present with greater elbow extension torque, weak shoulder internal rotation relative to external rotation, and limited total arc of the shoulder. These findings may result in increased stress on various tissues in the throwing arm, potentially leading to increased risk of injury to the shoulder or elbow. Athletic trainers should consider further evaluation of clinical (ie: shoulder range of motion and strength) and pitching biomechanics in pitchers with lower KJOC scores.

Data collected for this study was provided in part by Graduate Student Research and Creative Activity Fund at the the University of Nebraska at Omaha through the Office of Research and Creative Activity.

## Infraspinatus Atrophy Due to Suprascapular Cyst in Elite Men's Volleyball Athlete

Zerbe JN, Smith BI: University of South Carolina, Columbia, SC, and The Pennsylvania State University, State College, PA

**Background:** Suprascapular neuropathy accounts for only 1%-2% of all causes of shoulder pain and may stem from space occupying lesions at the spinoglenoid notch. Atrophy of both the supraspinatus and infraspinatus indicates a more proximal compression of at the suprascapular notch and is even less common. The history and clinical evaluation are almost never revealing because clinical presentation of the suprascapular neuropathy often mimics other more common shoulder pathologies. Other shoulder pathologies are known to exist in conjunction with suprascapular neuropathy such as rotator cuff injuries, scapular dyskinesis, and subacromial impingement.
**Patient:** A 20-year-old, male, international volleyball athlete reported to the athletic trainer with a complaint of right shoulder pain during a volleyball match. The patient denied a particular mechanism that caused the initial pain. Upon observation, the patient presented with forward head posture, and an elevated and protracted shoulder. He was tender to palpation over the long head of the biceps brachii tendon, as well as the infraspinatus muscle belly.
**Intervention & Treatment:** Initial treatment consisted of modalities targeting pain relief, and manual therapy to address pain and muscle spasms. The use of NSIAD medication was also incorporated. Strengthening exercises were directed towards the biceps tendon and scapular stabilizers. After four weeks of conservative treatments, the patient demonstrated continued weakness and after referral, the team physician obtained an MRI showing a cyst impinging on the suprascapular nerve at the suprascapular notch with subsequent infra- and supraspinatus atrophy. The patient chose arthroscopic suprascapular nerve decompression/excision of the cyst at home in Poland. The surgery and initial rehabilitation occurred over summer break. Details regarding the surgery were severely limited due to the correspondence being impaired relative to language, system, and distance complexities as well as incomplete records. The initial rehabilitation during the patient's acute stage of healing primarily involved 3 weeks of rest in a postoperative sling, followed by ROM exercises. Strengthening exercises utilizing resistance bands were also incorporated during the sub-acute phase.
**Outcomes or Other Comparisons:** The patient completed a return to hitting program in 8 weeks (21 weeks post-surgery). Examination by the team surgeon confirmed adequate scapular control. Although strength subjectively improved, infraspinatus muscle size stayed the same. It was noted that muscle atrophy will likely remain present throughout the duration of the patient's college career. The patient was returned to full participation following the completion of the hitting program and physician clearance. The physician stressed the importance of communication if feeling pain during activity.
**Conclusions:** The case presented reflects the literature surrounding rehabilitation postoperatively, however, the use and timeframe of a sling differs. Patients are typically instructed to wear a sling for the first 48 to 72 hours for comfort, but not for structural reasons. It is suggested that the use of a simple sling until full ROM is achieved. In comparison to the presented case, the patient was instructed to wear a simple sling for 3 weeks. The international nature of this case may have contributed to this unique approach. Little is known of the initial phases of rehabilitation due to incomplete records and information transferred from another country.
**Clinical Bottom Line:** As suprascapular neuropathies are more common in overhead athletes, ATs and other rehabilitation-based clinicians should be cognizant of this differential diagnosis as a source of pain and dysfunction. As this diagnosis can be overlooked, a differential diagnosis such as subacromial impingement, rotator cuff injury, cervical radiculopathy, brachial plexopathy, or unexplained shoulder pain, a suprascapular nerve injury must be considered. A thorough physical examination, specifically observing rotator cuff atrophy will be key to a correct diagnosis. Addressing comorbidities, especially those involving scapular mechanics, is an important rehabilitation goal. Doing so will prevent misdiagnosis and mismanagement of injuries.

# Free Communications, Rapid Fire Presentations: Understanding the Complexities of the Lower Extremity: A Case Study Session

Friday, June 28, 2024; 12:15 PM-1:10 PM; Room 260-262
Moderator: Patrick McKeon, PhD, ATC, CSCS

## Achilles Tendon Rupture in an International Collegiate Long Jumper: Type 3 CASE Study

Wagoner M, Moffit DM, Judge K, Pook M: Idaho State University, Pocatello, ID, and University of Arkansas, Fayetteville, AR

**Background:** Many serious track injuries are due to ignoring initial signs/symptoms of injury, as with Achilles tendon ruptures. An international student-athlete whose second language is English was unable to articulate concerns, leading to a worse-case scenario. In this case, the athlete was unable to fully articulate her concerns, as well as completing the acute stage of rehabilitation in her home country, creating a unique situation due to rehabilitation in both Spain and the U.S.
**Patient:** A 19-year-old female athlete practicing long jump on a wooden indoor track surface felt a sharp pain during the approach sprint, causing her to fall to the ground. Initial evaluation revealed obvious deformity at the right Achilles tendon. No previous history of Achilles problems was reported.
**Intervention & Treatment:** Immediately post-injury evaluation, ice was applied to the area for pain management. She was placed in a boot and provided a scooter for safety. Diagnostic ultrasound confirmed a 3- to- 4-inch full-thickness Achilles tendon rupture. Surgery occurred three days post-injury. The tendon was repaired using cadaveric Achilles tendon graft with Ethibond suture. No surgical complications were reported. Initial rehabilitation outlined goals (Table 1). Weight-bearing progression began in the boot, gradually advancing to full weight-bearing. Strength, manual therapies, ROM, and functional mobility were initiated prior to summer break in Spain, with instructions for doctor follow-up in August. Spain: Physiotherapy notes reported lack of strength, hypotonia, and tightness in the gastrocnemius and soleus muscles. Rehabilitation techniques included manual therapy, Indiba (not approved in the U.S.), osteoarticular and scar treatments, stretching, and localized heat. Return to Play: Sport-specific work commenced upon her return to the U.S., progressing from jogging to hopping, into speed build-ups. At 7-to-8-months, pain was experienced during acceleration; once getting to speed, pain was negligible. Ankle mobilization, paired with eccentric exercise resulted in improvement ROM and strength. Months 8 to 9, she began working on her stride and form. To address foot speed and running form, dribble drills were beneficial to practice foot contact while sprinting. The patient was released at 39 weeks post-surgery. After review of the risks of return to activity, the patient chose to continue high-level athletic competition. She expressed being nervous, but competed during the 2023 indoor track and field season.
**Outcomes or Other Comparisons:** No serious complications occurred during rehabilitation. Mental health and understanding pain were a concern. She had difficulty maintaining a good attitude about recovery, having never sustained a serious injury. Much of the pain and feelings were difficult for her to articulate, especially deciphering between pain and soreness as she was returning to full participation. Educating her on differences between soreness and types of pain was integral to recovery.
**Conclusions:** The athlete's age (<40 years) and mechanism were unusual. The injury occurred during her sprint approach on a controlled flat surface rather than initial take-off or landing into the pit. As an international student the patient received rehabilitation methods unfamiliar to U.S. practitioners. Clinical Bottom Line: Clinicians need to understand the importance of athlete education, the necessity of being able to be part of a sports medicine team, and the importance of language differences. Working as a team, the collaboration among the doctor, physiotherapist, and athletic trainer was evident. Non-native speakers need to be able to communicate in their native language to express their emotions and concerns; interpreters need to be utilized.

**Table 1. Rehabilitation Goals**

| Short-Term | Long-Term |
|---|---|
| 65 on lower extremity functional scale (LEFS; initial score 43/80) | 80 on LEFS |
| Ambulate stairs, pain no greater than 2/10 | Ambulate stairs pain-free |
| Walking 20 minutes with pain no greater than 2/10 | Walk 20 minutes pain-free |
| Understand/independence with home exercise program | Gain 15 degrees of dorsiflexion |
| 4+/5 in ankle flexor/extensor groups | 5/5 strength in tested muscle groups |

## Atypical Return-to-Play With a Grade 1 Tibial Tubercle Avulsion Fracture: Level 2 Case Study

Calzadilla C, Stewart J, Williams A: Florida International University, Miami, FL

**Background:** This was a level 2 case study focused on the treatment and rehabilitation process of a Grade 1 Tibial Tubercle Avulsion Fracture in a 15-year-old male basketball player, a common injury among adolescent athletes aged 14 to 17. It results from a tensile force during extension and often affects those with a history of Osgood-Schlatter disease, making up 3% of proximal tibial fractures.
**Patient:** A 15-year-old male basketball player went for a rebound during a basketball game and landed lumbering in pain in his right knee. There were no preexisting knee issues and the patient exhibited an antalgic gait. On initial assessment, the patient complained of pain and weakness in his anterior knee, was tender to palpation on the tibial tubercle, experienced pain at terminal knee flexion during AROM and PROM, preformed a 3/5 knee extension MMT, and exhibited pain with a ¾ single leg squat. Valgus, varus, patella apprehension, and grind test were negative. The patient was referred for an X-ray and diagnosed with a grade 1 tibial tubercle avulsion fracture.
**Intervention & Treatment:** The patient was initially immobilized in a knee brace locked in full extension for two weeks. At his two-week follow-up, an X-ray resulted in a grade 1 tibial tubercle avulsion fracture to the right knee and the knee immobilizer was discontinued. For a surgical intervention to be implemented, the avulsion fracture would be at a grade 2 or 3. With that being said, a conservative protocol was elected, implementing a 6-phase, 24-week time frame. Phase I, weeks 0-4, the protocol included no ROM, a knee immobilizer locked in extension, and strengthening of the quadriceps, glutes, and ankle. Phase II, weeks 4-6, the patient is weight bearing as tolerated with crutches and starts progressing through PROM and AAROM while strengthening straight leg raises abduction, extension, and flexion. Phase III, weeks 6-8, the patient begins light closed chain strengthening. Phase IV, weeks 8-12, the patient can begin stationary cycling and open chain isotonic exercises. Phase V, weeks 12-16, the patient can begin straight-line jogging. Phase VI, weeks 16-24, the patient can RTP after meeting the discharge criteria. Discharge criteria includes full ROM, no effusion, no TTP, satisfactory strength test and sport specific agility program, and physician approval. At four weeks, patient goals were hip strengthening, quadricep flexibility, 4-way clam shells, proprioception training, balance training, and beginning sports-specific shooting and dribbling. After 7.5 weeks the patient was cleared to RTP.
**Outcomes or Other Comparisons:** In relation to literature, the patients age, sport, and mechanism of injury was as expected. However, the typical RTP ranges from 16 to 24 weeks and this athlete RTP was 7.5 weeks. During phase I the patient should have been immobilized for 4 weeks but, the knee immobilizer was discontinued after 2 weeks. During phase II the patient should have been weight bearing as tolerated with crutches progressing to AAROM and RROM, but the patient began sports-specific shooting and dribbling. During phase III the patient should have begun light closed chain strengthening but the patient was cleared to RTP. Remarkably, the patient fully recovered and RTP was 7.5 weeks.
**Conclusions:** The challenge associated with this case was aligning the clinician's protocol with current evidence-based protocol associated with grade 1 tibial tubercle fractures. Though typical protocols have pediatric aged athletes RTP at 16 weeks from initial grade 1 tibial tubercle avulsion fractures there is a potential to RTP at 7.5 weeks.
**Clinical Bottom Line:** Clinicians should be aware that while there may be deviations to a conservative protocol, recovery time may be accelerated individualized case by case bases.

**Stener-Like Lesion of the Superficial Medial Collateral Ligament With Associated Anterior Cruciate Ligament Tear of the Knee Following a High-Grade Pivot-Shift Mechanism in a High School Football Athlete: A Case Report**

Freer S, Herrera M: Palmer Trinity School, Miami, FL, and Miami Institute for Joint Reconstruction, Miami, FL

**Background:** A 15-year-old high school football lineman sustained a high-grade pivot-shift mechanism following an opposing lineman falling on the lateral aspect of his (L) knee. During the initial on the field examination, the athlete complained of 8/10 pain with significant tenderness to medial and lateral femoral condyles, medial and lateral tibial plateaus, and medial and lateral joint lines. The Lachman's stress test noted significant anterior translation of approximately 15mm. Additional orthopedic stress tests or range of motion assessment were not performed due to pain. No related previous medical history.

**Differential Diagnosis:** Anterior cruciate ligament tear, medial meniscus tear, lateral meniscus tear, lateral femoral condyle contusion, posterior cruciate ligament tear.

**Intervention & Treatment:** The patient was further examined by a team orthopedic physician on the sideline confirming significant laxity to the anterior cruciate ligament. No other orthopedic stress tests were performed due to pain. Initial treatment consisted of cryotherapy, elastic wrap, crutches, and over-the-counter non-steroidal anti-inflammatory medication. Magnetic resonance imaging (MRI) radiology the following day revealed full-thickness tear of the anterior cruciate ligament (ACL), intermediate-grade of sprain of the posterior cruciate ligament (PCL), high-grade partial tear of the medial collateral ligament (MCL) at the tibia with avulsed fracture fragment, complete rupture of patellar retinaculum, complete rupture of the medial patellofemoral ligament (MPFL) proximally, marrow edema contusion of the mid anterior femoral condyle and anterior and posterolateral tibial plateau compatible with pivot-shift mechanism, subcortical microtrabecular fracture along lateral femoral condyle, small tear of posterior horn of lateral meniscus, low-grade sprains of the lateral collateral ligament (LCL) and popliteus tendon and moderate-to-large joint effusion. Surgical reconstruction of the ACL and refixation of the superficial MCL (sMCL) was performed approximately two weeks post initial injury. The surgeon decided to delay repair of the MPFL until a later date. At the time of this abstract, the patient is within their first month of outpatient physical therapy. A gradual return to sport specific activity is expected to begin approximately postoperative month six following completion of a functional sports assessment.

**Uniqueness:** Combined injuries of the ACL and the MCL complex represent the most common combined ligamentous injuries of the knee joint.1 The sMCL is the main knee stabilizer against valgus stress and serves as a secondary restraint under rotational trauma.2 Therefore, the sMCL is more susceptible to acute injuries after a valgus force, with or without a rotatory load as seen in combination with ACL tears. The most common portion involves the proximal femoral attachment or the midsubstance portion of the sMCL and is typically treated nonoperatively. However, sMCL injuries involving the distal tibial insertion are seen less frequently, in approximately 5% to 19% of cases, and are commonly referred to as a stener-like lesion.3 First reported over 3 decades ago, a stener-like lesion of the sMCL is a rare injury of the knee that is described as "wave sign" on MRI findings4,5 and represents a distal avulsion of the sMCL, with inter-position of the pes anserinus between the ligament and its tibial insertion inhibiting anatomic healing of the lesion.3 Surgical refixation is indicated in a SLL of the sMCL to restore anatomy and aid in ligamentous healing.3,6

**Conclusions:** Knowledge of the rare sMCL tibial avulsion, known as stener-like lesions, in patients with acute injuries after a valgus force, with or without a rotatory load is necessary to avoid overlooking and late diagnosis.

## Enchondroma in a Collegiate Division II Women's Acrobatics and Tumbling Athlete: A Level 4 CASE Study

Minter RL, Lopez RM, Myers J, Tritsch AJ: University of South Florida, Tampa, FL, and Saint Leo University, St Leo, FL

**Background:** A 19-year-old female acrobatics and tumbling athlete presented with shooting pain (pain scale: 7/10) in her right thigh that moved from knee to hip when dismounting acrobatic lifts. Tumbling was not painful. The patient reported no mechanism of injury and noted feeling a similar but less severe pain within the past year. Upon evaluation by an athletic trainer, the patient was tender to palpate over the distal vastus lateralis and iliotibial band but also described a deep pain in the anterolateral thigh. Flexion and extension range of motion of the knee and hip were normal. Manual muscle tests for hip flexion, extension, internal rotation, external rotation, and adduction were all 5/5. The manual muscle test for hip abduction was 5/5 but painful. Varus and valgus stress test, Lachman test, posterior drawer test of the knee, hip scouring, FADIR, and FABER special tests were negative. Cupping and massage were performed on the anterolateral thigh, and a compression wrap was applied for practice the next day. Upon re-evaluation, fulcrum test was positive on the right femur. The patient was referred to a physician for further evaluation 2 days after the athletic trainer's initial evaluation.
**Differential Diagnosis:** Iliotibial band syndrome, femoral stress fracture, femoral fracture, quadriceps or tensor fascia latae strain, enchondroma, tumor.
**Intervention & Treatment:** The patient was removed from impact activities for a total of 10 days. The physician ordered radiographs, which ruled out an acute femoral fracture and soft tissue abnormality but showed a 9mm benign-appearing lytic lesion in the proximal femoral diaphysis indicative of an osteoid osteoma. Radiography also revealed an incomplete ossification of the right anterior iliac crest and ischial tuberosity, which was considered normal for the patient's age. CT scan of the right hip and proximal femur conducted 11 days post-evaluation revealed an 8x11x12mm cortical-based lytic lesion in the proximal right femoral metadiaphysis with minimally sclerotic margins and curvilinear central calcifications, which indicated an enchondroma. MRI confirmed a 12mm cortical-based lesion in the proximal femoral metadiaphysis and the absence of a fracture or soft tissue injury. The patient was diagnosed with a 12mm enchondroma of the right femur and was cleared to return to sport as tolerated. The physician recommended an oncology referral if the pain continued or worsened. The patient reported no pain after resting from impact activities and consistent therapeutic exercise. After 10 days of limited activity, the patient successfully performed and progressed the intensity of impact skills (i.e., hops, tumbling) based on pain tolerance over a period of 3 days. For the remaining 4 weeks of the acrobatics and tumbling season, the patient reported no pain with continued self-monitoring, completing maintenance rehabilitation at least once per week, and limiting impact repetitions. Eight months following the initial presentation, the patient is not experiencing pain.
**Uniqueness:** Enchondromas are benign tumors that normally occur in middle-aged adults and are usually asymptomatic. This case is unique due to the location of the enchondroma, as they are typically found in the long bones of the hands and feet. Only about 0.7% of incidental enchondromas occur in the proximal femur. The patient in this case experienced performance-limiting pain due to the lesion in her proximal femur, which is another rare finding for this condition.
**Conclusions:** Athletic trainers should be aware of atypical conditions of the bones or other deep structures, as they may present similarly to fractures or soft tissue injuries. Referral for further evaluation and diagnostic imaging is the best method to determine the correct diagnosis and the severity of the injury and dictate the most appropriate treatment for the patient. Further referral is warranted if the patient does not respond to the treatment plan.

## Diagnosis and Management of Femoral Stress Fracture in an NCAA Division I Football Athlete: A Level 3 Case Study

Fiankan A, Pollard-McGrandy AM, Funte J, Roskelly J, Scott R, Belhomme T, Covassin T: Michigan State University, East Lansing, MI

**Background:** Femoral shaft stress fractures are uncommon and account for approximately 2.8 -7% of all sport related fractures. However, when they do occur, it is typically at the proximal 3rd of the femur. Femoral stress fractures are commonly mistaken for a quad contusion as the presenting signs and symptoms for both injuries can present similarly. A femoral stress fracture diagnosis is often delayed due to the injury being associated with anterior thigh pain, indicating muscular or tendon injuries. Moreover, injuries to the femoral diaphysis occur very infrequently making this injury difficult to diagnosis. The purpose of this case study is to describe a femoral stress fracture in a Division I football athlete.

**Patient:** A 21-year-old male, junior, Division I collegiate football player, presented with positive indications for a quad contusion. The initial mechanism of injury was a helmet to the quad followed by a snap during back pedaling formation. The athlete exhibited swelling to the medial belly of the quadriceps, tender to palpate (TTP), and experienced difficulty performing a back pedal. The initial evaluation performed by the athletic trainer (AT) indicated a diagnosis of a quad contusion, as the athlete complained of quad pain in the muscle belly along with hip flexor tightness. The athlete was previously treated for bilateral patellar tendonitis. Three and a half weeks post initial quad contusion diagnosis, the athlete was administered a dual x-ray absorptiometry (DEXA) scan, which indicated the athlete had a femoral stress fracture.

**Intervention & Treatment:** September 9, 2023, was the initial evaluation of athlete complaining of quad pain along with hip flexor tightness resulting in blood flow restriction (BFR) treatment. Second evaluation on September 11,2023, revealed TTP on the medial belly of the quad, with equal strength bilaterally upon initial evaluation. The treatment plan started as a quad contusion incorporating seated long arc quads with BFR, non-weightbearing internal and external rotations, Keiser terminal knee extension, isometric holds, and hamstring curls. September 17,2023, during the third evaluation symptoms had not subsided therefore an MRI was performed. Imaging revealed femoral shaft stress fracture. Following imaging results the athlete was non-weightbearing for 3 weeks. The athlete is back to running and functional activities.

**Outcomes or Other Comparisons:** A quad contusion commonly occurs with a direct impact or trauma to the quadriceps muscles on the anterior aspect of the thigh. The clinical presentation includes mild discomfort to severe pain during active range of motion, inflammation of the muscle belly, and difficulty weight bearing. Whereas a femoral stress fracture typically presents with symptoms that develop gradually over time due to repetitive, high impact motion. With similar symptoms to a quad contusion, a diagnosis can only be determined with an MRI.

**Conclusions:** Femoral stress fractures and quadriceps contusions can exhibit similar symptoms such as pain, swelling, and issues weight bearing. Both injuries commonly occur in athletes, particularly runners or those involved in high-impact activities. Symptoms of a femoral stress fracture can overlap with the symptoms of a quadriceps contusion such as pain and difficulty weight-bearing. These similarities can cause confusion in diagnosis without proper medical evaluation or imaging techniques. Furthermore, the proximity of the femoral bone to the quadriceps muscle often leads to misdiagnosis. Thus, without detailed examination and diagnostic imaging such as bone scan, DEXA or MRI, distinguishing between the two injuries can be challenging.

**Clinical Bottom Line:** Early diagnosis and treatment are essential for femoral stress fractures in younger patients, as there can be complications such as displacement, non-union, and vascular necrosis of the femoral head. Future research is required to explore better femoral stress fracture diagnosis methods.

## Knee Dislocation Resulting in ACL, PCL, and LCL Tear and Peroneal Neuropraxia in a Minor League Baseball Player: Type 3 CASE Study

Berry HE, Mast KE, Martin BM, Vidal AF: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** Knee dislocation(KD) can be defined as "complete disruption of the integrity of the tibiofemoral articulation." These often result in multi-ligament injuries1 which is the disruption of 2 or more of the major ligaments in the knee.6 KD are found to make up 0.02%-0.2% of orthopedic injuries.2 Posterior dislocations are the most common KD. Vascular injuries are reported in 18% and peroneal nerve injuries are reported in 25% of KD. Damage to the peroneal nerve causes loss of sensation to the anterior and dorsal portions of the lower leg and motor function to dorsiflex the foot. These occurred most often with a bicruciate and LCL injury(32%) and posterior KD(25%) due to the popliteal artery and peroneal nerve traveling through the popliteal fossa.2 This type 3 CASE study describes a posterior KD that develops a foot drop and is treated with staged procedures.

**Patient:** 24-year-old male minor league baseball player reported 11-days after right KD occurring during a game while hopping over the baseline. He reported no previous right knee history. Initial physical examination by ATC revealed positive Lachman, anterior and posterior drawer testing, laxity with varus stress testing, and a positive dial test. Patient reported decreased sensation in the peroneal nerve distribution. Radiographs showed no acute fracture. MRI showed disruption of the ACL and PCL, complete tear of the LCL, biceps femoris retraction, grade 1 sprain of the MCL, and mild increased signal in the peroneal nerve.

**Intervention & Treatment:** Initial staged procedure included right open peroneal nerve neurolysis, open biceps femoris repair, lateral meniscus repair, LCL reconstruction, posterolateral corner reconstruction, and intraoperative nerve stimulation. Following the first procedure, he had increased sensation in his lower leg but lacked active dorsiflexion so he was placed in an ankle-foot orthosis. Seven weeks status-post he underwent arthroscopy, ACL reconstruction with bone-tendon-bone autograft, PCL repair with internal brace, and platelet-rich-plasma injection. His procedures were staged due to sufficient ROM being necessary for a successful ACL reconstruction. This presentation of a multi-ligament injury presents with disruption of both cruciate ligaments and 1 of the lateral stabilizers being disrupted is commonly seen in KD. It's estimated that out of all knee dislocations 79-87% of the time there is a PCL injury. Vascular injuries associated with knee dislocations are reported to be around 18%.2 While nerve injuries are found in 25% of KD.2 It was found that peroneal nerve injuries are more likely to occur with a PCL injury.4

**Outcomes or Other Comparisons:** Peroneal neurolysis is a recommended procedure during the early stages of ligament reconstruction.5 The literature found 88% of patients who underwent a neurolysis had favorable outcomes. This patient underwent a neurolysis in the initial staged procedure and had improvements with his peroneal nerve functioning. His ROM and sensation improved. Staged procedures allowed the patient's PCL to scar down and the second procedure to be less invasive. The patient will continue physical therapy and be evaluated regularly in the coming weeks and months to monitor progress.

**Conclusions:** It's debated if surgical intervention of multi-ligament knee injuries should be staged. Staged procedures often are decided against due to neurovascular or soft tissue injuries.7 Benefits of a staged procedure are less operative time and reduced risk of arthrofibrosis, where single procedure benefits are a reduced recovery time due to 1 operation.1

**Clinical Bottom Line:** Athletic trainers rarely see KD but will typically be the first to evaluate in sport settings. When they do occur, many things should be considered such as the recovery timeline, adherence to rehabilitation process as well as how they are mentally and emotionally able to handle staged or not staged procedures.

## Management of an Acetabular Fracture and Associated Labral Tear in a Division I Collegiate Track and Field Athlete

Fitzpatrick SF, Pasque CB: University of Oklahoma, Norman, OK, and University of Oklahoma College of Medicine, Oklahoma City, OK

**Background:** A 21-year-old Division I Track and Field Athlete fell during a set of hurdle drills when his trail leg struck the hurdle. He attempted to finish the workout but noticed pain in his anterior hip over his hip flexor tendons that would not allow him to continue. He had mild pain with the FABER test and was able to actively flex his hip to 100 degrees without pain. His internal and external rotation range of motion was 35 degrees and 45 degrees respectively. At this time, the athletic training staff opted to have him utilize a set of crutches and referred him for hip X-Rays and follow up with a team orthopedic physician.
**Differential Diagnosis:** Hip contusion, hip flexor strain, labral pathology, hip impingement.
**Intervention & Treatment:** Initial X-Rays of the hip were normal, only showing a slight pincer impingement. The athlete was referred to the team orthopedic physician a week later where he was diagnosed with a hip flexor strain and hip contusion with a low chance of intraarticular pathology. He would be allowed to return to low impact activities over the next two to four weeks and would follow up with the team physician if he was not improving. He was also given naproxen sodium BID for two weeks. The athlete's symptoms were steadily improving after his initial follow-up, but his pain shifted to the posterolateral hip. He was placed on a Medrol dose pack and told to work on additional hip range of motion and hurdle drills. The plan at this time was to continue his return to play and follow-up in an additional four to six weeks. On his subsequent follow-up, an MRI Arthrogram was ordered due to ongoing symptoms and pain in the proximal glute and groin. The MRA revealed a mildly displaced fracture of the posterior rim of the left acetabulum, osteochondral fractures off the central and superior femoral head, bone marrow edema in the femoral neck, a 1.3cm osteochondral loose body in the anterior joint, high-grade cartilage loss on the superior acetabulum, and a detached tear through the superior and anterior labrum extending posterior to the fracture. At this time, it was recommended that he undergo a left hip arthroscopy, debridement, and potential labral repair. Following a successful surgery, he utilized crutches for five weeks and he began rehabilitation focusing on gentle range of motion. After his next follow-up, he was allowed to utilize the stationary bike in an elevated seat position. About 3-months post-surgery, the athlete started a return to running program with an emphasis on hip strengthening in the weight room. He successfully returned to training with the team in the Fall following his surgery.
**Uniqueness:** This type of injury is generally seen in high velocity incidents like motor vehicle accidents and falls from substantial height. Even following the injury, the athlete was surprised he injured his trail leg and not his lead leg. This injury was likely a mix of a chronic or pre-existing condition to his hip combined with a traumatic injury.
**Conclusions:** While initial X-Rays were negative in this case, the incidence of hip labral pathology in Division I collegiate athletes is well known, and the risk of hip impingement is relatively high. Despite the injury being a relatively slow velocity fall, the injury was much more traumatic in nature.

# Free Communications, Rapid Fire Presentations: After the Return: Beyond Clinical Recovery From Concussion

Friday, June 28, 2024; 1:40 PM-2:35 PM; Room 260-262

Moderator: Landon Lempke, PhD, ATC

### Concussion Alters Lower Extremity Muscle Activity During Static Balance Assessments

Wood TA, Grahovec NE, Hill CM: Northern Illinois University, DeKalb, IL

**Context:** Concussions create long-lasting health consequences, such as movement dysfunction, osteoarthritis, and physical disability. We hypothesize these negative health consequences may result from concussion-related neuromotor alterations. Our study aimed to examine group differences in lower extremity muscle activity during static balance tasks between individuals who sustained a concussion 3-18 months prior to testing and healthy controls.

**Methods:** We employed a cohort study at a university research laboratory utilizing a convenience sample of 60 young participants (18-35 years). Thirty-two participants who sustained a concussion (injured 6.5±0.6 months prior to testing; 18 males, 14 females) and 28 healthy controls (13 males, 15 females) took part in the study. Wireless EMG sensors (Delsys Inc, Natick MA) were affixed to the right vastus medialis (RVM), semitendinosus (RST), medial gastrocnemius (RGM), and tibialis anterior (RTA). Participants completed 4 120-second static balance trials under the following conditions: 1) Eyes Open Single Task (EO), 2) Eyes Closed Single Task (EC), 3) Eyes Open Dual Task (EODT), 4) Eyes Closed Dual Task (ECDT). Dual task testing was done with the serial 7s cognitive test. A custom MatLab code filtered and rectified the raw EMG data and calculated mean amplitude for the first 30 seconds and the full 120 seconds. A linear mixed model was used to determine differences in muscle activity, with Group (Concussed, Control), Duration (30s, 120s), Muscle (RVM, RST, RTA, RGM), and Task (EO, EC, EODT, ECDT) held as fixed effects and participants as random effects. Post-hoc analyses were performed with a Sidak correction. All statistical analysis was conducted in SPSS v28 (IBM Corp., Armonk, NY, USA) with an a-priori alpha of $< 0.05$.

**Results:** A significant Group x Muscle interaction was found ($F(3,1798)=3.397$, $p=0.017$), with Concussed participants displaying higher RTA muscle activity compared to Control [MD: 0.12, $p=0.037$, 95%CIs=0.001-0.023]. A significant Group x Task interaction was found ($F(3,1798)=3.315$, $p=0.019$) with Concussed participants displayed greater muscle activity during EC compared to EODT [MD: 0.009, $p=0.041$, 95%CIs=0.000-0.017]. Similarly, EO had greater muscle activity compared to EODT [MD: 0.010, $p=0.006$, 95%CIs=0.002-0.019]. No significant differences in Task were found for Control. A significant Duration x Muscle interaction was found ($F(3,1798)=6.463$, $p < 0.001$), where all muscles demonstrated lower EMG amplitude during over 120 seconds compared to the first 30 seconds ($p < 0.001$).

**Conclusions:** Concussed individuals had greater muscle activity during static balance tasks, indicating greater neuromuscular activity to maintain postural stability, compared to healthy controls. Altered neuromuscular activity may be a direct result of concussion and the mechanism underlying concussion-related movement dysfunction. More research is needed to understand concussion's effects on muscular output and how it alters movement. Clinicians should be aware that concussions may produce neuromuscular alterations, identify concussion-related movement deficits, and apply appropriate interventions to prevent future injury and disability.

Northern Illinois University Research and Artistry Opportunity Award (RA21-0021).

**Prospective Associations of Sport-Related Concussion History and Virtual Reality Metrics With Core or Lower Extremity Sprain or Strain Among High School Athletes**

Carlson LM, Wilkerson GB, Acocello SN, Wynn KR, Dill PW: The University of Tennessee at Chattanooga, Chattanooga, TN

**Context:** A history of sport-related concussion (HxC) is a recognizable risk factor for musculoskeletal injury, additional concussions, and brain function impairment. Dual-task protocols that require engagement of cognitive and motor processes have been increasingly advocated for post-concussion assessment of performance capabilities. However, many dual-task clinical tests are not sensitive in detecting subtle impairments in perceptual-motor performance. While clinical tests mainly use simple motor responses, virtual reality (VR) measurements can detect subtle impairments that increase injury risk. There is a need for a clinical test that can identify individual athletes who possess elevated risk for further injury. Previous studies link HxC to musculoskeletal injuries in high school athletes, but limited research focuses on perceptual-motor deficits in adolescent athletes. Thus, the purpose of this study was to investigate if HxC and VR perceptual-motor performance are prospectively associated with core or lower extremity sprains or strains in high school athletes.

**Methods:** We studied 68 adolescent athletes (41 female soccer, 27 male football) from two private high schools with guardian consent. Exclusion criterion included an injury that prevented VR testing. Prior to the first pre-season practice, we administered an electronic survey and measured eye, neck, arm, and whole-body movements during 40 successive lunging / reaching responses to moving visual stimuli presented on an immersive VR headset. Perceptual latency (PL) was the time from stimulus appearance to the start of neck rotation (6 degrees), arm reach (10 cm), or lunging (10 cm). Response time (RT) was the time from stimulus appearance to movement completion. We calculated 40-trial average PL (PL-Avg) and RT (RT-Avg) for neck, arm, and step movements, and assessed intra-individual variability (PL-IIV, RT-IIV). We used a rate correct score (RCS) to evaluate speed-accuracy trade-off. Intraclass correlation coefficients demonstrating acceptable test-retest reliability have previously been documented (PL-Ave and RT-Ave .837-.922, PL-IIV and RT-IIV .693-.836, PL-RCS .851, RT-RCS .887). Injury occurrences were electronically documented from the first pre-season practice to the final game of the season.

**Results:** A statistically significant and intrinsically credible 2-factor prediction model for core or lower extremity injury occurrence included an interaction between female sex and a self-reported history of 2 or more concussions, along with slow response time for arm reach (OR = 4.67; 95% CI, 1.51-14.43) (Figure). Follow-up analyses identified sex-specific cut points associated with elevated injury risk, which were arm reach response time ≥ 1.385 s for females and ≥ 1.257 s for males.

**Conclusions:** High school female soccer players who have sustained more than one concussion appear to be highly vulnerable to core or lower extremity sprain or strain, with injury risk compounded by slow arm reach response time. Slow perceptual-motor response time for arm reach was also identified as a potentially important injury risk factor for male football players.

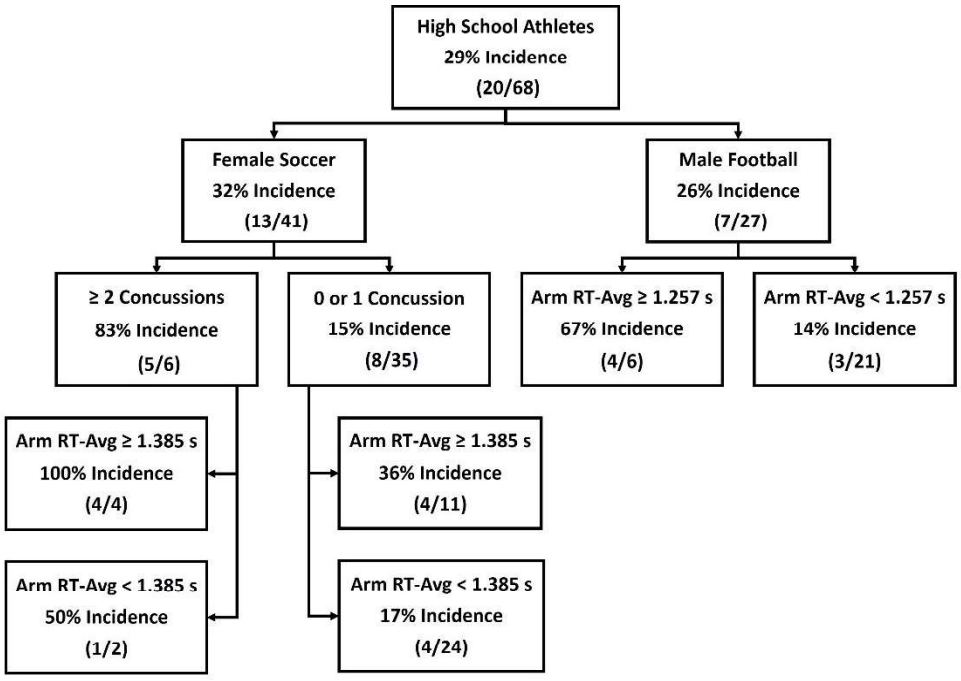


**Figure.** Classification tree depicting accuracy derived from binary predictors of core or lower extremity injury occurrence among female and male high school athletes.

## Associations of Age at First Concussion and Sex With Long-Term Mood-Related Outcomes in Active-Duty and Veteran Military Service Members

Walton SR, Lempke LB, DeJong Lempke AF, Resch JE, Oldham JR: Virginia Commonwealth University School of Medicine, Richmond, VA; University of Michigan, Ann Arbor, MI; University of Virginia, Charlottesville, VA

**Context:** Concussions are common among military service members and veterans (SMVs) and may adversely affect long-term mental health. Lifetime concussion history negatively associates with symptoms of depression, anxiety, and emotional-behavioral dyscontrol (EBD) among SMVs and athletes. Female athletes often report worse mood-related symptoms compared to males both before and after a concussion, and early lifetime exposure to concussions may also associate with mood disturbances. However, little is known about the effects of sex and age at the first lifetime concussion specifically among SMVs. This study was designed to examine the association of sex and age at first recorded concussion with mood-related symptoms among a large sample of SMVs. We hypothesized that female sex and younger ages at the first lifetime concussion would associate with worse mood-related outcomes.

**Methods:** Participants (n=1,344 SMVs; n=144[10.7%] female; aged 42.7±9.8 years) in this cross-sectional investigation were part of the larger Long-term Impact of Military-relevant Brain Injury Consortium – Chronic Effects of Neurotrauma Consortium study. Lifetime concussion history was captured via structured interview, including age at the time of first concussion, total number of concussions, and time (in years) since the most recent concussion. Mood-related outcomes were evaluated using the Patient Health Questionnaire-9 (PHQ9; depressive symptoms) and the Traumatic Brain Injury Quality of Life (TBI-QoL) anxiety and EBD modules. Multivariable linear regressions were used to evaluate the associations (standardized beta coefficients [β]) of self-reported sex and age at first concussion with PHQ9, anxiety, and EBD symptom T-scores separately. Next, multivariable binary logistic regressions were used to calculate odds ratios [OR] for sex and age at first concussion with exceeding clinical thresholds for the PHQ-9 (≥ 10), TBI-QoL anxiety (T-Scores ≥ 60), and TBI-QoL EBD (T-Scores ≥ 60) separately. Current age, total number of lifetime concussions, and time since each participant's most recent concussion served as covariates in all statistical models.

**Results:** Identifying as female was associated with statistically significant, but negligibly higher depression (β=0.08) and anxiety (β=0.08) symptom endorsement when compared to males. Females also had a statistically greater odds of exceeding clinical thresholds for the PHQ-9 depression (OR=1.51) and TBI-QoL anxiety (OR=1.75) measures (Table). Being an older age at first concussion was associated with modestly higher symptom reports (βs=0.13 to 0.21) and minimally higher odds (ORs=1.03 to 1.04) of meeting screening criteria for each measure (Table).

**Conclusions:** Among SMVs with a history of one or more concussion, both sex and age at first concussion were statistically significant, but lacked clinically meaningful associations with mood-related symptom scores in a large sample of SMVs. Clinicians do not need to evaluate mood-related symptoms differently for sex or age at first concussion; however, these factors should still be considered alongside other patient-specific factors to develop individualized care plans related to mental health concerns.

This work was supported by the Assistant Secretary of Defense for Health Affairs endorsed by the Department of Defense, through the Psychological Health/Traumatic Brain Injury Research Program Long-Term Impact of Military-Relevant Brain Injury Consortium (LIMBIC) Award/W81XWH-18-PH/TBIRP-LIMBIC under Awards No. W81XWH1920067 and W81XWH-13-2-0095, and by the U.S. Department of Veterans Affairs Awards No. I01 CX002097, I01 CX002096, I01 HX003155, I01 RX003444, I01 RX003443, I01 RX003442, I01 CX001135, I01 CX001246, I01 RX001774, I01 RX 001135, I01 RX 002076, I01 RX 001880, I01 RX 002172, I01 RX 002173, I01 RX 002171, I01 RX 002174, and I01 RX 002170. The U.S. Army Medical Research Acquisition Activity, 839 Chandler Street, Fort Detrick MD 21702-5014 is the awarding and administering acquisition office. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the Department of Defense.

| | Mood-Related Outcome Descriptive Statistics | | | Multivariable linear regression Standardized β (*p*-value) | | Multivariable logistic regression Odds Ratio (95% CI) | |
|---|---|---|---|---|---|---|---|
| | Raw score mean (SD) | Standardized score (T-score) mean (SD) | Met screening threshold n (%) | Self-reported sex (female vs. male) | Age at first Concussion (1 SD [9.8 years]) | Self-reported sex (female vs. male) | Age at first Concussion (1-year increase) |
| **Depressive Symptoms (PHQ9)** | 8.5 (6.1) | 56.2 (9.5) | 529 (39.4) | 0.08* (0.004) | 0.21* (<0.001) | 1.51* (1.06, 2.15) | 1.03* (1.01, 1.05) |
| **Anxiety Symptoms (TBI-QoL)** | 22.0 (9.4) | 55.2 (10.5) | 494 (36.8) | 0.08* (0.003) | 0.15* (<0.001) | 1.74* (1.22, 2.48) | 1.03* (1.02, 1.05) |
| **Emotional-Behavioral Dyscontrol (TBI-QoL)** | 22.9 (7.1) | 54.3 (7.8) | 302 (22.5) | -0.01 (0.843) | 0.13* (<0.001) | 0.94 (0.61, 1.45) | 1.04* (1.02, 1.06) |

## Evaluating the Effects of Concussions Across a Collegiate Career: Preliminary Findings From the Concussion Assessment, Research, & Education Consortium

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**Context:** Our understanding of how concussions impact varsity student-athletes during their careers has grown immensely over the past three decades; however, how concussions affect varsity student-athletes immediately after their collegiate careers is still unclear. Recently, the Concussion Assessment, Research, and Education (CARE) Consortium has sought to evaluate longitudinal changes following student-athletes' collegiate careers. Therefore, the purpose of this investigation was to compare change scores between pre-injury baseline and initial athletic career completion (i.e., exit) for various clinical measures across lifetime concussion history stratified by sport exposure.

**Methods:** Varsity student-athletes were recruited across 30 civilian and military sites from 2014-2021. Student-athletes were excluded if they were not classified as varsity or did not participate in both evaluation timepoints. Data were collected at baseline using self-reported questionnaires, followed by several clinical assessments including, but not limited to, the Sport Concussion Assessment Tool 3rd edition (SCAT3), Balance Error Scoring System (BESS), 18-item Brief Symptom Inventory (BSI-18) and Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT). The standard four composites from ImPACT were collected: visual motor speed, visual memory, verbal memory, and reaction time. To determine the cumulative effects of concussion on the outcome variables, student-athletes were categorized by lifetime concussion history (i.e., 0, 1-2, 3+) and sport exposure (i.e., high, low, or unexposed). Descriptive statistics were determined for age, sex, race, and baseline psychiatric conditions. Once stratified by sport exposure, change scores (exit–baseline) were compared across concussion history groups using Kruskal-Wallis Rank Sum, Pearson's Chi-squared, or Fisher's Exact Tests.

**Results:** The analysis included 3,840 student-athletes (mean age=18.6±1.0 years at baseline; 21.6±0.9 years at exit). Of the overall sample, 50.8% were female, 76.2% identified as White, and 17.4% sustained a concussion during CARE. Within the high exposure group, differences in change scores were noted for SCAT3 symptom severity (0 concussions: median=0.0 [IQR:-2.0,2.0]; 1-2 concussions: median=0.0 [IQR:-3.0,2.0]; 3+ concussions: median=0.0 [IQR:-4.0,2.8]; P=.04). Change in ImPACT visual motor speed differed across both high (0 concussions: median=1.5 [IQR:-1.3,4.7]; 1-2 concussions: median=2.2 [IQR:-0.7,5.4]; 3+ concussions: median=3.4 [IQR:0.4,6.1]; P=.04) and low exposure groups (0 concussions: median=1.1 [IQR:-1.3,4.1]; 1-2 concussions: median=2.1 [IQR:-0.7,5.2]; 3+ concussions: median=1.0 [IQR:-0.1,4.2]; P=.03), suggesting those with increasing concussion history performed worse. There were no statistically significant differences relative to the unexposed group, or among groups for BESS, BSI-18, or ImPACT visual memory, verbal memory, or reaction time composites.

**Conclusions:** Collectively, this study suggests student-athletes demonstrated notable differences in several concussion measures between baseline/exit time-points based on lifetime concussion history. Indeed, student-athletes in both the high and low exposure groups who sustained more than two concussions performed worse on the ImPACT visual motor speed composite at exit. How these findings influence outcomes decades after concluding sport participation remains uncertain.

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## Balance Performance Under Single- and Dual-Task Conditions Using a Mobile Application

Petit KM, Szalinski S, Krokstrom C: University of Wisconsin Oshkosh, Oshkosh, WI

**Context:** Following a sport-related concussion (SRC) a multifaceted evaluation strategy is recommended, minimally consisting of a symptom evaluation, cognitive test, and balance assessment. Of these assessments, balance testing has often been believed to contribute the least to the concussion assessment protocol. Due to this, researchers have evaluated other methods to assess postural stability and coordination after SRC. Moreover, after SRC, dual-task gait assessments have been found to identify postural control deficits far longer in recovery than traditional single-task measures. Yet most clinicians still utilize a single-task, static balance protocol in their clinical practice. There is a need to determine if static balance yields differing results under a dual-task condition when compared to the more traditional single-task protocol. Thus, the purpose of this study was to evaluate balance performance under single- and dual-task conditions in healthy college-aged adults.

**Methods:** A sample of 43 college-aged adults (60.5% female, age: 20.2±1.6yrs, 27.9% with concussion history) were randomly assigned to complete either a single-task or dual-task balance protocol, with the other condition occurring exactly one week later. The balance protocol consisted of five balance positions (double leg, single leg right, single leg left, tandem right, tandem left) each of which were completed three separate times. All trials were conducted with eyes closed and lasted approximately 10 seconds. The dual-task condition required participants to count backwards by sevens from a randomly assigned starting number between 100-150. The Sway Medical Application was utilized to analyze participant's postural sway. Scores were calculated by taking the average of the three testing trials for each position, with a max score of 100. Separate dependent samples t-tests were used to compare balance performance for each testing position under single- and dual-task conditions. Alpha was set a priori to .05.

**Results:** Significant differences were found for all single- and dual-task balance comparisons, with dual-task conditions yielding worse performance. Single leg left (S-T: 82.1±15.3, D-T: 75.5±19.5, p= < .009), tandem stance right (S-T: 93.6±7.9, D-T: 87.0±11.6, p= < .001) and single leg right (S-T: 82.1±16.4, D-T: 75.7±18.8, p=.003) had the largest mean difference, while tandem stance left (S-T: 93.0±7.0, D-T: 89.2±8.4, p=.003) and double leg stance (S-T: 97.8±2.7, D-T: 94.6.0±5.0, p= < .001) had the lowest mean difference.

**Conclusions:** These findings suggest that static balance performed under a dual-task condition may be significantly more challenging than a traditional single-task balance assessment. Increasing the level of difficulty for widely used SRC balance assessments may improve their sensitivity when identifying impairments following a SRC. Thus, future research is needed to evaluate dual-task static balance performance in individuals with a SRC.

## The Influence of Concussion History on Symptom Provocation During the Vestibular - Ocular Motor Screen in Healthy Collegiate Athletes

Fedewa TF, Rosenblum DJ, Resch JE: University of Virginia, Charlottesville, VA

**Context:** History of motion sickness and biological sex have been shown to influence symptom reporting during the vestibular-ocular motor screen (VOMS) at the pre-injury (baseline) assessment. However, the evidence regarding the role of concussion history on VOMS symptom provocation at baseline remains mixed. The purpose of this study was to assess the influence of concussion history on VOMS symptom provocation in healthy collegiate athletes. We hypothesized that athletes with or without a history of one or more concussions would have similar total symptom severity scores following the VOMS administration.

**Methods:** Division I collegiate athletes (N=761, 40.7% female,18.9 ± 1.6 years of age) participated in this descriptive laboratory study. Participants' concussion history was recorded via the pre-injury (baseline) concussion evaluation. Participants were divided into groups based on if they did (CON [27.2% (207/761)]) or did not (NoCON [72.8% (554/761)]) have a history of one or more medically diagnosed concussions. The VOMS was administered to all participants by trained examiners. Mann Whitney U tests were used to determine group differences on each VOMS sub-test (smooth pursuit[SP], horizontal[HS] and vertical saccades[VS], near point convergence[NPC], horizontal[HVOR] and vertical[VVOR] vestibular ocular reflex, visual motion sensitivity[VMST]) and the total symptom score. A Chi-squared ($\chi 2$) analysis was performed to compare the proportion of participants in each group who had a total symptom severity ≥8 or NPC ≥5cm. All analyses were performed with $\alpha$=0.05.

**Results:** Statistical differences between groups were observed for symptoms reported following the VOMS SP[U=61,199,p=0.008], HS[U=61,712.5,p=0.006], VS[U = 60969, p = .017], NPC[U = 60561.5, p = .029], and VVOR[U = 61253.5, p = .01]. Groups were similar in terms of VOMS total symptom severity [U = 59042, p = .818]. In terms of the NPC cutoff, the proportions of participants with an NPC ≥ 5 cm (X2 [1, N = 761 = .036, p = .85]) were similar. In terms of the total symptom cutoff, a significantly greater proportion ($\chi 2$[1, N=761] = 8.5, p=0.004]) of participants in the CON group (18% [38/207]) exceeded the clinical threshold for VOMS symptom severity as compared to the NoCON group (10% [58/554]).

**Conclusions:** Our findings suggest that healthy collegiate athletes with or without a history of one or more medically diagnosed concussions report similar levels of total symptom severity following the completion of the VOMS. However, a greater proportion of individuals with a concussion history scored above an established clinical cutoff at their baseline assessment. These findings reinforce the need for clinicians who use the VOMS to collect baseline data to inform clinical decision-making following concussion in collegiate athletes.

**Influence of Sex on the Relationship Between Concussion and Acute Upper Extremity Musculoskeletal Injury**

Ward KM, Aderman MJ, Roach MH, Ross JD, Malvasi SR, Kelly TF, Donohue MA, Gee SM, Svoboda SJ, Pasquina PF, Cameron KL: Keller Army Hospital, West Point, NY; Extremity Trauma and Amputation Center of Excellence, Defense Health Agency, Falls Church, VA, and Womack Army Medical Center, Department of Clinical Investigation, Fort Liberty, NC; Walter Reed National Military Medical Center, Bethesda, MD

**Context:** Evidence suggests that individuals may be at an increased risk for musculoskeletal injury (MSKI) following a concussion. A dearth of literature exists regarding rates of acute upper extremity (UE)MSKI post-concussion, specifically in females. Therefore, this study aimed to investigate the influence of sex on acute UEMSKI sustained after recovering from a concussion in service academy cadets.

**Methods:** A nested case-control study was conducted among participants enrolled in the Concussion Assessment, Research and Education (CARE) Consortium at the United States Military Academy at West Point. The cohort was observed for a total of 12 months following unrestricted return to activity (URTA) from concussion to identify incident cases of acute UEMSKI. The primary outcome of interest was time from URTA to acute UEMSKI during the follow-up period. Kaplan-Meier survival estimates were calculated to estimate the impact of sex on sustaining an acute UEMSKI. Univariate and multivariate Cox proportional hazards regression models were utilized to estimate the association between sex and UEMSKI incidence ($\alpha < 0.05$). Multivariable models controlled for competition level (varsity, club, company athletics), sport contact level (non-contact, limited contact, contact), concussion history (yes, no) and acute UEMSKI history (yes, no). Hazard ratios (HR) and 95% confidence intervals (95% CI) were calculated.

**Results:** From May 2015 to June 2018, 390 participants (39% female, 20.06±1.69y, 174.60±9.81cm; 76.57±14.95kg) sustained a concussion. Kaplan-Meier survival estimates for time from URTA clearance to acute UEMSKI by sex are displayed in Figure 1. In the univariate models, females were twice as likely to sustain an acute UEMSKI during the observation period than males (HR=1.941; P=0.006; 95% CI=1.21-3.12). Univariate models also revealed a decreased risk of sustaining a UEMSKI in company athletics (HR=0.391; P=0.001; 95% CI=0.22-0.69) and club sports (HR=0.453; P=0.020; 95% CI=0.23-0.88) compared to varsity sports and an increased risk with reporting any prior history of UEMSKI (HR=2.232; P=0.001; 95% CI=1.36-3.65). No significant association was observed in univariate models between risk of UEMSKI and sport contact level or concussion history. Multivariable models revealed specific factors independently associated with acute UEMSKI incidence following concussion. UEMSKI risk was increased in females (HR=2.079; P=0.015; 95% CI=1.15-3.75), decreased in non-varsity competition levels compared to varsity (HR=0.368; P=0.011; 95% CI=0.17-0.79), decreased in contact sports compared to non-contact sports (HR=0.275; P=0.034; 95% CI=0.08-0.90), and increased in subjects reporting an acute UEMSKI injury history (HR=2.203; P=0.007; 95% CI=1.25-3.90).

**Conclusions:** Females returning to participation after a concussion were two times more likely than males to sustain an acute UEMSKI during the follow-up period, after controlling for significant covariates. Competing in varsity athletics or in non-contact sports and reporting any history of acute UEMSKI was associated with an increased risk of sustaining an acute UEMSKI during the follow-up period while concussion history was not a risk factor.

# Free Communications, Rapid Fire Presentations: The Fountain of Youth: From Pathologies to Prevention

Friday, June 28, 2024; 9:00 AM-9:55 AM; Room 271-273

Moderator: Kevin Biese, PhD, LAT, ATC

## Youth Athletes With Sever's Disease Exhibit Altered Achilles Tendon Morphology

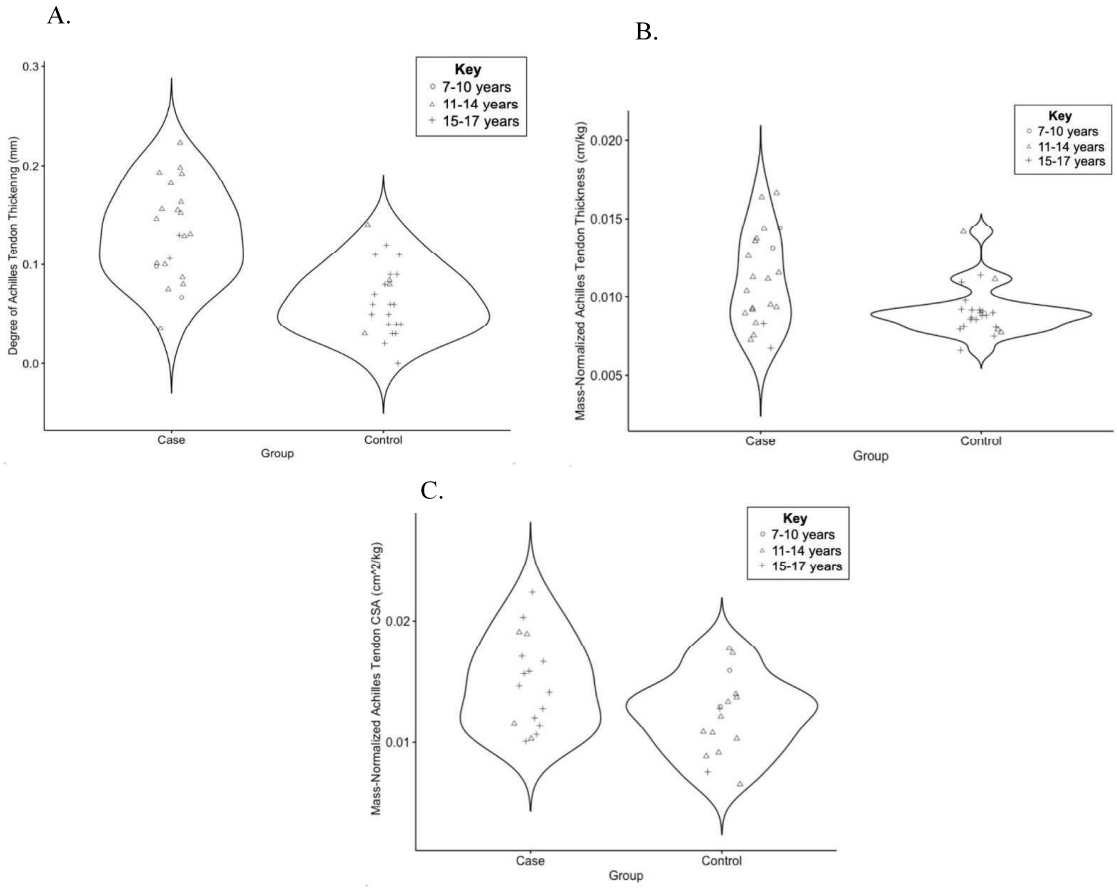
Hanlon SL, Whitney KR, DeJong Lempke AF: California State University Fullerton, Fullerton, CA; Boston Children's Hospital, Boston, MA; Virginia Commonwealth University, Richmond, VA

**Context:** Calcaneal apophysitis (Sever's disease) is an overuse condition caused by repetitive traction stress to the calcaneal apophysis. Whether Achilles tendon morphology is altered in this young patient population remains unknown. Therefore, we aimed to identify differences in Achilles tendon morphology between youth athletes diagnosed with calcaneal apophysitis and healthy controls.

**Methods:** This retrospective chart review included 46 patients ((n=23 Sever's disease, 15F/8M, 12.4±2.3 years old) and (n=23 healthy controls, 13F/10M, 15.9 ± 1.5 years old) who sought care in a Children's Hospital Sports Medicine/Orthopedics Department between 2012-2022. We measured ultrasound-derived degree of tendon thickening, Achilles tendon thickness(cm), and cross-sectional area (CSA (cm2)). Separate multivariate analyses of covariance (MANCOVAs) were used to compare degree of thickening, mass-normalized Achilles tendon thickness, and CSA between participant groups, covarying for age. Cohen's d effect sizes were used to assess the magnitude of mean differences and standard error (MDSE) between groups.

**Results:** Young athletes with Sever's disease had a significantly greater degree of tendon thickening (Figure 1A) with a large effect compared to healthy controls (MDSE: 0.07 [0.01]mm $p<0.001$, $d=1.39$). Achilles tendon thickness and CSA did not statistically differ between groups, however the magnitude of between-group differences for these measures (MDSE: 0.18 [0.05]cm, MDSE: 0.27 [0.07] cm2, respectively) were moderate (Figure 1B-C).

**Conclusions:** Our findings demonstrate previously unrecognized differences in Achilles tendon morphology between young athletes with clinically diagnosed Sever's Disease and healthy controls. Our study supports incorporating diagnostic ultrasound as part of a comprehensive examination to ensure appropriate diagnosis and clinical management for adolescents with heel pain.



## Adolescent Running Biomechanics Relationships With Musculotendinous Characteristics and Prospective Adaptations

DeJong Lempke AF, Hunt DL, Willwerth SB, d'Hemecourt PA, Meehan WP III, Whitney KE: University of Michigan, Ann Arbor, MI; Boston Children's Hospital, Boston, MA; The Warren Alpert Medical School of Brown University, Providence, RI

**Context:** Running biomechanics, such as reduced cadence, increased ground contact time, and increased ground reaction forces, have been extensively linked to the development of lower limb musculoskeletal injuries. Such biomechanical characteristics have been postulated to relate to tissue-level adaptations during running, though these relationships have yet to be established. Portable ultrasound imaging offers a reliable and non-invasive manner to prospectively evaluate musculotendinous properties, and relate characteristics back to running biomechanics. The purpose of this study was to assess the relationships between 1) running biomechanics and lower extremity musculotendinous characteristics and 2) running biomechanics and changes in musculotendinous properties over a 6-month period.
**Methods:** Thirty-three adolescent runners were included as part of larger, on-going studies (19F, 14M; age: 15.8±1.6 years; height: 167.8±7.8 cm; mass: 60.7±8.9 kg). Ultrasound images of lower extremity musculotendinous structures were obtained at rest using standardized procedures to assess the tibialis anterior, gastrocnemius, abductor hallicus, and flexor digitorum brevis muscles, and the Achilles and patellar tendons. Musculotendinous thickness and echogenicity measures (surrogate measure of tissue quality) were calculated for all structures. Running biomechanics were obtained in the field using validated wearable sensors to collect spatiotemporal (cadence, stride length, contact time), kinetic (shock), and kinematic (foot strike, and maximum pronation velocity) outcomes. There was a subset of participants that had repeat ultrasound evaluations following a 6-month running training program (n=11; 6F, 5M). For the primary aim, separate multivariate stepwise linear regressions were used to assess the relationships between running biomechanics and ultrasound measures. For the secondary aim, preliminary paired t-tests reflected that biomechanics did not significantly change across timepoints (p-range: 0.38-0.90), while ultrasound measures differed from baseline to 6-months (p-range: <0.001-0.05). Thus, Pearson's correlations were used to assess the relationship between biomechanics and the change in musculotendinous characteristics. Correlation coefficients were interpreted as: |0-0.2| = trivial, |0.21–0.39| = weak, |0.40–0.59| = moderate, and |0.60–1.0| = strong.
**Results:** The strongest overall relationships between biomechanics and ultrasound thickness measures were for the Achilles tendon (R^2=0.42, F=1.92, p=0.11), medial gastrocnemius (R^2=0.44, F=0.62, p=0.75), and flexor hallicus brevis (R^2=0.40, F=1.75, p=0.14). The interaction between pronation excursion and velocity was a significant predictor for increased Achilles tendon thickness (0.001 [<0.001] deg*deg/s; p=0.02), and decreased medial gastrocnemius thickness (-0.004 [<0.001] deg*deg/s; p=0.05). Contact time was a significant predictor for reduced intrinsic foot muscle thickness (-0.002 [<0.001] ms; p=0.01). The remaining regression models were weak (R^2-range: 0.18-0.39). The secondary analysis reflected moderate to strong correlations across biomechanical measures and changes in musculotendinous thickness and echogenicity (r-range: |0.41-0.65|; Table).
**Conclusions:** Biomechanical characteristics often noted among individuals with running-related injuries were moderately related to tissue-level changes during running training. These noted associations set the precedence for future prospective evaluations to determine injury risk.

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Table. Correlations between running biomechanics and lower limb musculoskeletal echogenicity and thickness measures.

| | Achilles Tendon | | Gastrocnemius | | Patellar Tendon | | Tibialis Anterior | | Abductor Hallicus | | Flexor Digitorum Brevis | | KEY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Echogenicity | Thickness | Echogenicity | Thickness | Echogenicity | Thickness | Echogenicity | Thickness | Echogenicity | Thickness | Echogenicity | Thickness | -1.0 |
| Cadence (steps/min) | 0.48 | 0.47 | -0.27 | 0.44 | 0.02 | 0.28 | -0.58 | 0.34 | 0.01 | 0.52 | -0.3 | 0.18 | -0.8 |
| Stride length (m) | -0.54 | -0.3 | 0.21 | -0.41 | -0.06 | -0.22 | 0.65 | -0.04 | -0.14 | -0.57 | 0.05 | -0.08 | -0.6 |
| Contact Time (ms) | -0.33 | -0.25 | 0.04 | -0.15 | -0.53 | -0.26 | 0.02 | -0.49 | -0.08 | -0.29 | 0.17 | -0.12 | -0.4 |
| Shock (g) | -0.33 | 0.23 | 0.08 | 0.08 | -0.32 | 0.34 | 0.38 | -0.32 | 0.34 | -0.54 | 0.15 | 0.09 | -0.2 |
| Footstrike | 0.32 | -0.06 | 0.04 | 0.14 | -0.51 | 0.12 | -0.21 | -0.48 | 0.02 | -0.26 | 0.23 | -0.004 | 0.0 |
| Pronation Velocity (°/s) | -0.01 | 0.13 | 0.12 | 0.04 | -0.44 | 0.2 | 0.44 | -0.24 | 0.26 | -0.01 | 0.07 | -0.17 | 0.2 |
| | | | | | | | | | | | | | 0.4 |
| | | | | | | | | | | | | | 0.6 |
| | | | | | | | | | | | | | 0.8 |
| | | | | | | | | | | | | | 1.0 |

Caption: Pearson's r correlation coefficients are presented to demonstrate the relationships with sensor-derived running biomechanical measures with changes in musculotendinous tissue echogenicity (tissue quality) and thickness (tissue strength). Stronger relationships are depicted in darker hues, with positive correlations in gold and inverse relationships in navy.

**Collegiate Coaches' Perceptions of Youth Sport Specialization's Impacts on Sport Performance**

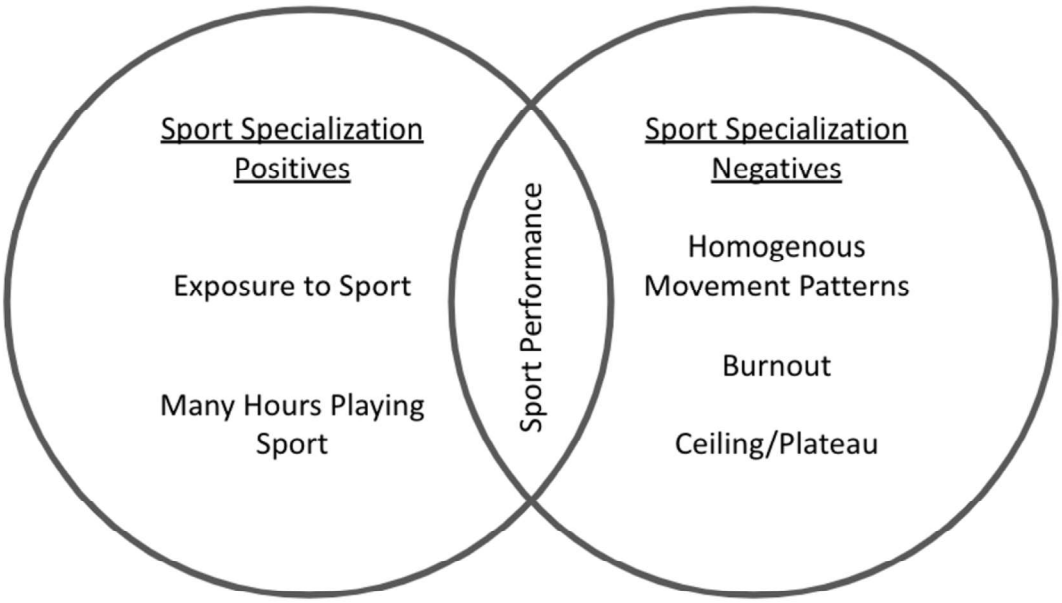
Srygler EC, Renner MN, Adler SN, Powell AJ, Chambers JS, Bell DR: University of Wisconsin–Madison, Madison, WI

**Context:** The shift in youth athletics toward earlier specialization is resulting in a greater number of injuries in youth athletes. An increased number of injuries in youth athletes can lead to greater workload for athletic trainers across a multitude of settings. Collegiate coaches are important stakeholders in the future of youth sports and hold the key to many financial and emotional benefits for these athletes. The purpose of this study was to explore their perspectives on youth sport specialization and how it may affect sport performance. This information is critical to guide athletes hoping to play at the collegiate level in making decisions for their athletic future and their health.

**Methods:** We used a phenomenological approach to guide our methods for investigating coaches' lived experiences. Interviews were conducted either via videoconference (Zoom, San Jose, CA), phone, or in-person. Coaches were recruited via email based on inclusion criteria that they 1) are currently in a coaching position and 2) that their current position is at a NCAA Division-1 or Division-2 institution. A semi-structured interview script was developed by the research team and content was validated by 3 experts in the field. The interview script was also reviewed by a qualitative research expert outside of the field to ensure appropriate question format. Data was collected until the research team felt that saturation was met. Eleven collegiate coaches were interviewed for this study (2 women, 9 men) representing a broad range of coaching experience (11.8 ± 9.7 years). Participants include men's and women's soccer, women's rowing, men's gymnastics, men's and women's cross country, and men's and women's track & field coaches. Transcripts were coded by a researcher with qualitative research experience using the consensual qualitative research framework and codes were validated using a panel of 3 content experts and the coder's reflexive memos. Themes and subthemes were developed by the same content experts using inductive data generation methods. Trustworthiness was achieved by member checking and a review by a third-party qualitative research expert to ensure unbiased and representative creation of themes and codes.

**Results:** Two main themes emerged from our analysis of the data: 1) sport specialization's negative impacts and 2) sport specialization's positive impacts on sport performance. For sport specialization's negative impacts on sport performance, we identified three subthemes: homogenous movement patterns, burnout, and a ceiling/plateau effect. Coaches described highly specialized athletes as having less diverse movement patterns resulting in an increased risk for overuse injuries, a greater tendency to burnout of sport due to excessive volume and/or a loss of enjoyment in participation, and as already potentially having hit their ceiling of skill development and not being able to progress athletically after reaching the college level. Coaches conversely discussed multi-sport athletes as being "undertrained" and having more capacity to develop once they got to the collegiate level and focused on a single sport. However, for sport specialization's positive impacts on sport performance, we identified two subthemes: exposure to sport and many hours playing sport. Coaches indicated that consuming sport content on social media or television and participating in many hours of a single sport are how athletes find success and ultimately build the skills needed for the next level of competition.

**Conclusions:** Our data indicates that although collegiate coaches recognize and acknowledge that there are negatives to youth sport specialization, they ultimately believe that high volume of participation in a sport is what allows athletes to find a high level of success in athletics. This study provides important insights into the perceptions of collegiate coaches and creates a platform for further research about youth sport specialization within this important population.



## Dual Ankle Sprain in a Youth Soccer Player: Level 3 Case

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**Background:** This level 3 Case study was focused on the diagnosis, interventions, and treatment of a youth soccer player with a dual medial and lateral ankle sprain. Lateral ankle sprains are the most common athletic injury in general sports. In this case, the patient exhibits a medial and lateral ankle sprain. Medial ankle sprain being the least common based on the body's anatomical properties to protect the deltoid ligament. However, there is limited evidence of dual ankle sprains.

**Patient:** The patient was a 16 y/o soccer player presenting with a non-contact ankle injury during a match. MOI was forced inversion, eversion, and ankle plantarflexion after stepping on his own foot. On-field evaluation revealed pain in the right ankle and inability to bear weight. Based on Ottawa ankle rules, The patient was referred for x-ray of right ankle. The radiograph ruled out fracture. The patient was immobilized in a hard cast for two weeks. Post-cast removal, the patient exhibited decreased AROM and PROM of dorsiflexion, plantarflexion, inversion, and eversion, due to swelling and pain. Differential diagnosis was a dual eversion and inversion ankle sprain

**Intervention & Treatment:** The physician elected to conservative treatment, with the patient NWB with crutches and in a hard cast for two weeks. When the cast was removed, an aggressive rehabilitation protocol was used to accelerate the patient's return to sport. The acute phase of rehabilitation was focused on removing swelling and increasing ROM by using milking massage, PROM and AROM ankle exercises. During the sub-acute phase, the patient was FWB, and the goals were to progress ankle exercises to RROM and strength exercises, proprioception exercises, joint mobilizations, and gait training in the anti-gravity treadmill. The Alter G was instrumental in allowing the patient to start gait training in the second week, starting at 30% of their body weight. The patient's weight bearing capacity progressed until FWB. By week six, patient was FWB and cleared for non-contact practice. The patient was instructed to do rehabilitation before practice. Pre-practice rehabilitation included return to run, AROM, proprioceptive and strengthening exercises for the foot and ankle muscles. After 7.5 weeks of rehabilitation, patient was cleared for full practice. The patient adheres to a maintenance protocol and receives taping and bracing for games and practice.

**Outcomes or Other Comparisons:** The patient was cleared to RTP after 7.5 weeks of rehabilitation; during the first game back, he had a direct force to the lateral side of his ankle. Swelling present in the lateral malleolus side; he continues maintenance work and gets closed basket weave tape reinforced with elastikon tape on his right ankle. Compared with early ankle joint mobility rehabilitation that lasts 4-6 weeks, the use of a hard cast prolonged the rehabilitation to 7.5 weeks.

**Conclusions:** This case study provides an overview of a 16-year-old soccer player with a dual medial and lateral ankle sprain. When using a hard cast for protection, it appeared to delay the rehabilitation when compared to early mobilization. Also, the usage of the anti-gravity treadmill during the early phase of rehabilitation proved to be effective in maintaining fitness and gait training.

**Clinical Bottom Line:** The usage of hard cast for protection of ankle static stabilizers could delay the healing process by approximately two weeks, in comparison to research regarding injuries with similar presentation. Additionally, implementation of an anti-gravity treadmill during the early phase of rehabilitation could accelerate the healing and recovery process while preserving a patient's physical fitness through gait training.

## The Association of Previous Youth Tackle Football Participation With the Incidence of Concussions in High School Football Players

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**Context:** Opponents of youth tackle football argue it increases risk of sport-related concussions (SRCs) in young players. In contrast, proponents suggest youth tackle football is necessary to teach proper techniques that may result in players sustaining fewer SRCs later in high school (HS) football. The purpose of this study was to determine if youth tackle football participation before high school was associated with a decreased risk for SRCs in HS football players.

**Methods:** Football players from 45 Wisconsin high schools were recruited to participate during the 2022 and 2023 football seasons. Participants completed preseason surveys regarding their previous youth tackle football participation and history of SRCs in the prior year. Athletic Trainers at each school reported the number of football exposures (games and practices) for the players, the onset of SRCs that occurred and the days needed to recover for each SRC. Repeated measures binomial and ordinal logistic regression with players nested in schools was used to model the odds of having an SRC as well as the days needed to recover from the SRC.

**Results:** 3,119 players (Male: 99%, Age 15.9+1.1 yrs. Grades 9-12) were enrolled and took part in 3,461 football seasons (342 played both seasons). 2,638 (85%) played tackle football before HS (Median 3 [IQR 1,4] yrs.), with 1519 (49%) playing tackle football before 6th grade (< 6th). Players participated in 193,492 football exposures (competition=17%, practice=83%). 211 players (6.7%) sustained an SRC that occurred in practice=68 (32%) or games=143 (68%) and recovered in (Median, [IQR [25th,75th]) 13, [9,17] days. SRCs were sustained most often by offensive backs (n=45, 38%), offensive linemen (n=36, 15%) and linebackers (n=29, 14%) and occurred most often by tackling / being tackled (n=124, 59%) and blocking / being blocked (n=65, 31%). There was no difference in the number of players sustaining SRCs by total years playing tackle football before HS (YesSRC:3 [1,4] yrs. NoSRC:3 [1,4] yrs. OR= 1.01 [0.93-1.09], p=0.792, Figure 1) or participation in tackle football before 6th grade (Yes< 6th: n=107 [6.4%], No< 6th: n=104 [5.8%], OR= 1.10 [0.83-1.46], p=0.483). There was no association with the days needed to recover from an SRC and total years playing tackle football before HS (R:-0.06, p=0.419) or by participation before 6th grade (Yes< 6th:13, [9,17] days, No< 6th:13, [9,17] p=0.861).

**Conclusions:** The total years of tackle football before HS and playing before 6th grade were not associated with decreased odds of sustaining an SRC in HS players. The total years of tackle football and participation before 6th grade were not associated with fewer days needed to recover from an SRC. This data suggests that prior youth football tackling experience may not be protective in HS players.

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## A Simple Factor Structure Defines the Dimensions of the Concussion Quality of Life-Youth Patient-Report Outcome Measure

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**Context:** Sport-related concussion can affect many dimensions of an individual's health, including participation in sports, school, and activities of daily living, resulting in lower perceived health-related quality of life (HRQOL). Understanding the patient's perspective on HRQOL is important, yet a concussion-specific patient-report outcome measure (PRO) does not exist. Our research team has been developing a concussion-specific PRO for adolescent athletes, which has demonstrated acceptable readability, test-retest reliability, internal and concurrent validity. This study investigated the factor structure of the Concussion Quality of Life in Youth scale (CQOL-Y) in the acute phase following concussion.

**Methods:** Adolescent patients diagnosed by an athletic trainer or physician with a sport-related concussion (n=134, male=68.7% males, White=70.9%, Non-Hispanic=73.1%, age=15.7±1.4 years) completed the CQOL-Y on day 3 post-concussion. The CQOL-Y is a concussion-specific PRO with 27 items in domains identified as important to adolescents following concussion, including cognitive and school, social, mood and emotions, and sleep. Responses are captured through a 5-point Likert scale (1=Never-to-5=Always). The CQOL-Y produces a raw total score ranging from 0-135, with higher scores indicating better HRQOL. An exploratory factor analysis (principal axis factoring) was conducted on responses to the 27 items. The Kaiser-Meyer-Olkin measure of sampling adequacy (.89) and Bartlett's test of sphericity ($p<.001$) indicated that the data were amenable to factor analysis. Factor loadings were considered to be uninformative if they were less than .31 (less than 10% of variance shared between the item and factor).

**Results:** Table 1 summarizes the factor loadings and percent variance accounted for by each of the five identified factors (Cognitive, Mood, Worry/Anxiety, Sleep, Social). The 5-factor solution accounted for a total of 61.0% of the variance in the items. The average correlation between factors was, r=.37. The analysis yielded a simple structure, i.e., each item loaded highly on only 1 factor, with a single exception: "It is harder for me to have fun with my friends/teammates," which cross-loaded on both cognitive and social factors. For the final scale score construction, variance in this item will be assigned only to the social scale where it had the higher loading.

**Conclusions:** The CQOL-Y demonstrated a factor structure reflective of domains of HRQOL known to be impacted by concussion during the acute phase of injury. These and previous preliminary results suggest that the CQOL-Y is a clinically useful PRO measure for use in adolescent athletes following a sport-related concussion. Findings highlight the importance of school and cognitive functioning as well as mood and anxiety as important dimensions of health to evaluate in adolescent patients following a concussion. Future studies should continue to validate the CQOL-Y for use in patient populations, including determining longitudinal validity to support clinicians in clinical decision-making over-time.

Project funded by the A.T. Still University Warner Fund.

| | Factor | | | | |
|---|---|---|---|---|---|
| | Cognitive | Mood | Worry/Anxiety | Sleep | Social |
| It is harder for me to keep up with my school work. | 0.871 | | | | |
| I feel like I am doing worse in my classes. | 0.777 | | | | |
| It is hard for me to pay attention in class. | 0.751 | | | | |
| My schoolwork seems harder. | 0.639 | | | | |
| It is harder for me to do classwork on the computer or tablet. | 0.635 | | | | |
| My thinking seems slower. | 0.544 | | | | |
| I worry about doing well in school. | 0.540 | | | | |
| It is hard for me to remember things. | 0.504 | | | | |
| It is hard for me to remember what I was just thinking. | 0.379 | | | | |
| I feel alone more often than usual. | | 0.862 | | | |
| I am sad more often than usual. | | 0.676 | | | |
| I feel irritable more often than usual. | | 0.670 | | | |
| I feel frustrated more often than usual. | | 0.633 | | | |
| I feel everything in my life is going wrong. | | 0.618 | | | |
| I worry about my future success in sports. | | | 0.847 | | |
| I worry about my future outside of sports. | | | 0.737 | | |
| I worry that I won't get better. | | | 0.576 | | |
| I worry I have disappointed my teammates. | | | 0.482 | | |
| It takes me longer to fall asleep. | | | | 0.855 | |
| My sleep is different every day. | | | | 0.830 | |
| I sleep less than usual. | | | | 0.609 | |
| I feel tired a lot of the time. | | | | 0.504 | |
| It is harder for me to have fun with my friends/teammates. | 0.393 | | | | 0.593 |
| I feel left out from my team. | | | | | 0.516 |
| It is harder for me to talk to my friends/teammates. | | | | | 0.486 |
| I am not able to keep up with my friends. | | | | | 0.442 |
| My teammates do not treat me the same. | | | | | 0.406 |
| Percent variance accounted for: | 41.8 | 6.7 | 5.3 | 4.4 | 2.8 |

**Beyond the Usual Suspects: Unraveling Overlapping Spinal Pathologies in a Young Athlete: A Type 4 CASE Study**

Froom RJ, Strauch EL, Martin BM, Evans TA, Gill SS: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** A 19-year-old female collegiate volleyball player, with a past medical history of Methicillin-Sensitive Staphylococcus aureus(MSSA) infection leading to discitis and osteomyelitis at L4-L5 at age 11, and a pars interarticularis fracture at L5 at age 18 returned for evaluation by an athletic trainer with chronic centralized low back pain(LBP). Her pain intensified a few months after she received full clearance from her pars interarticularis injury. The pain is localized to the same region as when she had been diagnosed with the pars fracture.

**Differential Diagnosis:** Reinjury or nonunion of previous L5 pars interarticularis fracture, muscle strain, disc herniation, and recurrence of discitis/latent infection.

**Intervention & Treatment:** Initial concern was for latent infection in the L4 and L5 vertebrae or disc due to history and morbidity associated followed by concern of nonunion or reinjury of the L5 pars fracture. Radiographs suggested Schmorl's node formation and L4-L5 endplate degenerative changes. CT scans revealed disc space irregularity at L4-L5 but ruled out any pars interarticularis fracture. MRI imaging indicated advanced L4-L5 disc degeneration with Schmorl's nodes and mild sclerosis along the left L5 pars interarticularis, indicating healed previous pars fracture. Laboratory results were negative for infection. She was diagnosed with intervertebral disc degeneration of L4-5 resulting from her previous spondylodiscitis. She failed conservative treatments. The patient subsequently received bilateral L4-L5 transforaminal epidural steroid injections(TFESI). The steroid injections resulted in 100% pain relief for the first few hours, 70% relief over the last month, and improved functionality. The current course of treatment is to continue L4-L5 TFESI PRN and consider a lumbar fusion of L4-L5.

**Uniqueness:** The combination of past MSSA infection, osteomyelitis, potential for non-healing of fracture, and the need to differentiate between the conditions makes this CASE distinctively instructive. Discitis is a rare and overlooked condition characterized by inflammation within the intervertebral discs typically resulting from an infection. The incidence of discitis in the United States is around 0.4-2.4 per 10,0000 people each year, with cases in pediatric and male patients being the most prevalent.1,2 The rarity of discitis, especially in the pediatric and young adult population, can lead to challenges in prompt diagnosis and management.3 In children, blood vessels extend from the cartilaginous endplates of the vertebrae into the nucleus pulposus, whereas in adults these vascular supplies degenerate, and only extend into the annulus fibrosis.4,5,6 This vascular anatomy of the spine contributes to the susceptibility to infections through hematogenous dissemination.4,7 The lumbar area is predominantly affected due to its rich blood supply.1,4,8 Discitis can lead to severe complications, such as osteomyelitis, if not treated promptly. When both the intervertebral disc and vertebrae are infected the term spondylodiscitis is used. This pathology necessitates a multifaceted approach to diagnosis and treatment to prevent long-term sequela such as chronic pain, deformity, and neurological impairment.4 The L5 pars fracture was thought to be sequela from the spondylodiscitis coupled with repetitive spinal extension during volleyball. This CASE underscores the importance of considering it as a differential diagnosis in young athletes presenting with symptoms of LBP and systemic signs of infection. This case underscores the need for a wide array of differential diagnoses for LBP in youth and adolescents as the consequences of discitis can cause long-term morbidity.

**Conclusions:** This CASE underscores the diagnostic challenges faced when managing young athletes with a history of spinal infections, especially spondylodiscitis. Athletic trainers and clinicians must be meticulous in history-taking and clinical examination, employing a comprehensive differential diagnosis approach. The importance of considering past medical history, even if years have passed, is paramount, as it can influence current complaints. The case also emphasizes the value of continually reassessing diagnoses in light of persistent or changing symptoms.

## Kinesiophobia in Collegiate Athletes and Non-Athletes With and Without Chronic Ankle Instability


Perez NM, Griffin K, Osborne R, Koldenhoven RM: Texas State University, San Marcos, TX



**Context:** Individuals with chronic ankle instability (CAI) exhibit pathomechanical, sensory-perceptual, and motor-behavioral impairments, however, the impact of kinesiophobia (fear of movement) has not been extensively studied in this population. Kinesiophobia is a substantial psychological factor that may impact sport performance and activities of daily living. Athletes may be further impacted by kinesiophobia as they are expected to return to sport and perform at pre-injury levels. The purpose of this study was to determine the levels of kinesiophobia between collegiate athletes and non-athletes with and without CAI.

**Methods:** A Qualtrics survey was distributed to students at a Division 1 Collegiate Institution in Texas. Ankle health status was evaluated using the Foot and Ankle Ability Measure (FAAM) Sport subscale, Identification of Functional Ankle Instability (IdFAI), and ankle sprain history questions. Kinesiophobia was assessed using the Tampa Scale of Kinesiophobia-11 (TSK-11) and scores were categorized into 4 levels (no, low, moderate, high kinesiophobia) using previously published guidelines. A 4x2 analysis of variance (ANOVA) was used to assess differences in athletic groups (NCAA Division 1, Intramural, Club, Non-athlete) and ankle health status (CAI, healthy) and Tukey's post hoc analyses were performed when significant differences between existed. An exploratory 2x2 ANOVA was conducted where athletes and non-athletes were classified into 2 groups to assess the differences in groups and ankle health status.

**Results:** Of the 531 respondents that completed the survey, 140 (female=94, male=46) met the inclusion criteria for the study (116=CAI, 24=Healthy). For the FAAM Sport, there was a significant main effect for ankle health status ($p < 0.001$, CAI=62.68±15.11%, Healthy=99.57±0.01%), no significant main effect for athlete status, and no significant interaction. For the IdFAI, there was a significant main effect for ankle health status ($p < 0.001$, CAI=21.63±5.34, Healthy=2.42±2.93), no significant main effect for athlete status, and no significant interaction. For the TSK-11 questionnaire there was a significant main effect for ankle health status ($p < 0.001$, CAI=26.04±6.22, Healthy=16.75±5.50), no main effect for athlete status and no significant interaction.

**Conclusions:** Individuals with CAI demonstrated higher levels of kinesiophobia than those who have never sprained their ankle regardless of athlete status. Clinicians treating patients with CAI should assess each individual for increased levels of kinesiophobia and consider collaborating with psychologists or sport psychologists when fear of movement is present. By acknowledging and addressing the psychological aspect in conjunction with the physical rehabilitation, clinicians can offer a more comprehensive and patient-centered treatment that may lead to improved patient outcomes. Further research in this area is necessary to gain a better understanding of the impact of kinesiophobia on individuals with CAI and to develop appropriate intervention strategies that may lead to better patient care and long-term management of this condition.

## Relationships Between General and Ankle-Specific Self-Efficacy and Patient-Reported Outcomes in Individuals With Chronic Ankle Instability

Walsh BM, Kosik KB, Torp DM, Hoch JM, Hoch MC: University of Kentucky, Lexington, KY

**Context:** Self-efficacy is a modifiable factor that has been correlated with psychosocial and HRQL outcomes in patients with various types of musculoskeletal injury. However, the relationship between self-efficacy, self-reported ankle function, and injury-related fear has not been thoroughly evaluated in individuals with CAI. Examining this relationship will help researchers and clinicians understand additional modifiable factors that maximize HRQL outcomes in individuals with CAI. Therefore, the purpose of this study was to compare levels of general and ankle-specific self-efficacy with self-reported ankle function and injury-related fear in individuals with CAI.
**Methods:** Fifty-nine adults (37 Female, Age: 31.6±8.0, Episodes of Giving Way: 2.4±1.7, Cumberland Ankle Instability Tool: 13.5±5.7) with CAI volunteered to participate in this online survey study. Participants were included if they were 18-55 years of age and met previously established inclusion criteria to be classified as having CAI. Participants completed a demographics questionnaire and a series of valid and reliable patient-reported outcomes (PROs), including the General Self-Efficacy Scale (GSE), the Foot and Ankle Disability Index Activities of Daily Living (FADI-ADL) and Sport (FADI-Sport), and the Fear-Avoidance Beliefs Questionnaire-Physical Activity Subscale (FABQ-PA). Participants also completed the Ankle Self-Efficacy Questionnaire (ASEQ), which is presently undergoing psychometric assessment. The GSE scores range from 0-40 with higher scores indicating increased levels of general self-efficacy. The FADI-ADL and FADI-Sport scores ranged from 0-100%, with lower scores indicating lower foot and ankle function. The FABQ-PA scores ranged from 0-24 with higher scores indicating higher levels of injury-related fear. The ASEQ is scored from 0-60 with higher scores indicating increased levels of ankle-specific self-efficacy. Median and interquartile range were calculated for each variable. The relationship between scores on the GSE and ASEQ and all other PROs were examined through Spearman's rho correlations. The alpha level was set a priori at $p \leq 0.05$.
**Results:** Descriptive statistics and Spearman's rho correlations for PROs can be found in Table 1. There were significant moderate-to-strong correlations between the ASEQ and FADI-ADL, FADI-Sport, and FABQ-PA. Correlations between the GSE and all PROs were weak-to-mild and the only significant correlation was with the FADI-Sport. The correlation between the ASEQ (52 [17]) and the GSE (34 [7]) was insignificant and weak ($r=0.050$, $p=0.709$).
**Conclusions:** Individuals with CAI that demonstrated higher levels of ankle-specific self-efficacy, also reported greater ankle function in ADLs and sport, as well as decreased injury-related fear. However, similar relationships were not identified when examining relationships between general self-efficacy and PROs in individuals with CAI. Additionally, the lack of correlation between the GSE and ASEQ suggests that the GSE is not specific enough to assess the region-specific variations in self-efficacy present in individuals with CAI. Therefore, ankle-specific self-efficacy may be an important factor for clinicians and researchers to consider when treating individuals with CAI.

## Constructs of Pain Catastrophizing Are Associated With Knee Pain Severity in Individuals With ACL Reconstruction

Genoese FM, Reiche ET, Harkey MS, Baez SE: Michigan State University, East Lansing, MI, and University of North Carolina, Chapel Hill, NC

**Context:** Individuals with ACL reconstruction (ACLR) experience psychological responses to injury, such as pain catastrophizing. Pain catastrophizing is a cognitive-affective response to actual or anticipated pain and is characterized by three constructs: magnification (i.e., perceiving pain as unusually more intense), rumination (i.e., difficulty in shifting attention away from pain), and helplessness (i.e., feeling helpless in controlling pain). Pain catastrophizing has been linked to knee pain severity in individuals with ACLR. However, given the multidimensional nature of this psychological response, investigation of the unique contributions of the three constructs of pain catastrophizing on knee pain severity is warranted to inform targeted treatment approaches for the management of knee pain in this population. Therefore, the purpose of this study was to examine the associations between the constructs of pain catastrophizing (i.e., magnification, rumination, and helplessness) and knee pain severity in individuals with ACLR. We hypothesized that individuals with ACLR who exhibit higher levels of pain-related magnification, rumination, and helplessness would report worse knee pain severity.

**Methods:** Fifty participants (34 females; age=19.3±3.5 years) with history of primary, unilateral ACLR at least 4-months post-surgery (time since surgery=19±14 months) were included in this cross-sectional study. Participants completed the Pain Catastrophizing Scale (PCS) and the Knee Injury and Osteoarthritis Outcome Score Pain (KOOS-Pain) subscale. The PCS measures an individual's perceptions of their pain experience and is comprised of a Magnification subscale (score range 0-12), Rumination subscale (score range 0-16), and Helplessness subscale (score range 0-24), where higher scores indicate greater respective aspects of pain catastrophizing. The KOOS-Pain subscale (score range 0-100) is used to evaluate self-reported knee pain severity, where higher scores indicate less or no knee pain. Separate multivariate linear regression analyses were conducted to examine independent associations between scores on each PCS subscale with KOOS-Pain scores. Age and time since surgery were included as covariates in each model due to their potential effect on knee pain. Alpha was set a priori $p < 0.05$.

**Results:** Descriptive statistics for the PCS subscales included in each model are in Figure 1. KOOS-Pain Median [IQR]= 93[10]. Results of the separate multivariate regression analyses indicated that each PCS subscale score significantly predicted KOOS-Pain scores when controlling for age and time since surgery (PCS Magnification: $p=0.019$, $\beta=-1.31$; PCS Rumination: $p=0.017$, $\beta=-.85$; PCS Helplessness: $p < .001$, $\beta=-.99$).

**Conclusions:** Individuals with ACLR who exhibit higher levels of pain-related magnification, rumination, and helplessness may experience worse knee pain severity. This is concerning as increased knee pain severity is associated with worse quality of life among individuals with ACLR. Integration of cognitive behavioral intervention strategies into ACLR rehabilitation that allow for reappraisal of pain and enhanced coping may improve constructs of pain catastrophizing and positively influence knee pain in this population.

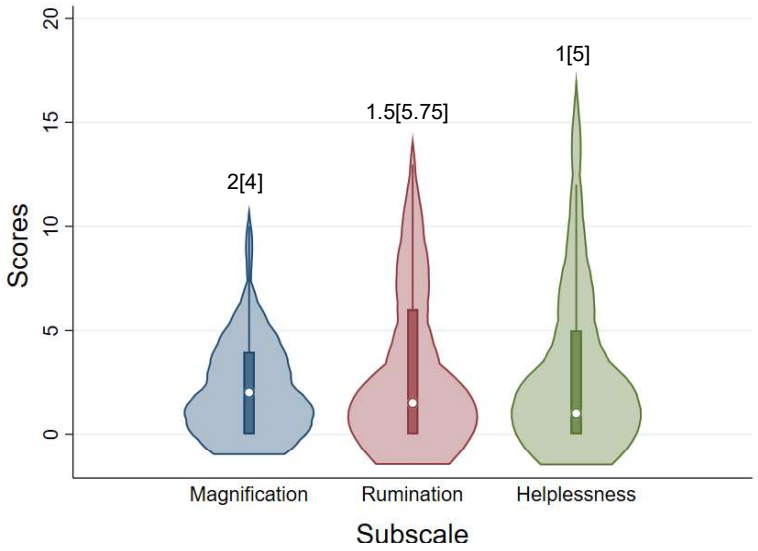


**Figure 1.** Pain Catastrophizing Scale scores by subscale

**Kinesiophobia Associates With Lower Extremity Landing Biomechanics in Individuals With ACL Reconstruction**

Volz A, Rush JL, Bazett-Jones DM, Murray AM, Norte GE: University of Toledo, Toledo, OH; Ohio University, Athens, OH; University of Central Florida, Orlando, FL

**Context:** Lower extremity biomechanics placing greater load on the knee and strain on the ACL are widely observed following ACL reconstruction (ACLR). However, 2 in 3 individuals recovering from ACLR cite a psychological reason for not returning to sport, suggesting a need to look beyond movement. While our understanding of psychological adaptations to ACL injury has grown considerably, the relationship between psychological function and biomechanics associated with risk for second ACL injury is unclear. Our purpose was to evaluate such relationships among individuals with ACLR. We hypothesized that worse psychological outcomes relating to knee function, HRQL, and pain-related fear of movement or reinjury would associate with poor landing biomechanics.

**Methods:** We used a cross-sectional design to assess psychological function and landing biomechanics among 20 individuals with primary, unilateral ACLR (10 female, age: 20.1±2.0 years, time from surgery: 36.1±30.9 months) in a research laboratory. Participants first completed the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation, Veterans RAND 12-Item Health Survey (VR-12), and Tampa Scale of Kinesiophobia (TSK-11). We then used 12 high-speed motion capture cameras synchronized with two embedded force plates to collect landing biomechanics while completing the LESS. Biomechanical outcomes included sagittal and frontal hip and knee angles (°) and internal moments (Nm/kg*m), as well as vertical ground reaction force (vGRF) (N/kg). Outcomes were quantified at initial contact (IC), peak vGRF, and as peaks within the first 100 milliseconds of IC for the injured limb only. Pearson's r or Spearman's ρ correlation coefficients were used to evaluate relationships between psychological and biomechanical outcomes. A Benjamini-Hochberg correction was applied to control for a 5% false discovery rate.

**Results:** At IC, higher TSK-11 scores moderately associated with lesser hip flexion (r=-.569, P=.009). At peak vGRF, higher TSK-11 scores highly associated with lesser hip flexion (r=-.724, P<.001), and moderately associated with lesser knee flexion (r=.561, P=.010) and greater internal knee valgus moment (ρ=-.606, P=.005). Within 100 milliseconds of IC, higher TSK-11 scores moderately associated with greater internal knee valgus moment (ρ=-.523, P=.018), and lower VR-12 scores moderately associated with lesser hip flexion moment (ρ=.498, P=.025). After controlling for a false discovery rate, only those findings at peak vGRF remained statistically significant (range P=.008-.027). Scatterplots for significant findings are presented in Figure 1.

**Conclusions:** Pain-related fear of movement or reinjury demonstrated the strongest associations with aberrant landing biomechanics at a time when the largest magnitude of forces were being applied to the joint. Our findings suggest that individuals with greater kinesiophobia may adopt a stiffer landing profile with greater medial knee compartment (varus) loading. While the causal relationships between psychological and biomechanical outcomes remain unclear, well documented deficits in each reinforce the need for a biopsychosocial approach to intervention following ACLR.

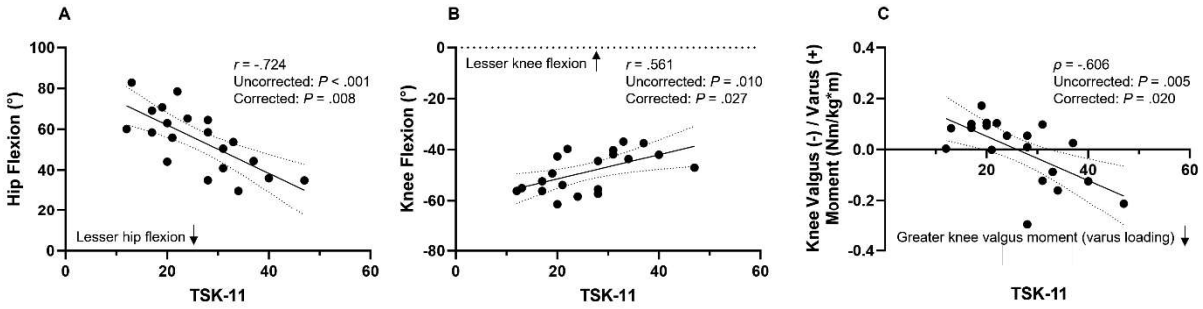


**Figure 1**. Scatterplots depicting the relationships between TSK-11 (kinesiophobia) and (A) hip flexion angles, (B) knee flexion angles, and (C) frontal plane internal knee moments at the time of peak vertical ground reaction force during double limb landing among individuals with ACL reconstruction.

## Sex Differences in the Relationships Between Hip Torque and Squatting Kinematics in Individuals With Patellofemoral Pain

Glaviano NR, Kim S, Gilgallon T, Malone Z, Carson R, Batista N, Bazett-Jones DM, Mangum LC: University of Connecticut, Storrs, CT; University of Central Florida, Orlando, FL; University of Toledo, Toledo, OH

**Context:** Patellofemoral pain (PFP) is a common condition that is twice as prevalent in females than males. Little evidence exists comparing differences in neuromuscular or biomechanical function between females and males with PFP. While moderate associations exist between hip torque and increased frontal plane kinematics in females; the association in males with PFP is unknown. Therefore, the study aimed to 1) compare neuromuscular and biomechanical variables between males and females with PFP and 2) investigate the association between hip torque and squatting kinematics in females and males with PFP.

**Methods:** Fifty-seven individuals with PFP, 36 females (age: 23.8±5.5 years, mass: 70.5±16.8kg, height: 162.9±6.6cm; symptom duration 46.8±33.9 months; current pain: 2.9±2.5 cm on visual analog scale; disability: 56.9±13.1 in KOOS-Patellofemoral Subscale) and 21 males (age: 23.8±4.6 years, mass: 83.7±16.3kg, height: 176.9±6.9cm; symptom duration 39.6±31.7 months; current pain: 2.1±2.4 cm on visual analog scale; disability: 57.7±18.3 in KOOS-Patellofemoral Subscale) participated in baseline testing for a larger randomized controlled trial. Hip abduction and extension force were quantified with a hand-held dynamometer while two-dimensional frontal plane kinematics were calculated during a single leg squat (SLS). Torque was calculated as the product of force and moment arm, normalized to participant's body mass. Average knee frontal plane projection angle (KFPPA), hip frontal plane projection angle (HFPPA), pelvic drop, and lateral trunk motion (LTM) were calculated with a custom MATLAB program. T-tests compared neuromuscular and biomechanics variables between sexes. Pearson correlations examined the association between hip torque and frontal plane kinematics in females and males. Correlation coefficients (r) were interpreted as weak (< .4), moderate (.40 to .70), and strong (> .70). Alpha was set a priori to $p < .05$.

**Results:** Males with PFP were heavier and taller than females with PFP ($p < .05$), but there was no difference in symptom duration, pain, or disability, ($p > .05$). Males with PFP had greater hip abduction and extension torque, less HFPPA, and greater ipsilateral LTM than females with PFP. Hip abduction torque was associated with KFPPA (r= -.61, p=.003), HFPPA (r=.39, p=.02), and LTM (r=-.45, p=.007) in females, but not in males. Hip extension torque was not associated with SLS kinematics in females (p=.39-.99), but males had moderate, associations with HFPPA (r=-.41, p=.044) and pelvic drop (r=.42, p=.013).

**Conclusions:** Males with PFP had greater hip torque but performed a SLS with less HFPPA and greater ipsilateral LTM than females with PFP. Lesser hip abduction torque was associated with greater KFPPA, HFPPA, and LTM in females while greater hip extension torque was associated with lesser HFPPA and pelvic drop in males during a SLS. Differences in hip torque between sexes and associations with SLS performance suggest different intervention strategies may be warranted for females and males with PFP.

This work was supported by the Office of the Assistant Secretary of Defense for Health Affairs through the Peer Reviewed Orthopaedic Research Program under Award No. (W81XWH-22-1-0532). The funding source provided feedback on the design of the study but will not have any role in its execution, analyses, interpretation of data or decision to submit results. Opinions, interpretations, conclusions and recommendations are those of the authors and are not necessarily endorsed by the Department of Defense.

**Test-Retest Reliability and Concurrent Validity of Daily Athlete Health Surveys in Collegiate Athletes**

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**Context:** Short daily surveys are common in elite sports to capture psychological outcomes, but there is no information on the surveys test-retest reliability and construct validity. The purpose of this study was to determine the test-retest reliability and validity of daily athlete health surveys in collegiate athletes.

**Methods:** Collegiate athletes (n=142, 48M, 94F) completed daily athlete health surveys on their smartphone device during a competitive season between 2021-2023. Participants responded to sliding scale questions regarding readiness (scored from 0-100), Fatigue, Stress, and Sleep Quality (-5 [indicating low or poor scores] to +5 [indicating high or "good" scores]). At preseason and midseason times, participants completed the perceived stress scale (PSS-10), Pittsburgh sleep quality index (PSQI), Overuse Injury Scale (OSTRC), and the Acute Recovery and Stress Scale (ARSS). To assess test-retest reliability, intraclass correlation coefficients (ICC) were calculated from daily athlete health survey data subsetted from participants who completed the survey twice on the same day. Precision was calculated as the standard error of measurement (SEM). To assess validity, Pearson r and Spearman rho (ρ) correlation coefficients (depending on data normality) were used to assess the relationship between each 30-day average athlete health variable and the corresponding validated survey.

**Results:** All daily athlete health variables demonstrated either good or excellent reliability (ICC = 0.86 – 0.91; SEM = 0.593 – 4.82). Daily stress was correlated with the PSS ($r = -0.34$, $p < 0.001$), daily sleep quality was associated with the PSQI ($r = -0.48$, $p < 0.001$), and daily readiness was associated with the OSTRC ($\rho = -0.18$, $p = 0.025$). Daily fatigue and stress were associated with the recovery and stress dimensions of the ARSS ($\rho = -0.31 – 0.39$, $p<0.05$). Daily sleep quality was also associated with the recovery dimension of the ARSS ($\rho = 0.34$, $p = 0.004$). These indicate convergent/concurrent validity.

**Conclusions:** Although all daily health variables demonstrated acceptable reliability and precision, sleep quality, stress, and fatigue were most closely correlated with the outcomes scores of their validated surveys. Daily readiness was associated with the OSTRC, but the strength of the association was weak. Clinicians should feel comfortable using measures such as stress, sleep quality, and fatigue as part of daily health surveys to identify athletes. Clinicians should exert caution when using readiness and other more nebulous psychological measures.

**Patient-Reported Function in Patients With Chronic Ankle Instability Improves Following Rehabilitation Regardless of Transcranial Direct Current Stimulation Intervention**

Everhart KL, Howard JS, Skinner JW, Grattan SA, Roberts SE, Watson MG, Needle AR: Appalachian State University, Boone, NC

**Context:** Patients with CAI report diminished function and HRQL compared to uninjured individuals. Recent work has highlighted the role of improving neural excitability on improving HRQL in patients with CAI, achieved by combining therapeutic exercise with transcranial direct current stimulation (tDCS) over the motor cortex. As this represents one potential application, we aimed to compare motor versus frontal cortex stimulation combined with rehabilitative exercise on HRQL in patients with CAI.

**Methods:** This study implemented a double-masked randomized controlled trial design in a university research laboratory. Forty-five individuals with CAI volunteered for this study, with power estimates indicating 11 per group were needed to detect differences (β=0.95, f=0.27). Participants reported for testing sessions at 2-week intervals including baseline (week 0), mid-training (week 2), post-training (week 4), and retention (week 6) during which participants completed the Foot and Ankle Ability Measure (FAAM) and Disablement in the Physically Active Scale (DPAS). Additionally, at mid-training, post-training, and retention, participants also provided a Global Rating of Change (GRoC). Between baseline and post-training, participants reported for 8 total sessions of rehabilitative exercise with tDCS. The 20-minute sessions consisted of obstacle course walking, single-limb reactive balance, and lateral agility exercises of progressing difficulty. Prior to exercise, participants were instrumented with tDCS to receive either motor or frontal cortex anodal stimulation (1.5mA over 18 minutes) or sham stimulation (1.5mA over 1 minute). Scores on the FAAM, DPAS and GRoC were compared with factorial analysis of variance to compare group (Motor, Frontal, Sham) and time (α=0.05).

**Results:** Of the 45 recruited, 37 individuals completed the entire study (Frontal: n=11, 23±6 yrs, 175.3±12.6cm, 73.2±12.5kg; Motor: n=14, 23±3 yrs, 169.3±12.9cm, 69.3±14.0kg; Sham: n=12, 26±6 yrs, 170.3±9.1cm, 72.4±16.6kg). Across all outcomes, there were no significant group-by-time interaction effects or group main effects (P>0.005). However, significant effects of time were noted for FAAM (ADL: F[3,99]=4.34, p=0.002; Sport: F[3,99]=11.80, p<0.001) and DPAS (F[3,99]=7.80, p<0.001). Further GRoC indicated improvements and GRoC (F[2,66]=18.4, p<0.001), ranging from "a tiny bit better" (1) at mid-training to "somewhat better" (3) at retention (Table).

**Conclusions:** This study demonstrated small-to-moderate improvements in patient-reported outcome measures following a 4-week intervention, regardless of whether tDCS was delivered. Previous evidence has found that tDCS interventions have improved disablement; however, that was with a more concentrated motor intervention. Collectively, these data suggest that while rehabilitation can improve outcome measures, tDCS-benefits may be dependent on exercise selection.

This study was funded by the National Athletic Trainers' Association Foundation.

**Table:** Means (standard deviations) for scores on the Foot & Ankle Ability Measure (FAAM), Disablement in the Physically Active Scale (DPAS), and Global Rating of Change (GroC) across treatment groups and time points. GROC rated from -7 to 7 with 0 indicating no change. [a] significantly different (p<0.05) from both baseline & mid-training values. [B] significantly different (p<0.05) from mid-training values.

| | | Baseline | Mid-training | Post-training | Retention |
|---|---|---|---|---|---|
| **FAAM-ADL Subscale (%)** | *Motor* | 86.1 (15.0) | 87.6 (12.5) | 90.7 (10.7) [a] | 92.1 (10.0) [a] |
| | *Frontal* | 90.0 (10.3) | 89.1 (13.6) | 89.5 (14.6) [a] | 90.4 (14.0) [a] |
| | *Sham* | 88.4 (10.9) | 92.5 (6.6) | 93.5 (7.3) [a] | 94.2 (6.9) [a] |
| **FAAM-Sport Subscale (%)** | *Motor* | 75.9 (19.5) | 79.1 (14.9) | 83.9 (13.4) [a] | 83.9 (13.4) [a] |
| | *Frontal* | 73.9 (22.9) | 75.7 (22.5) | 79.9 (19.2) [a] | 81.8 (16.8) [a] |
| | *Sham* | 70.5 (17.9) | 76.9 (18.4) | 80.7 (12.2) [a] | 80.7 (12.2) [a] |
| **DPAS Total Score** | *Motor* | 16.3 (15.8) | 15.3 (15.5) | 12.1 (12.9) [a] | 9.9 (11.2) [a] |
| | *Frontal* | 15.7 (16.4) | 15.4 (14.6) | 12.6 (14.1) [a] | 12.9 (14.1) [a] |
| | *Sham* | 15.7 (7.6) | 12.2 (10.0) | 9.8 (9.4) [a] | 8.2 (8.6) [a] |
| **GRoC** | *Motor* | | 1.4 (1.7) | 3.0 (2.0) [b] | 3.4 (2.1) [b] |
| | *Frontal* | | 0.83 (2.0) | 2.3 (2.3) [b] | 2.5 (2.6) [b] |
| | *Sham* | | 1.2 (2.7) | 1.8 (2.3) [b] | 2.4 (2.4) [b] |

### A Chest Injury in a High School Athlete

Jacobs D: University of Kentucky Orthopaedic Surgery and Sports Medicine, Lexington, KY

**Background:** A 16-year-old male (5'11",120 lbs.) reported to the Athletic Training room in pain and in respiratory distress. He stated he was doing box jumps for track conditioning, and during a jump he landed near the edge of the platform, the box tilted and fell backwards, and he landed on his back and shoulder at the base of the box. The patient was tender to the touch over his right posterior lower ribs and right scapula. No visible deformities were noted. He stated he had a cracking sensation during inspiration which was painful and dizziness. The parent was notified about his condition and EMS was called to transport the patient to the hospital.
**Differential Diagnosis:** 1) Rib contusion 2) Intercostal muscle contusion 3) Rib fracture 4) Rib fractures with a Pneumothorax. X-rays revealed displaced fractures to the right 9th and 10th ribs. A CT scan confirmed the fractures of the right ribs and revealed a pulmonary contusion. No other injuries were noted.
**Intervention & Treatment:** The patient was discharged once he was breathing normally, and oxygen levels were normal. He returned to school 7days after the injury and reported no problems with daily activities. Nine days after the injury he was in class and developed extreme right side chest pain, pain down his right arm and up to his jaw and began experiencing respiratory distress. He denied a new injury or fever, chills, or diaphoresis. EMS was called, he was given supplemental oxygen and transported to the hospital. The EKG was normal, and x-rays revealed a pneumothorax in the right lung. He was admitted to the hospital upon which surgery was deemed necessary. A chest tube was placed in the 4th intercostal space and air was removed from around his lung. X-rays were repeated 3-days later revealing clear lungs. The tube was then removed, and he was discharged from the hospital. The next morning the patient awakened with dyspnea, right chest pain, and sensation of a “bubble” in his chest. He returned to the ED where X-rays revealed a larger pneumothorax. A chest tube was placed in the 5th intercostal space, secured with suction drainage and x-rays confirmed placement of the tube. X-rays were ordered daily to check the size of the pneumothorax. 3-days post-surgery a CT scan was ordered revealing the size pneumothorax had not decreased. There was also a collection of air between the lung and outer surface of the lung. 6-days later x-rays revealed the pneumothorax was not decreasing and a larger chest tube was inserted. 3-days later a video-assisted thoracoscopic surgery was performed with a wedge resection of the injured upper portion of lower lobe. Mechanical and chemical pleurodesis was also performed to keep the layers of the lung lining together and chest tube was inserted. 3-days post-surgery the chest tube was removed, and he was discharged 4-days post-surgery. Two weeks later x-rays revealed clear lungs. He was cleared to return to sports six weeks after the last procedure.
**Uniqueness:** A Pneumothorax are rare and occur when air collects outside the lung but stays within the plural cavity forcing pressure on the lung causing it to collapse. Pneumothorax may be caused by traumatic events or spontaneously. A small pneumothorax may heal without treatment. In this case the pneumothorax did not present until a week after the injury.
**Conclusions:** A Pneumothorax are difficult to diagnosis on physical exam. This athlete had a risk factor of spontaneous pneumothorax due to his body type. This injury was caused by multiple rib fractures. The delay in the onset of the pneumothorax shows the importance of monitoring the patient after injury.

**A Femoral Neck Stress Fracture in a High School Swim and Cross Country Athlete**

Cerjan MC, Williams SJ, Smoot MK, Talwalker V: University of Kentucky Sports Medicine, Lexington, KY

**Background:** A 14 year old cross country and swim athlete presented with abnormal, right hip pain for two weeks after running a 5K. After being unable to continue her runs thereafter, due to the pain, the athlete came to the training room for evaluation. Both FABER, FADIR and log roll testing were found to be positive so she was sent to sports medicine for evaluation.

**Differential Diagnosis:** Femoral Acetabular Impingement (FAI) (Cam versus Pincer), Hip Flexor Irritation, Femoral Neck Stress Fracture

**Intervention & Treatment:** X-rays showed no abnormalities and sports medicine providers ordered a same day MRI. 75mg of Diclofenac was prescribed to be taken twice daily with food along with non-weightbearing on crutches. The MRI showed a femoral neck stress fracture. The athlete was to remain non-weightbearing for the next four weeks. Labs including CMP, CBC, Vitamin D, PTH, TSH, magnesium, phosphorus and a DEXA bone scan were ordered. The patient was to take Vitamin D 50,000 units per week for the next eight weeks. Another MRI was taken four weeks later. Slow advancement to physical therapy and light weightbearing would be considered pending the new results. This MRI showed delayed healing and after careful consideration early prophylactic fixation was decided on. A percutaneous screw stabilization and fixation of the right femoral neck was undergone six days after meeting with the pediatric surgeon and eight and a half weeks post initial exacerbation of hip pain symptoms. The athlete was seen two times per week for six weeks and then down to one physical therapy session per week for the last four to six weeks. At about four months post-operation the athlete was able to perform light plyometrics without increased pain. At six, the athlete was running at 80% body weight on the AlterG and was increasing up to 90%. This athlete completed her physical therapy regimen at about seven months, where she was able to run and exercise without any difficulty. She was released to return to play at this time on a running progression that was provided. This athlete is now a year out and setting her own limitations.

**Uniqueness:** This athlete was suffering from disordered eating, depression and anxiety both before and during her injury. After months of ramping up her running routine she runs at a level where she is most comfortable at; not for time nor for mileage. The athlete's workout depends on how she feels that day. After months of being uncomfortable in her own skin, in pain from her hip and mentally away from the stress of sports, this athlete has never been better.

**Conclusions:** 52% of sporting athletes typically return to the same level of sport, whereas elite athletes typically choose to end their careers after suffering femoral neck stress fractures (Robertson, Wood 2017). This athlete made the decision, a year after surgical intervention and therapy, to return fully back to her swimming routine, but reduce her running to a level that best fit her own needs. Typically, we see athletes wanting to go back to the exact level that they came in with, if not better. This athlete chose to put her own mental, physical and emotional needs above her athletic abilities. She has chosen to perform at the level that she feels the best and healthiest at. 75% of femoral neck stress fractures are nearly misdiagnosed or completely diagnosed based solely off of physical examination due symptoms normally appearing as vague (Biz, et al. 2017). The Freshman listened to both her body and mind, not regretting her injury or the path that it landed her down.

**A Leap of Faith: Traversing the Trampoline Trilemma of Training, Trauma and Triceps Rupture in a Young Athlete: Type 3 CASE Study**

Froom RJ, Martin BM, Leitch AC, Froman S, Hackett TR: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** Triceps tendon ruptures are uncommon, accounting for less than 1% of all tendon injuries in the upper extremity and 2% of all tendon avulsions.1,2 They are rare in adolescents, existing literature concentrates on incidences in middle-aged men, weightlifters, and football, typically resulting from direct trauma or eccentric overload. 3-8 This Type 3 exploration CASE study delves into a complete triceps rupture due to a trampoline injury in a high-level adolescent mogul skier. Trampoline-related injuries is a prominent concern, marked by an increase in their frequency and the diversity in their severity. The incidence of severe trampoline injuries is notably high, with a recorded annual incidence of 6.28/100,000 in children and adolescents.9,10 Trampolines are integral for training in sports like skiing and snowboarding to hone aerial skills and enhance spatial awareness, offering a controlled environment for practicing.

**Patient:** A 14-year-old male, Olympic hopeful mogul skier, complained of acute right elbow pain and pronounced swelling following a fall onto an outstretched hand during trampoline training. Initial examination by an athletic trainer revealed palpable tenderness over the olecranon and triceps tendon, with a noticeable limitation in elbow's active range of motion and an inability to extend his arm against gravity. Radiographic images showed an avulsion fracture of the olecranon, while MRI further confirmed a high-grade partial rupture of the triceps with an avulsion.

**Intervention & Treatment:** If a patient can perform active elbow extension against gravity (MMT >3/5), the injury is considered partial and can be treated non-operatively with splint protection for 4-weeks at 30° flexion. If a tear of more than 50% is shown on MRI coupled with significant loss of triceps extension (MMT <3/5), then operative repair of the torn tendon is recommended.11 Being diagnosed with a partial rupture, the patient underwent surgical repair of the distal triceps. Intraoperatively, a complete rupture of the triceps tendon was observed contradicting the MRI results. The surgical approach placed 4 anchors into the olecranon and sutures through the tendon for optimal fixation of the tendon and reincorporation of the avulsion fragment. Postoperatively he was braced to avoid flexion. At the 8-week mark emphasis was placed on early mobilization and strength. Compared to existing literature, this CASE underscored a need for a more complex intervention strategy due to the trampoline-related injury's severity, high level activity of the patient, and uncommonly young age of the patient. Given the high velocity contraction required of the triceps muscle during push off from the starting position in mogul skiing, surgical intervention was recommended even with his initial misdiagnosis of a partial rupture on MRI.

**Outcomes or Other Comparisons:** Postoperatively the patient showcased remarkable improvement in his pain, ROM, and strength. He anticipates returning to skiing at 4-months. Unlike conventional triceps injuries that require conservative management, this unique CASE presentation demanded surgical intervention followed by rigorous rehab given the patients age and high activity level. Isolated partial triceps rupture repairs have satisfactory outcomes when treated nonoperatively whereas full ruptures with associated avulsion of the olecranon, especially in an adolescent patient, necessitate operative intervention.12,13

**Conclusions:** This atypical manifestation of a triceps rupture underscores the inherent potential risks of trampoline training, especially for high-velocity sports, and stresses the importance of understanding the injury spectrum in young athletes. An astute clinical evaluation followed skepticism of MRI interpretations given the clinical presentation and targeted intervention remains paramount in managing unexpected sports-related traumas.

**Clinical Bottom Line:** Despite its benefits, trampoline training is not devoid of potential pitfalls, sometimes culminating in injuries like triceps ruptures in young athletes. A quick, precise diagnosis complemented by a specialized intervention protocol geared toward the patient's goals and activity demands can ensure a holistic recovery.

**Ankle Impingement Following Medial Malleolar Stress Fracture With Anterior Distal Tibial and Talar Neck Osteophytes in a Female Collegiate Basketball Player: A Level 4 Clinical CASE Report**

Arnold KR, Lipsett JZ, Lawrance SE: Purdue University, West Lafayette, IN

**Background:** This case report involves a 20-year-old female, collegiate basketball player, reporting medial ankle pain over 4 weeks. She noted increased, nondescript pain in the right anteromedial ankle, treated initially with activity modification and pain management measures. No MOI was identified but mild swelling in the anteromedial ankle was present. Pain was sharp in nature, made worse with repeated jumping and running. Initial radiographs were negative. A few days later, a computed tomography (CT) examination showed a small intra-articular fracture far anteromedial margin of the tibial plafond that extends 6.5 mm in craniocaudal dimension and 9.5mm in AP dimension. Sclerosis surrounds a small fracture line which extends into the region of the medial malleolus. Significant anterior and anterior medial ankle impingement with large osteophytes both on the dorsal neck of the talus and the anterior medial malleolus. An MRI showed a small early vertically oriented stress fracture of the medial malleolus. The fracture involved the anterior 40% of the distal tibial plafond and vertically extended about 1cm.

**Differential Diagnosis:** Prior to physician examination and diagnostic imaging, the differential diagnoses included: high ankle sprain, dorsal talonavicular ligament sprain, and bone contusion with edema.

**Intervention & Treatment:** The patient was given non-operative and surgical treatment options. In consultation with the surgeon and athletic trainer, the patient decided to pursue the more aggressive, surgical option, due to the long-term outcome. An open reduction internal fixation (ORIF) of the medial malleolar stress fracture was performed with two screws placed obliquely across the medial malleolus. The patient followed a standard postoperative rehabilitation protocol without incident or complication, involving progressive ROM and strengthening exercises. Approximately one month postoperative, increased weightbearing activities in an antigravity and underwater treadmill were performed. Improvements in all clinician-related impairments were seen during rehabilitation, returning to normal at approximately 6 months. Ankle ROM was slightly limited due to continued pain and impingement in the medial ankle. During her 6.5 month follow-up visit with the surgeon, it was determined the mild pain was over the anterior screw head and anteromedial tibial stress fracture sight. Continued impingement of the medial malleolus and dorsal medial neck of the talus due to the osteophytes was also noted. At this point in her recovery, the osteophytes were more painful than the stress fracture site. A second surgery was recommended to remove the osteophytes and add an additional screw to give support to the medial malleolar stress fracture site. The arthroscope was performed one week later with debridement of the talar neck, and distal tibia, and revision ORIF medial malleolar stress fracture. Following the second surgery, a similar rehabilitation protocol was used, and the patient progressed without complication. She was able to return to unrestricted athletic activities approximately 12 weeks post-operative with documented full union at the stress fracture site with only complaints of minimal pain during high-intensity athletic activities.

**Uniqueness:** This case is unique in that a young collegiate athlete had a medial malleolar vertical stress fracture and significant anterior and anterior medial ankle impingement with large osteophytes on the dorsal medial neck of the talus and anterior medial malleolus. This is a rare condition with very few documented cases in the research literature.

**Conclusions:** In many cases, patients only have a medial malleolus stress fracture. The stress fracture and bone osteophytes present in this individual led to increasing ankle impingement which complicated the case. Athletic trainers who work with at risk individuals should be aware of this potential complication and treatment as this patient had excellent outcomes and a full return to competitive athletics.

**Anterior Cruciate Ligament Reconstruction With Lateral Tibial Plateau Open Reduction Internal Fixation and Multi Meniscal Repair: Type 3 CASE Study**

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**Background:** Tibial plateau fractures(TPF) can occur concomitantly with ligamentous and meniscal injuries. ACL injuries are reported in 21.6% of tibial plateau fractures and bilateral meniscus injury is associated 23% of the time1. ACL injuries are also associated with other tibia fractures, such as a Segond fracture and tibial eminence fracture. Eminence fractures are most commonly seen in children ages 8-14 years old and are present in 40% of ACL disruptions for this age group. The Schatzker classification for TPF has been described in relation to cruciate ligament injuries in the knee. TPF have been described with high instances of meniscal injury due to the mechanism of injury3-6. The depression of the TPF has been reported to be an indicator of associated meniscal tearing3. In this level 3 CASE study the patient sustained a Schatzker II lateral tibial plateau fracture, an ACL tibial eminence avulsion fracture, medial and lateral meniscal tear, and an MCL sprain.

**Patient:** The patient is a 30 year-old male skier who presented to the clinic with left knee effusion and pain. The patient was injured while coming to an abrupt stop on his skis. The patient was first treated in the emergency department where plain radiographs and a CT scan were obtained. When he presented to clinic, he was non-weight bearing. On physical exam the patient had decreased ROM, positive Lachman, pain with valgus stress test at 30° of flexion, and medial sided calf pain. An MRI was ordered as well as an ultrasound that ruled out a DVT. The patient's clinical exam and imaging were consistent with a complete ACL disruption, medial and lateral meniscus tears and a Schatzker II tibial plateau fracture. A Schatzker II is defined as a split depression of the lateral tibial plateau.

**Intervention & Treatment:** After discussion of the risks and benefits of surgical management, the patient elected to proceed with single-staged surgical intervention including ACL reconstruction with bone patellar tendon bone autograft, medial meniscal repair, lateral meniscal repair, arthroscopic assisted open reduction and internal fixation(ORIF) of lateral tibial plateau. The TPF was treated by arthroscopic assisted ORIF due to being in conjunction with an ACL reconstruction and meniscal repair. This could be addressed in a one stage surgery due to the location of the fracture1,7. The current literature reports that a posterior root tear of the lateral meniscus is more common in the setting of a lateral displaced plateau fracture. In the case of this patient, diagnostic arthroscopy did not reveal a posterior root tear6. The patient's post-operative course was complicated by DVT, for which he was treated with therapeutic anticoagulation.

**Outcomes or Other Comparisons:** The patient was able to return to all activity without issues 7 months out of surgery. The current research states that a ligamentous knee injury with a TPF does not decrease outcome scores7. In this case, the patient progressed appropriately for an ACL injury without significant set back.

**Conclusions:** A TPF with associated ACL tear is reported at 21.6% of the time. Meniscal tearing is seen with 23% of TPF. A Schatzker II is associated with meniscal tearing 72% of the time1. Athletic trainers should be aware that ACL and meniscal injury can be associated with TPFs.

**Clinical Bottom Line:** In this case, a patient with a complex injury involving the ACL, medial and lateral meniscus, and a TPF, can be successfully addressed in a one-stage procedure. This can be done without significantly delaying recovery. The findings of this case study suggest further research and data focused on a primary ACL tear in the setting of lateral TPF.

**Bilateral Total Hip Arthroplasties in an Adolescent With Severe Osteoarthritis Secondary to Legg-Calve-Perthes Disease: Type 4 Clinical Case Study**

von Arx JL, Seiter M, Yu H: Vail Summit Orthopaedics and Neurosurgery Research & Education Foundation, Vail, CO



**Background:** A 19-year-old, recreationally active male, presented to clinic with bilateral hip pain. He was diagnosed at 5 years old with bilateral Legg-Calves-Perthes Disease (LCPD) and at 6 years old, underwent a left proximal femoral valgus inducing osteotomy that took approximately 11 months to heal and was able to fully weight bear and overall provided little benefit. He declined a second osteotomy for his right hip. The valgus inducing osteotomy was the only surgical intervention the patient underwent for his hips, otherwise he has been treating the repercussions of his bilateral LCPD with conservative treatment, such as physical therapy, anti-inflammatories, and activity modification. On examination, the patient walks with an antalgic gait with a slight valgus weightbearing axis. Bilaterally, the greater trochanter was tender to palpate with some tenderness of the pubic symphysis. Hip ranges of motion were limited bilaterally due to apprehension and discomfort. The patient had a negative Trendelenburg, negative Romberg, negative Ober and negative Thomas test. The patient had 5/5 strength bilaterally in quadriceps, hamstrings, gluteal muscles, abductors, and abductors.

**Differential Diagnosis:** Bilateral hip osteoarthritis. Radiographic images demonstrate severe osteoarthritis of the femoral acetabular joints, femoral head flattening, significant bone loss of the femoral head, and evidence of callus formation from prior proximal femoral osteotomy.

**Intervention & Treatment:** Based on the physical examination, radiographic images, health history, pain pattern, and failure of conservative treatment, the physician diagnosed him with bilateral end stage hip osteoarthritis. The only remaining treatment option with osteoarthritis this severe is bilateral total hip arthroplasties. The hardware used for both arthroplasties was a titanium cup with polyethylene lining, ceramic head, titanium stem, and was cementless secured by biologic fixation. The left hip was treated first and then the right hip was treated two weeks later. Physical therapy was immediately prescribed and implemented after each procedure with weightbearing, strengthening, and range of motion progressed as tolerated.

**Uniqueness:** LCPD is an idiopathic disease where avascular necrosis of the proximal femoral epiphysis occurs. This disease is rare and only affects adolescents, occurring at a rate of 1 out of every 10,000 children in a 5:1 ratio favoring males over females. Of all the known cases, only 12% are the hips affected bilaterally.

**Conclusions:** Understanding the demographics, signs and symptoms, and uniqueness of the disease will aid in early referral and intervention in those affected and, as a result, can prolong osteoarthritis development. In conjunction with the latter, utilizing imaging modalities and classification systems throughout the phases of LCPD is especially important in the management of the disease. Regarding hip arthroplasties, there are many ways to treat LCPD affected hips. However, the primary goal of hip arthroplasties is to produce a fixation that has optimal longevity and implant success while minimizing wear, which is made more complicated when considering the disease state of LCPD patients' hips. Hip arthroplasties in LCPD hips are highly variable and complex to treat and requires more research to determine whether there is a gold standard to hip arthroplasties in these types of patients.

**Cardiac Ablation in a Collegiate Level Athlete: A Clinical Case Report**

Palacios D, Atkinson P, Cunha K: Louisiana State University, Baton Rouge, LA

**Background:** A 18-year-old female collegiate softball player. The athlete arrived at her new university in early August 2023, where she was then sent to complete pre participation physical exams prior to the season After conducting an electrocardiogram, it was discovered that she had a slight abnormality when looking at the electrical pathways. Upon further questioning, the medical staff learned that the patient had experienced symptoms of cardiac issues, but was never evaluated. She had a single instance of syncope and reported often experiencing cardiac arrythmias but dismissed them and assumed they were normal. After her preparticipation physical, the patient was referred to a cardiologist where she completed an exercise stress test. There, it was found that she had issues with cardiac deceleration. She agreed it was often difficult to control her heartrate following physical activity. When looking at the ECG, it was evident that an additional electrical pathway was present and was diagnosed with Wolff-Parkinson-White syndrome, a pre-excitation syndrome. Wolff-Parkinson-White Syndrome (WPW) is a cardiac condition where there is an extra signaling pathway between the hearts upper and lower chambers, causing tachycardia. For this athlete, the abnormality was a Delta wave in the QRS complex of her ECG.

**Differential Diagnosis:** Ischemic heart disease or ventricular hypertrophy.

**Intervention & Treatment:** Physicians consulted, and given the antegrade conduction at peak stress, the patient should be taken in for a cardiac ablation. Cardiac ablation is a procedure that scars tissue in the heart in attempt to block the irregular electrical signals. During the procedure, catheters were threaded through blood vessels to the heart where the physician burned/froze the scarred tissue. Following the procedure, the physician determined that the athlete indeed had a major lateral bypass – meaning the athletes condition was more severe than first anticipated. Recovery after the procedure: the patient was monitored and initiated a return to play protocol. The protocol lasted a total of 7 days; 2 being complete rest days, 1 day consisting of a few activities of daily living, and the last 4 days slowly integrated more and more ADL's. Cardiac activity was also monitored and reduced when returning to sport.

**Uniqueness:** WPW syndrome is a fairly rare condition but is primarily diagnosed in infants and young children. In this athlete's case, it went undiagnosed for 18 years even though she was often symptomatic.

**Conclusions:** Due to the extent of her condition, the physician believed a second procedure would be necessary. Her follow up ECG was completely normal, and the athlete was cleared for physical activity.

**Catastrophic Knee Injury in a High School Football Player**

Williams SJ, Cerjan MN: University of Kentucky Orthopaedic Surgery & Sports Medicine, Lexington, KY

**Background:** A high school junior football player was hit with a varus force to the left knee while his leg was extended during a punt return. He is also an outfielder for baseball. He said he felt multiple pops in his knee and was unable to ambulate. The patient also complained of numbness in his foot, and he was unable to dorsiflex his ankle. Normal dorsal pulse was felt. When examined on the field by an orthopaedic resident, he felt laxity with anterior translation of the knee. The doctor also felt the athlete had a positive varus stress test at 0 degrees.

**Differential Diagnosis:** lateral collateral ligament (LCL) tear, multi-ligament knee injury (MLKI), meniscal injury, common peroneal nerve (CPN) injury

**Intervention & Treatment:** The athlete was observed over the weekend for any neurovascular changes. Three days post injury, the athlete had x-rays and MRI done, which showed an anterior cruciate ligament (ACL) tear, posterolateral corner (PLC) injury, medial and lateral meniscus tears, and stretching of the peroneal nerve. Surgery was scheduled for 11 days after injury. The ACL was repaired with a bone-patellar tendon-bone autograft, the PLC was reconstructed and both menisci were repaired. A neurolysis was performed on the CPN. There was no rehabilitation protocol to follow, so communication between all stakeholders was key for his recovery. Rehab consisted of PT visits, AT visits, and constant passive motion (CPM) machine at home. Two months after his injury, the athlete had to have a manipulation under anesthesia (MUA) to regain knee extension. EMGs were performed every 3 months to evaluate the peroneal nerve palsy. Three months post-op, the athlete discontinued crutches, and at 7 months was able to start jogging on an Alter-G. Ten months after his injury, he jogged on a football field. At 13 months, the athlete was able to evert his ankle voluntarily. Eighteen months after injury, the athlete was able to return to baseball activities while wearing functional knee and ankle braces. He progressively has had the return of 25-50% peroneal nerve function, as detected by EMG now 2 years after his injury.

**Uniqueness:** MLKI in athletics are most common in contact sports. Up to 18% of all MLKI have an associated peroneal nerve injury, with higher incidence when it involves the PCL or PLC. Patients have a better chance of recovery with a partial nerve injury than a complete injury. Nearly one-half of the patients with peroneal nerve injuries have a permanent deficit. PLC injuries have a better outcome with reconstruction as opposed to a repair. MUA is not uncommon after a MLKI. When looking at athletes, it can take up to 25 months to return to sport, with most athletes not feeling like they are at 100% until 3 years after injury.

**Conclusions:** After an athlete sustained a MLKI and CPN injury, the Athletic Trainer was not able to give the athlete the answers he wanted in terms of return to play and if nerve function would return. There is no clear-cut path for MLKI, especially with an associated peroneal nerve injury. Fortunately, the athlete was able to work hard every day for 15 months to return to the sport that he loved. He is currently 25 months out from his injury and playing baseball in college.

**Collegiate Football Player With Bimalleolar Fracture and Fracture Blisters: A Case Study**

Clark E, Stanley O, Kern A, Pipers K, Benson A: Louisiana State University, Baton Rouge, LA

**Background:** In August 2023, a 20-year-old football player sustained a left bimalleolar fracture. He reported that he made a hard cut in the middle of practice and fell to the ground. He hopped off to the sideline. Upon arriving to the athlete, he stated that he felt like his foot was "hanging off of his body". The injury presented as a lateral ankle dislocation, but the athletic trainer could not confirm due to the ankle tape. The athlete's left ankle was vacuum splinted, and he was transported to the athletic training room for physician evaluation. During vacuum splinting, drills were still occurring, and an athlete ran into the emergency action taking place on the sideline. No further damage seemed to occur. Upon taking the athlete into the athletic training room and after cutting off his cleat, tape, and socks, the ankle did not visually appear fully dislocated. He had full capillary refill, normal profusion and full sensation.

**Patient:** 20-year-old collegiate football player

**Intervention & Treatment:** The athlete had radiographs taken of his ankle which showed a supination-adduction type bimalleolar fracture with a vertical sheer medial malleolus and transverse fibular fracture. The medial malleolus appeared to be displaced by approximately 5 mm. A CT scan was obtained that day showing an articular defect out at the medial plafond that was lodged into the tibial incisura, now a loose body that likely came from the visible OCD lesion on the tibial plafond. The physicians suspected that the OCD lesion came from the initial fracture, where a chip of bone came off of the tibial plafond. Then, when the athlete self-reduced, the chip moved across into the tibial incisura. Physicians also hypothesized that the initial break may have been so violent that they chip came from the initial break. The athlete was put into a well-padded posterior slab splint with stirrups, and a plan for surgery two-days later was made. The surgical plan included left ankle arthroscopy, loose body removal, ORIF of left ankle and possible microfracture of the plafond defect.

**Outcomes or Other Comparisons:** On August 7, the day of planned surgery, the patient's splint was removed, and fracture blisters were found. This was two days after injury. The blisters were drained, and the patient was put back into a posterior slab splint, plan for wound check the following week. On August 14th, there was some improvement, but blisters were still present. They were drained again, then the left ankle was put into another splint, with a follow-up planned for the next week. On August 21st, the blisters were well healed enough to proceed with surgery, approximately two weeks after the initial injury. Surgery occurred on August 22nd.

**Conclusions:** Fracture blisters are an uncommon condition and create additional problems including surgical delays and higher infection risk. While treatment is still debatable, research should continue on how to prevent this complication, and identify potential underlying factors that cause them. This case study shows how quickly blisters can arise, and how they delay surgery.

**Clinical Bottom Line:** Fracture blisters are a complication of bone fractures that are relatively uncommon. When they do occur, it is usually in places where skin is tightly on bone and there is little room for subcutaneous fat cushioning. They resemble that of a blister from a second-degree burn and can be filled with blood or a clear fluid. Some surgeons suggest treating them as burns, but there is no consensus on treatment. However, the blisters must heal before surgery. They develop between 6-72 hours post-injury and are primarily caused by the shearing forces placed on the skin, due to the angulation of a bony fracture.

**Concurrent Epstein-Barr Virus and Cytomegalovirus Infections in a Collegiate Baseball Pitcher: A Case Report**

Parker HN, Jacobsen AP, Galbraith RM, Warner BJ, Cage SA: The University of Texas at Tyler, Tyler, TX; UT Health East Texas, Tyler, TX; University of Texas Health Science Center, Tyler, TX; Grand Canyon University, Phoenix, AZ

**Background:** A 22-year-old male collegiate baseball pitcher reported to the athletic training staff complaining of fatigue, body aches, and decreased performance. The patient was afebrile, and denied any previous instances of fever or chills. Onset of symptoms was reported as two weeks before seeking care from the athletic training staff, and decreased performance was categorized by a significant decrease in pitch velocity without a musculoskeletal injury. The patient denied experiencing a fever prior to reporting to the athletic training staff, and did not recall being around anyone who had been ill in the days prior to experiencing symptoms. The patient did report that his significant other had been diagnosed with Epstein-Barr Virus the previous month, and had since recovered. Given the duration of symptoms, and the significant decrease in performance, the patient was referred to the team physician for further evaluation.

**Differential Diagnosis:** Epstein-Barr Virus, Overtraining Syndrome, Other Viral Infection.

**Intervention & Treatment:** At the time of initial physician evaluation, the patient reiterated that he had not experienced a fever during the course of symptoms. Patient reported mild point tenderness in the upper left abdominal quadrant. Over the course of the past month, the patient had not seen a significant increase in frequency, intensity, or volume for physical activity, and had been taking regular rest days to allow for recovery. In the absence of another potential diagnosis, the patient was referred for testing for mononucleosis, an abdominal diagnostic ultrasound, standard complete blood count panel (CBC). In the interim, the patient was instructed to withhold from vigorous physical activity and any drills in practice that might have resulted in blunt force trauma. All measures on the patient's CBC returned within normal limits. However, diagnostic ultrasound revealed mild enlargement of the spleen. The patient's mononucleosis culture also revealed the presence of Epstein-Barr Virus and Cytomegalovirus. The official diagnosis of the concurrent infection was rendered approximately three weeks after the initial onset of symptoms. The patient was instructed to avoid vigorous activity or contact drills during practice for an initial week to account for the observed splenomegaly. At the beginning of week five, the patient was allowed to begin gradually increasing intensity of physical activity and was allowed to resume contact drills during practice. Based on patient reported symptoms and average pitch velocity, the patient reached pre-infection levels of performance at roughly three months post infection.

**Uniqueness:** While Epstein-Barr Virus is estimated to infect 95% of the human population, the majority of individuals who contract Epstein-Barr Virus remain asymptomatic throughout the course of infection. In this case, the patient experienced fatigue, body aches, and decrease in physical performance. Additionally, the concurrent infection with Cytomegalovirus made this case more unique. Concurrent infections of Epstein-Barr Virus and Cytomegalovirus are not uncommon among patients who are immunocompromised. However, the patient presented in this case was an otherwise healthy young adult with no immunodeficiency.

**Conclusions:** When providing care for patients, timely referral and diagnosis is crucial. In this case, had the patient not had activities modified during the progression of his illness there was an increased likelihood of splenic rupture. When caring for patients, it is important clinicians consider all patient reported signs and symptoms. Educating patients on the necessity to report symptoms that do not fall within normal limits is important to ensure that healthcare providers can render the appropriate care. Athletic trainers should provide patients with opportunities for education on the signs, symptoms, and implications of common communicable diseases they may encounter.

**Covid Induced Atelectasis in a High School Athlete**

Lyvers RC, Garrett WZ: Marshall University, Huntington, WV

**Background:** High school aged male got diagnosed with covid in Fall 2021. The athlete was out for an extended period of time due multiple other illnesses. Parainfluenza 4, bronchitis, rhinovirus, and flu in combination with covid-19 caused the athlete to have decreased lung function. The athlete was cleared by a physician to return to play. When the athlete returned to play he complained of shortness of breath and had a productive cough post exercise. It was reported by the athletic trainer that his blood oxygen stats decrease rapidly during physical activity. Lung sounds were normal upon further investigation. The athlete was referred to a cardiologist and pulmonologist for further examination. Initial diagnosis from the original physician was asthma. With continuing decrease in lung function and athlete complaining of shortness of breath and being light headed the athletic trainer suggested further testing. After further testing the cardiologist and pulmonologist agreed on the diagnosis of atelectasis.

**Differential Diagnosis:** Atelectasis, asthma, long-term covid, parainfluenza 4, bronchitis, rhinovirus, flu

**Intervention & Treatment:** The athlete was able to play upon clearance from both cardiologist and pulmonologist. An inhaler was prescribed and the athlete was directed to use it prior to exercise. The athlete was also instructed to use a nebuliser with medication to help decrease the fluid build up in the lungs. Continual testing and monitoring of the athletes lung function has occurred from Fall 2021 until completion of their High school career. This includes CT scans and Pulmonary function tests. The initial PFT results showed values, not WNL. No significant increase or decrease in lung function was shown throughout the testing period according to the PFT. The atelectasis is still present in the athletes lungs as shown by the CT scans. A surgical intervention was suggested by the physician but due to the aggressive nature the surgery has been delayed until the athletes are finished with his athletic career.

**Uniqueness:** Atelectasis is seen primarily in surgical cases where the patient undergoes anesthesia. The patient's condition initially started with Covid-19. Long Covid also has shown to have significant limitations in activity among young adults. Among young adults 7.5% have shown to have a decrease in activity in 2022 and 6% in 2023. Long covid has shown long term lung effects in 7.5 % of population in 2022. In 2023 that number decreased to 6%. This shows that less people are experiencing long term lung effects from covid after a year.

**Conclusions:** The lasting effects of Covid-19 and the development of atelectasis has affected this athletes playing career drastically. A healthy high school aged athlete now has to rely on medications and treatments to have any chance for increased lung function. This case shows how Covid-19 pulmonary illnesses vary and may have long term effects on an athlete's participation in activities. The case also can inspire future studies and treatment plans for athletes and active populations who suffered from the long term effects of covid.

**Cutaneous Reflex Characteristics During the Stance Phase of Gait in an Individual With Pre-Surgical Mechanical Ankle Instability**

Friedman AMH, Madsen LP: Indiana University Bloomington, Bloomington, IN

**Background:** Recent studies exploring chronic ankle instability (CAI) have found alterations in cutaneous reflexes of musculature surrounding the ankle which may contribute to perceived instability and recurrent LAS seen in this population. Since CAI is considered a multifaceted condition, patients present with a collection of interrelated pathomechanical, sensory-perceptual, and motor-behavioral impairments making it difficult to determine the underlying cause of these altered reflexes. This case study was conducted to preliminarily explore how known pathologic laxity of lateral ankle ligaments affects sural nerve cutaneous reflexes during gait.

**Patient:** A physically active 25-year-old female (64in;130lbs) presented with mechanical instability of her left ankle diagnosed by her orthopedic physician. Her pathologies included a grade 3 tear of the calcaneofibular ligament (CFL) and presence of an os trigonum. A Broström reconstruction of the CFL via allograft was scheduled including a partial synovectomy and debriding of the affected region. Two days prior to surgical intervention, the case subject reported to our lab for testing where she noted 7 previous sprains in her left ankle and scored 31 on the IdFAI, 10 on the CAIT, and 51 on the FAAM. Chief complaints included pain during sport, and recurrent feelings of instability during ADLs, namely when walking downstairs or on uneven surfaces.

**Intervention & Treatment:** Muscle activity of the tibialis anterior, peroneus longus, medial and lateral gastrocnemius, biceps femoris, and rectus femoris of the affected limb was measured continuously as the subject walked on a treadmill at 4 km/hr. Random, non-noxious stimulations were administered to the sural nerve to elicit cutaneous reflexes across 8 equal phases of the gait cycle, 10 trials for each phase. Average middle latency reflex amplitudes (MLR=80-120ms post-stimulation) were calculated for each phase and normalized based on unstimulated muscle activity.

**Outcomes or Other Comparisons:** While conducting earlier group studies, our lab has found that healthy control subjects (n=24) and CAI subjects (n=24) exhibit PL facilitation throughout stance phases 2 (Control=32.9%; CAI=32.6%), 3 (Control=40.7%; CAI=29.8%), and 4 (Control=44.0%; CAI=26.8%). However, this case subject exhibited much lower PL facilitation in phases 2 (1.31%) and 3 (2.25%), and even inhibition in phase 4 (-2.78%). Previous literature also provides evidence for consistent PL facilitation throughout the stance phase of gait in both healthy controls and those with CAI, indicating this case's PL reflex pattern does not align with either subject group. Reflex activity of the other muscles measured during the stance phase were generally aligned with healthy controls.

**Conclusions:** PL facilitation during stance would increase dynamic stability of the lateral ankle following an unexpected perturbation. This case's lack of facilitation may leave them at greater risk for re-injury than other populations. Mechanical instability resulting from torn lateral ankle ligaments may contribute to the reflex variations seen in this case subject. While those with CAI are typically categorized based on symptoms of pain, instability, and recurrent sprain history, the CAI subjects included in earlier studies may not have had significant levels of pathomechanical impairments. The addition of prominent mechanical limitations are unique features in this case subject which provide further insight to the relationship between sensorimotor and pathomechanical deficits. Considering the heterogeneity of CAI, patients with this condition should be treated based on their specific symptoms rather than a one-size-fits-all rehabilitation protocol.

**Clinical Bottom Line:** Identifying the specific limitations experienced by an individual with CAI will allow for a more effective treatment and provide improved long-term health-related quality of life outcomes. The unique reflexive alterations observed in this case may act as a clinical marker for treating chronic symptoms among individuals with pathological laxity in the ankle. Future research would benefit from measuring these reflexes before and after reconstruction to determine if reflex patterns return to normal as other symptoms improve.

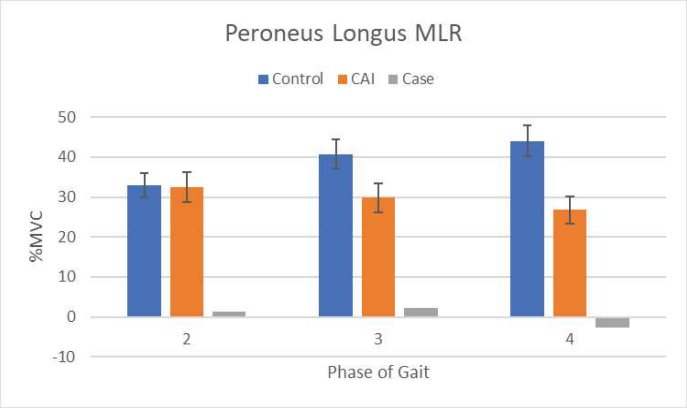


**Fig 1:** Net middle latency reflexes throughout the stance phase (2, 3, 4) in healthy controls (n=24), individuals with CAI (n=24), and the case subject (n=1). Error bars represent standard error at each phase of gait for the grouped data.

**Distal Triceps Rupture in High School Football**

Veress J, Fruscella V, Lowy N: Kean University, Union, NJ, and Carteret High School, Carteret, NJ

**Background:** Distal triceps rupture occurs when the tricep tendon detaches from its attachment point on the olecranon process of the ulna resulting in partial or complete weakness of elbow extension. This injury is rare and has an incidence rate of 0.8%. There are multiple risk factors for sustaining a distal triceps tendon rupture, however, this injury can occur simply as a result of trauma. Typically the signs and symptoms of this injury include pain, hearing or feeling a "pop" in the elbow at the time of injury, swelling and ecchymosis. There are different repairs for this injury and unless the patient is unfit for surgery, surgery is typically recommended.

**Patient:** A sixteen-year old high school football athlete suffered a right arm complete distal tricep tendon rupture during a football game. The athlete had an opposing player tackle his extended arm at full force creating an axial load. The athlete immediately heard and felt a pop as well as had immediate bruising and swelling. The athlete had no previous injuries to this area or any medical conditions.

**Intervention & Treatment:** Upon initial assessment the athlete had immediate pain and point tenderness over the distal tricep along with a gap was felt where the tendon inserts. The athlete's arm was in a full flexed position unable to extend it. The athlete was taken to the sideline where ice and a sling was applied. The athlete was transported to the emergency room for further testing where they did an XRay and an MRI. After the testing the doctors discovered a full tear of the distal tricep tendon and recommended he needed surgery over the next few weeks.

**Outcomes or Other Comparisons:** The athlete did have the surgery two weeks after the initial injury. There are two main surgeries to repair the tendon and the athlete had the suture anchor repair surgery. Given the athlete is so young, this surgery tends to be the stronger option. Even though every patient is different, the ideal time for him to heal with rehab is approximately 6 months. Immediately following surgery the athlete is completing wrist extension and flexion exercises keeping him pain free and minimizing the effects of immobilization.

**Conclusions:** With this injury being so rare, when it does occur it requires immediate surgery inorder for the best outcomes. Ideally it should be repaired within two weeks of the injury occurring but could wait as long as six weeks. However, given it is so rare it can be difficult to diagnose and oftentimes be misdiagnosed in the emergency department. Given the athlete's symptoms along with loss of range of motion and the gap, the athletic training staff immediately referred for imaging.

**Clinical Bottom Line:** The distal insertion of the triceps can rupture from a block activity involving sports such as football. Immediate imaging is required for appropriate diagnosis and surgery is necessary to repair the tear.

**Emergency Fasciotomy in a Collegiate Football Player: A Type 4 Clinical CASE Study**

Renna B, Jordan A, Odai ML: Florida International University, Miami, FL

**Background:** A 21-year-old collegiate running back sustained a direct blow to his left thigh during a spring football scrimmage. Initial evaluation on the field by the Athletic Trainer (AT) presented no immediate findings except for a pain level of 4/10. The athlete was instructed to report to the athletic training facility following the scrimmage, which he did not do. The next morning, the athlete woke up with soreness and limited mobility of the left leg, both of which got better throughout the day. However, his symptoms worsened that evening and included a pain level of 9/10, ecchymosis, and his quadriceps with 'rock hard'. He was taken to the emergency department by his mother. Due to it being an off day from practice, the athlete decided not to call or inform his AT.

**Differential Diagnosis:** Differential diagnosis included quad contusion and muscle strain.

**Intervention & Treatment:** The emergency department physician evaluated the athlete and diagnosed him with compartment syndrome via manometer measurements. A fasciotomy was performed three hours after admission to the hospital and included a hematoma evacuation in the deep quadriceps muscles/anterior compartment. The athlete was released from the hospital 3 days following surgery. He began rehabilitation with the AT the next day. The athlete was non-weight bearing on crutches for 10 days. Initial treatment focused on wound healing and pain reduction. Range of motion and strengthening of the hip, knee, and ankle followed. Six weeks post-surgery, the athlete began jogging and was cleared to progress as tolerated 11 weeks post-surgery. He maintains numbness and swelling on the lateral thigh. Biodex testing 15 weeks post-surgery revealed sufficient strength in the affected leg and the athlete was allowed to return to practice. One week later, while taking limited reps with the scout team, the athlete tore his left Achilles tendon. He was ruled out for the remainder of the season and will continue rehabilitation for both injuries.

**Uniqueness:** Acute anterior compartment syndrome of the thigh is rare and can be both limb threatening and life threatening. It requires urgent diagnosis and a disparity in outcomes results from different mechanisms of injury, severity of soft tissue trauma, fracture, and/or the timing of treatment. Once thigh compartment syndrome is identified, immediate and complete compartment releases are required to prevent further ischemic insult to the tissues.

**Conclusions:** Although the athlete did not report to the facility the day of the injury, during their brief encounter on the field, the AT educated him on what signs and symptoms to monitor. This interaction, although brief, was critical to the timely surgical intervention. There is suspicion that compensation played a role in the subsequent Achilles tendon rupture. It is important that an athlete feels physically and mentally prepared to return to play following such a significant lower extremity injury and surgery such as compartment syndrome. Additionally, communication between the operating physician and AT has been difficult because the athlete went to an emergency department outside of the team's affiliation.

**Failed Lower Extremity Fasciotomies Lead to Subsequent Split Posterior Tibial Tendon Transfer: Type 3 CASE Report**

Smith KS, Martin BM, Haytmanek CT: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** Traumatic compartment syndrome(TCS) is an increase in intra-compartment pressure(ICP) within a closed osteofascial compartment, typically occurring in a high-energy trauma(HET). TCS is a medical emergency often requiring immediate intervention to prevent loss of limb function, loss of limb, and even loss of life.1 There is currently no definitive consensus surrounding the safe time from injury to the necessary surgical intervention for treatment of TCS, though shorter times are favored. Fasciotomy is a surgical procedure in which the compartment is released with a longitudinal incision(s) to decrease ICP. Normal ICP for lower leg range from 0-8mmHg, pressure greater than 30mmHg is indication for fasciotomy.2 Early fasciotomy is one performed within 8-hours from onset of TCS and can prevent loss of limb function, or loss of limb.3

**Patient:** 51-year-old male presented to the emergency department(ED) with left knee and lower leg pain 4-hours following a HET while skiing. He described immediate knee pain following a rotational mechanism. He presented with severe pain, swelling, numbness, and tingling. Radiographs of the left lower leg and knee revealed a comminuted fracture of proximal tibia involving tibial plateau near midline with slight separation of fracture fragments measuring 5mm. CT angiogram of the left lower extremity revealed a comminuted fracture of tibial plateau, compression and 70-75% narrowing of popliteal artery, loss of opacification of the anterior tibial artery, and hemorrhages in the deep soft tissues between the soleus and gastrocnemius muscles. Anterior compartment pressure(ACP) was measured at 140mmHg.

**Intervention & Treatment:** Patient underwent a fasciotomy based on clinical exam and ACP readings. He had continued severe discomfort with compartment re-checks. Based on his worsening clinical exams, he underwent a postoperative ACP check, confirming persistent elevated compartment pressures and he was taken for a revision fasciotomy extending to the other three compartments of the leg. He subsequently underwent 4 additional surgeries for washout, debridement, and bicondylar tibial plateau fracture fixation with external fixator. He developed foot drop resulting from irreversible cell death in the anterior compartment of the left lower extremity. He was placed in an ankle foot orthosis(AFO) to combat equinus contracture and improve ambulation. He presented to our clinic 4-months following initial injury. Upon physical examination of the ankle he had 5° dorsiflexion, 45° plantarflexion, 10° eversion, and 15° inversion. Loss of peroneal nerve function was noted. Patient underwent a split posterior tibial tendon transfer to lateral cuneiform. Postoperative restrictions included, splinted NWB for 2-weeks, at which point he was placed in a short leg cast with foot in neutral position. The cast was removed at 6-weeks postoperatively, and he was transitioned into AFO until 6-months postoperatively.

**Outcomes or Other Comparisons:** At 3.5-month postoperatively ROM restrictions were lifted, and he was advised to continue working on strengthening, as he was noted to be able to dorsiflex to neutral. Posterior tibial tendon transfers are a commonly utilized intervention for foot drop, as they have shown to lead to positive outcomes with function and patient satisfaction. The tendon footprints vary, with no definitive transfer site for optimal postoperative outcomes.4,5

**Conclusions:** The “5 Ps” represent the signs and symptoms for recognizing TCS, however, some represent late findings.1,2 Improved awareness surrounding appropriate recognition and treatment of TCS is necessary to prevent the long-term consequences of untreated TCS. In patients with HET, TCS should be a suspected differential diagnosis and monitored for in patients presenting with HET with serial examinations and compartment pressure checks if indicated.

**Clinical Bottom Line:** Understanding risk factors to TCS in the acute practice setting has the potential to preserve limb or life. Timely interventions via fasciotomy is a critical decision that must be considered once TCS has been identified.

**Functional Outcome Measures and Mental Readiness to Return to Sport After Anterior Cruciate Ligament Reconstruction (ACLR): Type 1 Validation CASE Report**

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**Background:** After anterior cruciate ligament reconstruction (ACLR), functional outcome scores and mental readiness scores are obtained to better understand an individual's physical and mental preparedness for return to sport (RTS) and reduce the risk of re-injury. Prior observational studies report data at 6 months and at 2 years post-ACLR, but not 3 months post-ACLR and RTS. The purpose of this type 1 validation CASE report is to examine functional outcome measures and mental readiness to return to sport status through the post-operative rehabilitation process at 3 months post-ACLR, 6 months post-ACLR, and unrestricted RTS.

**Patient:** We tracked the recovery of a 23 year old NCAA Division lll collegiate women's soccer athlete who ruptured her left ACL (mass=70.45 kg, height=68.00 cm). She previously tore her right ACL six years prior, underwent ACLR, and made a full RTS. At the time of current injury, she complained of a “crack” and instant pain with a valgus force from an impact as the mechanism of injury. Upon observation of an effusion and limited range of motion, the athletic trainer referred her to the team physician and an MRI was ordered. Imaging confirmed the diagnosis of a left ACL tear and medial meniscus tear.

**Intervention & Treatment:** The patient underwent ACLR in October 2022. She completed functional outcome measures at 3 and 6 months post-ACLR as well as RTS. We used the Lower Extremity Assessment Protocol (LEAP) to obtain functional outcome measures. The LEAP included isokinetic strength tests at 90 and 180 degrees/s, vertical 4-hop test, jump landing, single limb hop test, and single leg balance. We also administered the KOOS, ACL-RSI, and IKDC forms, all of which have been found to be valid and reliable, to determine patient outcome measures. All functional outcome scores and objective measures were measured in the same controlled laboratory clinic at each time point. The athlete was cleared to play in August 2023, approximately 10 months post-ACLR.

**Outcomes or Other Comparisons:** Patient data can be found in the Table. At the 3 month assessment, the patient was above average for the KOOS and ACL-RSI, but below average on the IKDC and well below average for peak quadriceps torque at 90 degrees/s. The patient did not perform the triple hop or single leg hop at 3 months postoperatively because it was contraindicated based on her physical exam. At the 6 month interval, her ACL-RSI, IKDC, and average peak torque were below average and her KOOS score was average. Her triple hop and single leg hop were above average. At RTS, her KOOS, ACL-RSI, triple hop, and single leg hop were above average. However, her IKDC, and average peak torque was below average.

**Conclusions:** Our report highlights the clinical use of objective testing to identify patient-specific deficiencies throughout post operative rehabilitation that we used to guide exercise prescription. The changes between testing points enabled identification of improvements or declines in physical and patient-reported function. The objectiveness of the outcome measures informed clinical decisions on adjusting rehabilitation prescription, leading to successful RTS.

**Clinical Bottom Line:** Objective testing that includes patient reported outcome measures is critical information to optimize post operative rehabilitation following ACLR. Data-informed RTS decisions can help guide patients to safe participation in physical activity and sport.

**Hodgkin's Lymphoma in a Division I Cross Country and Track and Field Athlete**

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**Background:** A 19-year-old female Division I cross country and distance runner reported a palpable supraclavicular mass at the beginning of indoor track and field Season. The student athlete reported no additional symptoms related to her mass at the time of initial evaluation, but she also reported higher than usual levels of fatigue. She also had a primary relative with Hodgkin's Lymphoma

**Differential Diagnosis:** Hematoma, Lipoma

**Intervention & Treatment:** The student athlete contracted COVID-19 soon after reporting her mass and was referred to a team physician with subsequent referral to an oncologist after exiting isolation. The team physician ordered lateral and AP chest X-ray which were unremarkable. The Oncologist prescribed augmentin as well as ordering a CT scan with contrast and CBC with differential. The finding from the CT revealed three supraclavicular masses, the largest measuring 2cm in diameter. The CT also showed a paratracheal mass measuring 3.1cm. The parotid, submandibular, and thyroid glands presented as unremarkable. Following the diagnosis of Hodgkin's Lymphoma, the student Athlete began chemotherapy treatments every two weeks for a 6-month period. During the chemotherapy treatment, the student athlete maintained cardiorespiratory fitness without concern for sport specific training. Reduced impact training was utilized throughout return to play including running on the Hydro Worx™ and reduced body weight jogging on the Alter-G™ treadmill. Stationary biking was also utilized as a cross-training modality to maintain cardiorespiratory fitness.

**Uniqueness:** Cancer is an uncommon diagnosis in the college aged athletic population. Early recognition followed with prompt referral for diagnosis and treatment increases survivability even return to play. In this case, this student athlete had a quick diagnosis and returned to play the following season.

**Conclusions:** Athlete returned to play for the fall 2023 season and no longer reports any symptoms. There is limited research conducted on Hodgkin's Lymphoma and return to sport in college athletics regarding diagnosis and return to play.

**Isolated Gracilis Tear in a Collegiate Women's Soccer Player**

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**Background:** Injury to the adductor muscle group rarely involves the gracilis and there is a lack of information on the clinical presentation pattern of isolated gracilis muscle tears. A previous case series reported 7 instances of gracilis tears in athletes. Many reported initial sharp pain, no bruising, functional limitations with internal rotation and adduction of the leg and delayed seeking medical advice. Our patient had a contrasting presentation with a palpable, firm lump without initial pain, diffuse ecchymosis, and limited functional impairment. This case was consistent with previous findings of good tolerance of pain, a resolution within 6 weeks, and no re-injury.

**Patient:** : A 20-year-old women's collegiate soccer goalie presented after a game with edema on the posterior aspect of their right knee along with a firm lump that was palpable on the posteromedial side. The patient reported discomfort with knee extension but experienced no pain with knee flexion or manual muscle testing (MMT) to the hamstrings and adductors. Over the next few days, the patient developed ecchymosis migrating up the posterior thigh, and was referred to the team physician. The team physician utilized diagnostic ultrasound which showed a full thickness gracilis tear with hematoma formation. She was prescribed meloxicam and told she could try to participate as tolerated since the team was starting post-season play-offs.

**Intervention & Treatment:** The patient was treated for the diffuse ecchymosis with modalities, rehabilitation exercises to improve range of motion, and hip and groin strengthening to stabilize the hip core. For practices and games, the patient was fitted with a protective pad for the medial portion of their knee and a mulligan taping that assisted internal rotation and limited end range extension. They practiced as tolerated leading up to the first game, with limitations to the number of punts and amount of live action in drills.

**Outcomes or Other Comparisons:** The patient participated fully in a game six days later but had pain and decreased ROM post-match, which was managed with unloading and modalities. They completed the season participating in 4 additional post-season matches at full capacity. At the end of the season, they were advised to unload and rest, which resulted in injury resolution

**Conclusions:** Acute groin injuries commonly occur in soccer players in the adductor longus, leading to limitations in running and cutting and usually clinical findings of painful palpation and weakness during MMT have a high diagnostic accuracy. This patient had a gracilis tear with no reported mechanism of injury. Patients reporting medial thigh pain after eccentric contraction during hip adduction may have sustained injury to the gracilis. In this case, it likely happened during a routine punt. Although the distal gracilis MTJ was injured, palpation and manual muscle test did not initially distinguish the severity of the injury.

**Clinical Bottom Line:** Athletic trainers should be aware of discrepancies between clinical presentation and true anatomical pathology in acute groin injuries. Isolated gracilis tears, though anatomically severe, are well tolerated and often go under-reported due to the surrounding supportive musculature. In this case ultrasound was helpful in aiding the diagnosis. These injuries are managed well with a combination of unloading, taping and hip core strengthening allowing an athlete to participate in meaningful games with limited long-term consequences, since re-injury is not common.

**Non-Contact Chronic Cervical Radiculopathy in a Colligate Volleyball Player: Level 4 Case Study**

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**Background:** A 21-year-old female volleyball player presents with atypical signs of peripheral cervical radiculopathy and right shoulder pain. The patient reported 6 months prior with insidious radicular right shoulder pain. Previous medical history included Thoracic Outlet Syndrome of the right shoulder. On initial evaluation, peripheral radicular pain in shoulder and fingers was10/10 through PROM and AROM of abduction, flexion in the scapular plane, external rotation above 90, cervical lateral bending, and cervical rotation. Tenderness to palpation on the superior and anterior subacromial and the posterior levator of her right shoulder. The patient was (-) for discoloration or swelling in the shoulder or extremity. Special tests showed (+) for Drop Arm, Cervical Compression and Distraction, Cross Over Impingement, Hawkins Kennedy, and Empty Can tests. (-) for Spurling's, O'Brien, Jurgensen, and AC joint compression tests. Allen's, Roos, and Brace test were inconsistent. The vascular study was inconclusive. Two Electromyography tests were done, the first was negative, the second test showed possible occlusion due decreased signal. X-ray of the upper thoracic spine ruled out pathology to the 1st rib. The patient had a (-) Dopler. Two MRI tests were performed to assess the glenohumeral joint and cervical spine. The glenohumeral MRI showed no ligament or tendon pathology but did display bursitis. The patient was injected with a corticosteroid into the bursa that had no effect. A cervical spine MRI showed a partial bulge of C5-C6 compression on the cervical spine in the thecal sac. The patient was also referred for a nerve conduction study. The nerve conduction test was (-) at C2-C7 and did not indicate radicular symptoms.

**Differential Diagnosis:** Thoracic Outlet Syndrome, Rotate Cuff Tear, Bursitis, Hooked Acromion Process, S.L.A.P Tear.

**Intervention & Treatment:** Treatments focused on alleviating patient's radicular symptoms and pain. Thermal therapy with heat packs, Thermax with contrast, E-Stim, cold therapy and compression with GameReady were implemented. Treatments such massage, IASTM, cupping, cryotherapy, neurotherapy, nerve glides, and all resistive exercises that were upper extremity related made the patient's symptoms more severe and prolonged after treatment protocol. Patient was referred externally to both a chiropractor and physical therapist that specialist in neurological pathology, both yielded (-) affects and ultimately increased patients' symptoms for several days following each treatment.

**Uniqueness:** The patient presented with various differential diagnoses aligned with cervical radiculopathy injuries and symptoms throughout their medical investigation. Previous diagnoses of Thoracic Outlet Syndrome directed clinicians' final diagnosis, though various symptoms were incongruent with their initial assessments. The patient's examination led physicians to resolve to a final diagnosis of cervical radiculopathy.

**Conclusions:** Cervical radiculopathy is a dysfunction of the nerve root of the cervical spine. It mainly occurs at the C6 and C7 cervical nerve roots-the younger population results from disc herniation. Sports with increased flexion and extension have a high potential for cervical nerve root injuries from narrowing certain portions of the spinal cord, causing compression of the nerve roots. Patients note reduced symptoms by abducting their shoulders and placing their hands behind their head. This decreases tension in the nerve root. The incidence rate of 85 per 100,000 in the general population. The mechanism for cervical radiculopathy is either chronic degenerative spinal changes or acute trauma to the spine. This case is unique due to the alignment of the (-) test that leans towards multiple differential diagnoses but with a broad definitive diagnosis of cervical radiculopathy with associated symptoms of thoracic outlet syndrome.

**Optimal Blood Flow Restriction Training Protocol for PCL Post-Surgery Rehabilitation in Division I Collegiate Football Player: A Case 2 Study**

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**Background:** Muscle strengthening is one of the primary goals of rehabilitation following post cruciate ligament (PCL) surgery, as it provides the knee with stability. In a recent systematic review, there was a lack of agreement and evidence supporting the optimal rehabilitation protocol following PCL surgery. Blood Flow Restriction (BFR) can be used in knee rehabilitation to enhance muscle strength, as it stimulates similar muscle adaptations to traditional resistance training with only 15-30% training load. Meanwhile, the ischemic preconditioning (IPC) intervention can be utilized with BFR to improve recovery and re-establish muscle strength following exercise-induced muscle damage. The use of BFR and IPC is a promising approach for post-surgery rehabilitation to accelerate an increase in muscle strength.

**Patient:** 21–year–old male, junior, Division I collegiate football player, with a diagnosed grade-2 PCL injury and damage to surrounding structures. The athlete exhibited swelling, loss of function, and pain during the on-field assessment by the athletic trainer (AT) during a game on September 2, 2022. The athlete had a positive dial, posterior drawer, and varus test. The MRI revealed a bone contusion on the anterior proximal tibia, suggesting the mechanism of injury was direct trauma to the anterior of a flexed knee.

**Intervention & Treatment:** The patient had his first surgery for PCL repair on December 21, 2022. He couldn't flex past 90° therefore had a second surgery on Feb 2, 2023. The athlete was non-compliant until the start of summer when he wanted to resume his football career. Beginning July 10, 2023, the AT utilized BFR twice a week for the first two weeks. After the first two weeks, the AT used BFR up to four times a week for the next five weeks. All BFR settings were set to the lower body with an 80% occlusion. At week 8 the athlete's strength was tested using a Biodex Isokinetic Dynamometer which showed 40% asymmetrical muscle deficit. The AT reduced the BFR to IPC to accelerate the recovery process. In weeks 8 to 12, IPC was used 1-2 times per week which allowed for muscle recovery from BFR training. The AT incorporated various therapeutic modalities and exercises on non-BFR days to improve the range of motion, muscle strength, and power. The Biodex Isokinetic Dynamometer test was conducted again on week 12.

**Outcomes or Other Comparisons:** Following the five weeks of BFR training and IPC intervention, the Biodex tests showed a significant improvement from 40% asymmetrical muscle deficit to 90% symmetrical muscle strength between the injured and uninjured limb. An athlete with PCL surgery is expected to return to sport between 6 to 12 months. Despite facing setbacks, the athlete returned to full participation in 10 months.

**Conclusions:** Post-surgical PCL rehabilitation can be challenging due to the athlete's inability to perform therapeutic exercises with the optimal load. In this case study, the athlete experienced a significant increase in muscle strength in an accelerated time with the implementation of IPC during the late phase. It is critical to consider factors such as BFR training frequency to produce the optimal result. The recommended training frequency was two to three times a week. In this case, the frequency was higher in weeks 4 and 6 of rehabilitation. Furthermore, other treatment modalities and athlete's adherence to the rehabilitation program should be considered for the increase in muscle strength, as it may indirectly influence the timeline of strength improvement.

**Clinical Bottom Line:** The combination of BFR exercise and IPC could be a superior approach compared to traditional therapeutic exercise or BFR training alone in terms of increasing muscle strength post-surgery from PCL injury. Future research is needed to explore the effect of IPC and its underlying mechanisms.

**Orthobiologics: Utilizing Autologous Bone Marrow Aspirate Concentrate Injections in the Lumbar Spine: Type 1 CASE Study**

Hinson MT, Martin BM, Evans TA, Froom RF, Rogowski CJ: The Steadman Clinic, Vail, CO, and Steadman Philippon Research Institute, Vail, CO

**Background:** Degenerative conditions of the lumbar spine, such as degenerative disc disease(DDD), decrease the quality of life in a large percentage of the adult population. Traditional treatments primarily focus on managing pain and physical therapy. The emergence of regenerative therapies, particularly bone marrow aspirate concentrate(BMAC), has expanded the range of therapeutic options. As stated by Moreno-Garcia A. et al., orthobiologics encompass natural and synthetic substances that aid in the treatment of musculoskeletal disorders, to enhance the potential for healing bone and soft tissue lesions.1 In this Type 1 CASE study a comparison to the systematic literature reviews by Hirase et al. and Lu L, Xu A, Gao F, et al., showing the clinical effectiveness of intradiscal BMAC injections in the treatment of lumbar disc degeneration is examined with results suggesting notable enhancements in both pain and quality of life after BMAC injection. These results support the potential advantages of BMAC injections for the treatment of lumbar disc degeneration.2,3

**Patient:** A 69-year-old Caucasian female with chief complaint of constant low back pain with radiation to the left low back and buttock at a 5-7/10 on the pain scale presented to clinic. Conservative treatment included physical therapy, meloxicam, as well lumbar medial branch radio frequency ablations and transforaminal epidural steroid injections, gave her significant but short-term relief. MRI showed lumbar DDD, lumbar facet osteoarthritis, multilevel central and foraminal stenosis, and moderately severe scoliosis at thoracolumbar spine. Patient has also collected greater than 5 surgical opinions each recommended multilevel lumbar fusions. Patient declined surgical intervention. Given the extent of degeneration and the associated symptoms with failed conservative treatment, BMAC injections were discussed as a treatment option.

**Intervention & Treatment:** The patient consented to targeted intradiscal BMAC injections administered at L3, L4 and L5 and left intraarticular facet injections at L3-L4, L4-L5 and L5-S1 to address the lumbar facet arthropathy and DDD changes.

**Outcomes or Other Comparisons:** Two-months status-post, patient reported 90% reduction in lumbar pain, improved mobility and function. Follow-up MRI scans demonstrated improvement in Modic type 1 changes. Improvements were consistent with previous literature on BMAC injections and improvements in pain and quality of life. Mesenchymal stem cells from BMAC have shown to aid in disc regeneration, particularly in animal studies with positive outcomes and low instance of adverse events. 3 A comparison with previous images revealed, slight reversal of spinal canal stenosis at L3-L4, improved Modic type 1 changes from L2-L5 vertebrae and reduction in periarticular facet edema. Some mild residual edema did persist, particularly in the L4-L5 and L5-S1 regions.

**Conclusions:** Utilization of BMAC injections in this 69-year-old patient demonstrated a promising therapeutic approach in addressing lumbar degenerative conditions. Not only did the patient reports significant reduction in pain. Objective measurements and follow-up MRI also confirmed anatomical and functional improvements. In summary, while both previous literature and the CASE study use of intradiscal injections for treating DDD, the focus of the treatments and the details vary. Current literature provides a more in-depth look into BMAC injections, specifically, whereas the earlier information provides a broader overview of various intradiscal treatments. Both emphasize that certain treatments can lead to improvements in pain and function, as measured by the visual analog scale and Oswestry disability index. The literature highlights low complication rates with BMAC injections, with rare instances of herniated nucleus pulposus and low rates of subsequent surgeries. These promising results highlight the potential of BMAC comparatively to the potential risks of steroid injections.4

**Clinical Bottom Line:** The results derived from this CASE study highlight the capacity of BMAC injections as a feasible substitute for conventional methods of pain control in instances of lumbar DDD ailments.

**Post-COVID Pericarditis in a Collegiate Volleyball Athlete: A Level 2 CASE Study**

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**Background:** COVID-19 is an infectious disease caused by the SARS-CoV-2 virus, and symptoms lasting longer than 12 weeks following the infection but no longer testing positive is known as "post-COVID-19 syndrome." This level 2 exploratory CASE study focuses on a patient with post-COVID-19 syndrome who developed pericarditis, or inflammation of the heart's pericardium.

**Patient:** This patient is a 19-year-old female collegiate volleyball hitter with no medical or psychosocial history. The patient reported a family history of diabetes, hypertension, high cholesterol, and breast cancer. The patient tested positive for COVID-19 in December 2020 and began complaining of chest tightness, pain, and shortness of breath when she attempted to return to spring season volleyball lifts and practices in January 2021 with a negative test. Due to the patient's history of COVID-19 and persistent symptoms, the athletic trainer referred the patient to a cardiologist who performed a peak-air flow test, cardiac ultrasound, and EKG. Based on the patient's symptoms, the differential diagnoses were myocarditis, pericarditis, and lupus. The tests showed no abnormalities, so she was cleared to continue playing. Throughout January, her symptoms worsened to sharp, stabbing pain and pressure in her chest, so she sought a second opinion. He performed EKGs, ultrasounds, and a CT scan, which showed inflammation of the pericardium, leading to the patient's diagnosis of pericarditis in March 2021.

**Intervention & Treatment:** The patient was withheld from all activity and prescribed 25mg of atenolol daily to regulate her HR and BP. In June 2022, her cardiologist cleared her to begin an RTP protocol because the CT scans no longer showed inflammation and excess fluid in the pericardium. Her athletic trainer conducted the RTP protocol in August when pre-season began, which included two days of low-impact activity for 15-30 minutes on a stationary bike. Day 3 included low-intensity volleyball drills for 30 minutes. She continued to increase the time she practiced by 15 minutes if she had no symptoms and could fully return to sport after 2 weeks. According to recommendations, clearance for an RTP protocol following a COVID-19 diagnosis should include the following: cardiovascular, neurological, pulmonary, and musculoskeletal screenings for complications from the infection, being symptom-free for at least 7 days, and a repeat screening no longer than a year after clearance.

**Outcomes or Other Comparisons:** The patient had monthly follow-ups from March 2021 to June 2022. She was cleared to begin the RTP protocol once her CT scan and echocardiogram showed decreased inflammation and excess fluid; the patient's symptoms and vitals were monitored through self-report and a heart monitor observed by the team's athletic trainer. The patient reported that the medication helped immensely with limiting her symptoms, especially during activity. The patient completed 2 Short Form-36 Questionnaires to report her status before being cleared and her status as of April 2023; all scores increased between the 2 times other than the criteria "changes in role limitations due to emotional problems," which remained at 100%.

**Conclusions:** Since COVID-19 has only been in circulation for less than 5 years, research on post-COVID complications, such as pericarditis and post-COVID RTP protocols, is ongoing. As this case took place toward the pandemic's beginning, knowledge was limited, causing the diagnosis and rehabilitation of complications to be relatively undefined. This case identified the need for an RTP protocol following a COVID-19 diagnosis to ensure the athlete's health and safety.

**Clinical Bottom Line:** Post-COVID complications can significantly impact athletes at all levels; therefore, screening and RTP protocols should be a requirement for all athletes following a COVID-19 diagnosis to help in the early detection of complications and ensure their safety when returning to sport.

**Presence of Ramp Lesion Tear and Pivot Shift Contusion With Potentially Intact ACL**

Mundy B, Wujciak D, DiVirgilio R: Kean University, Union, NJ

**Background:** Ramp lesion tears of the meniscus are found in nearly 20 percent of all ACL tears when the posterior horn of the medial meniscus tears vertically, resembling a ramp. A pivot shift contusion pattern can be seen in 50 percent of ACL tears. This occurs due to the ACL tearing and being unable to prevent excessive anterior translation of the Tibia, which causes the lateral femoral condyle to strike the tibial plateau during a pivot motion.
**Patient:** An eighteen-year-old collegiate football player suffered a non-contact knee injury while covering a punt.
**Intervention & Treatment:** During the initial on-field evaluation the athlete stated that he felt a pop and his knee was stuck in a flexed position. While attempting to straighten the knee the certified athletic trainer and the athlete felt two pops which signified that the patella was dislocated and then relocated on field. A Lachman test, which is generally deemed one of the most reliable methods for assessing ACL tears with a sensitivity reported between 77.7 and 93.5 percent, performed by a certified athletic trainer/sports medicine physician was negative for laxity and pain. The team physician ordered an x-ray and MRI to rule out ligamentous and meniscal injury and performed a Lachman's test again with a negative result. An additional Lachman was performed by an orthopedic surgeon during the athletes MRI read appointment. The results of the MRI found that the athlete had sustained a High-grade sprain of the ACL, a ramp lesion tear of the medial meniscus, effusion of the joint with synovitis, an osteochondral impaction fracture of the lateral femoral condyle, and marrow edema of the posterior tibial plateau consistent with a pivot shift contusion pattern.
**Outcomes or Other Comparisons:** The athlete has been scheduled for surgery to repair the meniscus, however the decision to repair the ACL will be made in the operating room pending arthroscopy findings due to the stability of the ACL with the Lachman test and athlete's progression with rehabilitation.
**Conclusions:** In this case there is multiple indications that would lead one to believe the ACL is not torn. However, the verbiage in the MRI report of High-grade sprain instead of tear complicates the case. That, in conjunction with multiple negative Lachman tests, would indicate that the ACL is intact. Other factors would signal the contrary, beginning with the ramp lesion tear seen in the medial meniscus in combination with the pivot shift contusion pattern seen on the MRI. The combination of the high sensitivity of the Lachman test and the MRI which is considered the gold standard for injury should make the surgical plan more definitive, but the athlete will be going into surgery not knowing if he will have ACL reconstruction along with his meniscal repair.
**Clinical Bottom Line:** This highlights the importance in performing a comprehensive evaluation and not placing too much of an emphasis on one aspect of the process. Additionally, this case illustrates the benefit of diagnostic imaging in evaluations. Had the athletic training staff and team physician not exercised caution and conducted thorough evaluations the injuries to the athletes ACL and meniscus could have gone undiagnosed and caused further harm.

**Pulmonary Embolism Caused by Tibia Fibula Fracture**

Lema M, Hodgman N, DiVirigilio R: Kean University, Union, NJ, and Fairleigh Dickinson University, Teaneck, NJ

**Background:** Pulmonary embolisms are life-threatening and are mostly found in an older generation of people from the 60-80 year old age group, but can also be present in younger populations due to differing situations. Pulmonary embolisms are commonly formed by blood clots in the legs that form due to prolonged sitting or inactivity that travel up to the lungs. Still they can also form because of fat emboli that circulate in the blood. These fat emboli can be released due to a long bone fracture or, in some rarer cases, soft tissue damage. Pulmonary embolisms are most commonly detected using a CTPA or computed tomographic angiography. Despite having specific tests to detect them, pulmonary embolisms are often misdiagnosed.

**Patient:** An eighteen-year-old athlete was slide tackled during a match. Despite having no previous injury history in the area, the slide tackle ended up fracturing both the tibia and fibula of their left leg, the athlete tried to stand up but their leg folded under their body not being able to withstand the pressure.

**Intervention & Treatment:** The athlete was splinted and stabilized on the field, he was then sent to the hospital where soon after he had surgery to correct the tibia and fibula fracture. The surgery consisted of securing the tibia with a rod and three screws, one on the distal end and two on the proximal end. While the fibula did receive a complete fracture it was well aligned enough to not need surgical intervention and was left to heal on its own. In post-surgery during monitoring, the patient had trouble breathing, and blood oxygen level began to drop to concerning levels. The day after surgery, he was diagnosed with pneumonia in both lungs and was put on a respirator in the ICU. After six days in the ICU, the patient was taken off of the respirator and retested, where it was found that he didn't have pneumonia but a pulmonary embolism. The doctors concluded that fat emboli caused the embolism. The fat emboli are released because of the fracture of the long bones . After diagnosis, he was put on high-flow breathing tubes.

**Outcomes or Other Comparisons:** Once released from the hospital, the athlete had checkups with cardiologists and pulmonologists. A cardiologist cleared him after having an echocardiogram done. After around 4 months of physical therapy and rehabilitation with athletic trainers, the athlete has returned to about 75% normal strength in the affected leg, and the patient awaits clearance from the pulmonologist. The patient also suffers from slight peroneal nerve impingement due to pressure from the anchor screw. This impingement causes the athlete to not have some feeling in his left foot and also gives him slightly worse motor abilities.

**Conclusions:** While pulmonary embolisms are significantly more common in older age groups, it is still possible for people to get them at all stages in life. Pulmonary embolisms that are not caught early can be deadly, they claim approximately 60K-100K lives per year. It is crucial to run a wide variety of tests to rule out or reduce the chances of misdiagnosis

**Clinical Bottom Line:** Pulmonary embolisms are not expected but should be more carefully monitored when it comes to fractures of long bones in the lower half of the body. A faster diagnosis can save lives and potential medical issues for a patient's future.

**Surgical Repair Using a Semitendinosus Allograft for an Isolated Distal Lateral Collateral Ligament Tear in an Adolescent: A Case Study**

Wood ER: Vail-Summit Orthopaedics & Neurosurgery Research and Education Foundation, Vail, CO



**Background:** The lateral collateral ligament (LCL), popliteus tendon, and popliteofibular ligament are the primary lateral stabilizers of the knee. These structures resist lateral varus gapping and rotatory knee instability. LCL grade I and II injuries are typically managed conservatively, while proper management for grade III LCL injury is not fully established for adolescents. An isolated Grade III LCL injury is a rare injury. Typically, an LCL injury is associated with a cruciate ligament or posterolateral corner injury.

**Patient:** A 15-year-old male presented to clinic with a chief complaint of left knee pain, instability, and intermittent swelling following a twisting mechanism while playing competitive soccer. MRI confirmed an isolated distal grade III lateral collateral ligament tear. Surgically reconstructed using a semitendinosus allograft was agreed upon between surgeon and patient.

**Intervention & Treatment:** An examination was performed on the patient under anesthesia by the surgeon. They noted a gapping of 2.0 to 2.5mm with a varus stress test under fluoroscopy. This correlates with research findings of lateral gapping on bilateral stress x-rays for an isolated LCL injury. A diagnostic arthroscopy was performed on all three compartments of the knee, which all structures were intact minus the LCL. A peroneal neurolysis was performed at the start of the LCL reconstruction to protect the peroneal nerve throughout the procedure. The surgeon the reconstructed the LCL using a semitendinosus graft. Post surgery the patient was put in a T scope knee immobilizer.

**Outcomes or Other Comparisons:** The patient followed a protocol of 4 weeks toe touch weight bearing followed by 2 weeks of partial weight bearing. The patient is in the T scope hinged knee brace for 6 weeks. Physical therapy started at 4 weeks and progressed from ROM to strength training and functional sport specific exercises. At their 3-month post-operation the patient had no lateral gapping on the varus stress test. The patient is on track to have similar successful outcomes as other athletic patients who had reconstruction using a semitendinosus allograft.

**Conclusions:** Understanding of the posterolateral corner and LCL is important when treating these injuries. Proper management for an LCL injury is crucial for the patient's long-term outcome. Conservative management has mixed outcomes for Grade III LCL injuries. Studies looking at shorter time outcomes show a successful quicker return to play. However, studies looking at longer results show poor functional outcomes. There are multiple surgical management options. Starting with repair versus reconstruction using an autograft or allograft. For reconstruction, biceps femoris, bone-patellar tendon-bone, and semitendinosus are types of grafts that can be used to reconstruct the lateral ligament. Studies have shown an LCL reconstruction using a semitendinosus graft has successful outcomes in athletic population. Determining a gold standard of care for isolated grade III LCL tears in adolescents is key is their long-term knee health.

**Clinical Bottom Line:** Misdiagnosis or improper treatment of the LCL and/or posterolateral corner can be detrimental to the overall health of the knee. More research with direct comparison of conservative management versus surgical management for isolated grade III LCL injuries in adolescents for short term and long-term results needs to be conducted.

**The Implications of Celiac Disease in Young Athletes**

Rivero I, Frett Z, Martinez RE: Florida International University, Miami, FL

**Background:** This was a Level 3 case study focusing on Celiac Disease and its impact on the musculoskeletal system and overall health. This genetic autoimmune disorder is a reaction to eating gluten, a protein found in wheat, barley, and rye-based products. Consumption of gluten-based products leads to inflammation of the small intestine's lining and malabsorption of nutrients that may be critical for proper bone and muscular development.1 Due to restrictive diets and the body's inability to obtain the nutrients and vitamins found in food. Deficiencies in vitamin D absorption, for example, can lead to fatigue, bone pain, and muscular weakness which predispose the physically active individual to multiple musculoskeletal injuries.

**Patient:** Sixteen-year-old male track and field athlete and bowler. Patient's previous history included autism, Celiac Disease, and osteoporosis. He reported to the clinic with low back pain (LBP), plantar fasciitis, shoulder impingement, and wrist pain. Symptoms for his LBP included muscle tightness, visible posture deformity like scoliosis, decreased active and passive range of motion in flexion and lateral extension, and limited spine mobility. For his plantar fasciitis he reported pain with first steps in the morning, limited plantar flexion both active and passive. As for his shoulder impingement, there was pain with shoulder flexion and abduction, while throwing the javelin and shot pot, a positive empty can test, Hawkin's, and Neer's test. Patient reported wrist pain with flexion while bowling and point tenderness along the flexor wad.

**Intervention & Treatment:** When the patient first started treatment, they presented with wrist pain and shoulder pain. As a dual athlete, it is not uncommon to have multiple injuries. Rehabilitation sessions included manual therapy techniques such massage, cupping, and scrapping. Scrapping was something that he only tolerated for a short amount of time. Other modalities included to modulate pain were heat and IFC electric stimulation. The therapeutic exercises included shoulder flexion and extension with a therapeutic band, isometric contraction in flexion, extension, abduction, and adduction, and proprioceptive training to improve neuromuscular control. Although the patient continues to improve, complete cessation of symptoms has yet to be achieved. Those who have Celiac disease and osteoporosis have trouble with weight loss because of vitamin D deficiency.2 Weight loss is also something the patient struggles with.

**Outcomes or Other Comparisons:** Patient has not been adhering to treatment so there aren't many outcome results to report. Treatment options for this condition are similar to suggested research.

**Conclusions:** Celiac disease is an autoimmune disorder that primarily affects the digestive system, but it also has a significant impact on the musculoskeletal system and overall health. It affects the absorption of nutrients such as calcium and vitamin D. Malabsorption of these nutrients can lead to muscle weakness and fatigue, affecting an individual's ability to support their skeletal system properly that can lead to increased injury risk. Osteoporosis is known as a condition characterized by weak and brittle bones, making them more susceptible to fractures. Recommending him to a dietician could help improve his nutrient intake and help improve current injuries and prevent future ones.

**Clinical Bottom Line:** This CASE would educate athletic trainers on the effects that Celiac Disease and osteoporosis have on an injury. Athletic trainers would need to recognize symptoms like fatigue, muscle weakness and bone health issues that increase the risk of fractures. These athletes would need to be on a strict diet so that athletic trainers can help them make informed food choices.

**Vertebral Endplate as the Source of Chronic Low Back Pain: Type 3 CASE Study**

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**Background:** Low back pain (LBP) is often managed conservatively and can be a challenge to accurately diagnose. If conservative treatment fails, identifying the source of pain is critical for appropriate treatment. Common sources of LBP include discogenic, facetogenic, musculogenic, neurogenic, and psychosomatic, and is often a diagnosis of exclusion. In chronic LBP it is often assumed the pain is discogenic in nature. However, there is evidence linking the highly innervated vertebral endplates as a potential source of pain that should be considered in these patients.

**Patient:** We present the case of a 44-year-old physically active female with a two-year history of chronic LBP. She participates in weekly weightlifting and running and reports a previous diagnosis of lumbar disc herniation approximately ten years prior. When the pain returned two years ago, she was diagnosed with lumbar radiculopathy, which resolved after oral steroid medication, osteopathic manipulation, and physical therapy. New symptoms emerged immediately, which are presented in this case. The patient was re-evaluated by an Athletic Trainer. Her daily pain averaged 2 / 10 and described as "achy" with occasional transient axial pain of 8 / 10 with flexion or standing activities. No palpable tenderness was noted. Active ROM revealed discomfort and the "feeling of weakness" in trunk flexion. Extension, lateral flexion, and rotation also caused discomfort. Interestingly, MMT were all 5 / 5. All special tests were negative. Another bout of core-focused rehabilitation was recommended. After two months with little improvement the patient enrolled herself into a chronic LBP clinical trial. She was randomized into two treatment groups: (1) Enhanced Self-Care (modules on pain management) and (2) Acceptance and Commitment Therapy. After 6 months her pain remained the same. The possibility of psychosomatic pain could now be ruled out and she was then referred to a spine specialist. Physical exam findings remained consistent. Imaging was ordered and the MRI confirmed the previously diagnosed L5-S1 disc herniation and now showed degenerative disc disease with vertebral end plate edema on the L5 & S1 vertebrae. The patient was now diagnosed with vertebrogenic LBP and degenerative disc disease.

**Intervention & Treatment:** An L5 / S1 interlaminar epidural steroid injection was performed, which may be followed up with a radiofrequency ablation of the basivertebral nerve.

**Outcomes or Other Comparisons:** The steroid injection did not resolve the pain. Discogenic pain would have likely responded to the steroid injection, supporting the diagnosis of vertebrogenic pain. Vertebrogenic LBP was never previously considered. This case is ongoing and the likely next step for this patient will be the ablation procedure.

**Conclusions:** It is important to realize that the source of chronic LBP may change over time. Chronic LBP in a patient with a previous diagnosis of disc herniation is often assumed to be discogenic. However, there is histomorphological evidence of nerve ingrowth inhibition in the annulus fibrosus and nociceptor proliferation of the basivertebral nerve in the vertebral endplates. Conservative treatment should include minimizing axial loading and forward flexion and maintaining core strength but is not likely going to resolve symptoms. Radiofrequency ablation of the basivertebral nerve has shown promising results for vertebrogenic pain and is less invasive than most spine surgeries. Vertebrogenic pain should be added as part of the differential diagnosis to ensure timely management of these patients.

**Clinical Bottom Line:** Chronic, achy LBP accompanied with a lack of radiculopathy and negative special tests should lend itself to the suspicion of vertebrogenic pain. Imaging will allow visualization of end plate edema to confirm the diagnosis. Accurate diagnosis of the pain generators in chronic LBP is crucial in the efficacy of the course of treatment, prescription of therapeutic exercise, and timeliness of interventional or surgical procedures.

### Anxiety and Depression Amongst Female Athletes


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**Context:** Anxiety (categorized by a feeling of fear, dread, and uneasiness) and depression (mood disorder causing feelings of persistent sadness and loss of interest in things an individual once loved) are two major mental health disorders effecting females considerably who participate in sport. Females are more likely to present with anxiety (55-60%)1 and depression (1.844 times)2 compared to males. The purpose of this study was to examine the prevalence between mental health comorbidities (anxiety and depression), across females athletes aged 18-40.

**Methods:** An anonymous survey was distributed via snowball sampling using social media. Demographic data, Generalized Anxiety Disorder-7 (GAD-7), validated for use as a screening tool and severity measure across various settings and populations,3 and Beck Depression Inventory-II (BDI-II), with high reliability (0.83-0.96)4 were utilized. Analyses were conducted using SPSS with an Alpha level set at $p < 0.05$. Power calculation indicated a sample size of 84 participants. Frequencies and proportions were determined. Female athletes (n= 96, age: 22.47 ± 4.38 years, height 165.41 ± 7.51 cm, weight 64.15 ± 9.12 kg, BMI 23.48 ± 3.23) who were exercising for ≥5 days a week in an organized sport (i.e., clubs, teams, recreational), with total exercise volume of at least 8 hours per week met inclusion criteria.

**Results:** A total of 96 out of 109 participants completed the survey (88.1% completion rate). Some participants did not complete all questions, however for the GAD-7 and BDI-II, only those who completed those specific sections in full were used for analysis (GAD-7, n=90, BDI-II, n=80). Of those, 58.9% (n= 53/90) of participants were categorized as meeting clinically meaningful values of anxiety using the GAD-7. Less than 1% of participants reported taking anti-anxiety medication. 39.8% (n=30/80) of participants were categorized as having clinically meaningful values of depression and only 18.2% (n=8/80) of participants reported taking anti-depressant medication. 10 (11.1%) participants yielded severe anxiety scores and 6 (7.2%) scored severe depression. To note, 34.4% (n=31/90) presented with a comorbidity of both anxiety and depression. The majority (74%, n=71/96) of our population were collegiate athletes.

**Conclusions:** While our results are congruent with elevated anxiety and depression in female athlete populations, early identification (screening tools) and interventions are essential for a holistic landscape of the physical and mental health among female athletes. Clinicians should be prepared and equipped to recognize as well as assist with mental health comorbidities for quality patient centered treatment plans.

**Associations Between Injury-Related Fear and Self-Reported Well-Being in Individuals With a Previous History of Lateral Ankle Sprain and Modified Physical Activity**

Terada M, Suga T, Kusagawa Y, Isaka T: Ritsumeikan University, Shiga, Japan

**Context:** A lateral ankle sprain has negative psychological impacts. Injury-related fear have been well-documented in patients with lateral ankle sprain and considered as significant factor contributing to successful recovery. Patients with lateral ankle sprain may modify or avoid physical activity because of heightened kinsesiophobia. Recently, in the literature, a strong association between injury and self-reported well-being has been identified. The interference with physical activity has been found to be linked to self-reported well-being, suggesting that heightened kineshiophobia may negatively impact self-reported well-being. Therefore, the purpose of this study was to examine associations between kineshiophobia and self-reported well-being in individuals with a previous history of lateral ankle sprain who have modified physical activity because of their ankle injury.

**Methods:** This cross-sectional study enrolled 23 participants with a previous history of lateral ankle sprain who have modified physical activity following their ankle injury (M:21, F:2; Age=22.0±1.5yrs; Height=175.3±10.1cm; Mass=77.0±17.2kg). Injury-related fear was assessed with the 17-item version of the Tampa Scale of Kineshiophobia (TSK). Self-reported well-being was assessed using the Satisfaction with Life Scale and the 12-item Affective Well-being Scale. The Satisfaction with Life Scale is a 5-item questionnaire, and each item is a 7-point Likert scale with "1" indicating strongly disagree and "7" representing strongly agree. The total sum of five items were calculated, and greater scores indicates greater satisfaction. The 12-item Affective Well-being Scale is composed of two subscales: positive and negative affect. Each item on the Affective Well-being Scale is a 5-point Likert scale ranging from "1" indicating never to "5" representing extremely often or always. A high score on the resulting summation for each subscale represents a high level of affective well-being. Pearson product-moment correlation analysis was employed to examine correlations of the TSK with the Satisfaction with Life Scale and the Affective Well-being Scale. Significance was set at $P<0.05$.

**Results:** Fair correlations of TSK (41.0±6.9) were observed with the Satisfaction with Life Scale (21.3±5.6, $r=-0.432$, $P=0.040$) and positive affect on the Affective Well-being Scale (20.9±5.0, $r=-0.35$, $P=0.049$). No significant correlation of TSK was observed with negative affect (10.4±4.0, $r=0.076$, $P=0.364$).

**Conclusions:** Our findings indicate that an increase in injury-related fear may associate with decreases in life satisfaction and positive affect in individuals with a previous history of lateral ankle sprain who have modified physical activity because of their ankle injury. Clinicians need to be aware that individuals with a heightened kinesiophobia following a lateral ankle sprain may face well-being challenges and that high levels of injury-related fear could lead to worse outcome.

**Effects of Headache Disorders on Daytime Sleepiness in Collegiate Student-Athletes**

LaMonica T, Pazik M, Farmer KW, Roach RP, Chrabaszcz S, Tipper N, Altman J, Horodyski MB: University of Florida, Gainsville, FL

**Context:** Excessive daytime sleepiness (EDS) is a common symptom experienced by many, but there is still a lack of understanding of its etiology. Symptoms such as headaches, migraines, and previous concussions have been linked to daytime sleepiness. The Epworth Sleepiness Scale (ESS) was developed to objectively measure EDS in an adult population2. Prior research has found that higher EDS scores were associated with higher frequencies of headache disorders3. The purpose of this study was to determine if collegiate student-athletes with past medical history of headache disorders have higher EDS. It is hypothesized that student-athletes who report higher levels of EDS will also have higher rates of reported migraines and frequent headaches. We also hypothesized that collegiate student-athletes who reported a past medical history of concussion will have higher ESS scores.

**Methods:** This was a retrospective review of a prospective database of collegiate student-athletes at a NJCAA institution. During their initial Pre-Participation Exam (PPE), each student-athlete completed the ESS as an institutional requirement. Subjects were included if they were between the ages of 17-30 and participated on at least one of the institution's sponsored athletic teams. ESS scores were categorized into four categories: 0-5 Lower Normal Daytime Sleepiness; 6-10 Higher Normal Daytime Sleepiness; 11-12 Mild Excessive Daytime Sleepiness; 13-15 Moderate Excessive Daytime Sleepiness; 16-24 Severe Excessive Daytime Sleepiness1. Descriptive analyses were completed to determine means and standard deviations. Wilcoxon rank sum tests were utilized to assess differences between past medical history (answered as yes/no) and ESS scores. Chi-square tests were used to compare between groups for categorical variables.

**Results:** A total of 205 athletes were included, 115 of which were female and 90 males. The mean age was 19.2 ± .81 years. Our study found no significant difference in ESS scores of student-athletes who had a previous medical history of concussion (mean = 6.76±4.2) to those without concussion history (mean = 5.96±3.3, p=0.294). Student-athletes with a previous medical history of migraines (reporting yes to current migraines) have significantly higher ESS scores (mean = 8.17±2.9) than individuals with no history of migraines (mean = 5.96±3.5, p=.02). It was also noted that those who reported a previous medical history of frequent headaches (reporting yes to frequent headaches) had significantly higher ESS scores (mean = 8±3.57) than individuals with no history of headaches (mean = 5.9±3.48, p=0.02).

**Conclusions:** Our study found that student-athletes who reported experiencing migraines or frequent headaches had higher ESS scores, thus higher levels of EDS. This supports previous literature claims of individuals with higher EDS scores also experiencing migraines and headaches at a higher rate. Future research should be developed to further examine the relationship between intensity of headaches and EDS.

**Examining the Relationship Between Positive and Negative Psychological Health Outcomes Among Individuals With Chronic Ankle Instability**

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**Context:** Up to 60% of individuals with CAI do not report a clinically meaningful improvement in self-reported function after physical rehabilitation protocols that focus on local impairments (e.g., ankle strength or ROM). Therefore, research exploring other potential factors that contribute to a successful outcome after treatment is needed. For example, prior studies have demonstrated individuals with CAI report higher levels of pain catastrophizing, fear avoidance, and injury-related fear compared to healthy controls. However, perceived stress levels and a negative mood state are two other factors that have been linked to poor outcomes after rehabilitation, but not explored among individuals with CAI. Likewise, there is a lack of research on positive psychological factors, such as resiliency, that could promote better rehabilitation outcomes for CAI. Thus, the purpose of this study was to explore the relationship between negative and positive psychological factors among individuals with CAI as a first step towards considering psychological factors that should be addressed during rehabilitation.

**Methods:** A cohort study design was used to enroll 10 participants (F:5, age: 24.5±7.7 years, height: 174.5±12.3 cm, mass: 77.7±14.8 kg) from a university community. The International Ankle Consortium guidelines for CAI were followed for inclusion criteria. The Brief Resiliency Scale (BRS) was used to examine resiliency as a positive psychological factor. The Perceived Stress Scale (PSS-10) and the Optimal Screening for Prediction of Referral and Outcome (OSPRO-17) were used to examine negative psychological factors. The OSPRO-17 was used to obtain the negative mood state and generate a total number of yellow flags. A yellow flag is determined on estimated scores of negative and positive psychological questionnaires that fall within the top or bottom quartile, respectively. A higher number of yellow flags may inform clinical decision-making regarding a patient's response to treatment. Spearman's rho product correlations were used to determine associations between the negative and positive psychological. Significance was set a priori as $p \leq 0.05$.

**Results:** There was an inverse relationship between the BRS and PSS-10 ($\rho = -0.697$, $p=0.025$). The negative mood subscale of the OSPRO-17 was positively correlated with PSS-10 ($\rho = 0.708$, $p = 0.022$) while negatively correlated with BRS ($\rho = -0.751$, $p = 0.012$). The total number of yellow flags from the OSPRO-17 was negatively correlated with BRS ($\rho = -0.641$, $p = 0.046$). All other correlations were non-significant and weak.

**Conclusions:** Our preliminary analysis suggests that individuals with CAI who report lower levels of resiliency also experienced higher levels of perceived stress, negative mood, and more yellow flags. Clinicians may need to consider CAI patients' stress and negative mood levels as a means of improving resiliency. These preliminary data also support developing psychologically-informed therapies for patients with CAI to maximize the treatment response rate.

**Golfers With More Frequent Low Back Pain Report Higher Pain and Disability**

Callahan E, Skibski A, Ingersoll CD, Mangum LC: University of Central Florida, Orlando, FL

**Context:** The high repetitions of golf swings during a round or practice are one of the main contributing factors of low back pain (LBP), a leading cause of injury in golfers. Both the Oswestry Disability Index (ODI) and Golf-Specific Low Back Pain Questionnaire (GLBP) are effective in identifying LBP-related disability in golf populations. Similarly, the Numeric Pain Rating Scale (NPRS) and the Fear Avoidance Beliefs Questionnaire (FABQ) are commonly used to identify pain and beliefs associated with the pain experience. While the GLBP has been compared to the ODI in golfers with LBP, no study has compared these outcomes between those who suffer from frequent and infrequent LBP, as this may impact their ability to continue playing golf as desired. The purpose of this study was to compare LBP outcome measures between golfers who experience frequent LBP (most days of the week) compared to those who experience infrequent LBP (not on most days of the week).

**Methods:** This was a cross-sectional study design with an online questionnaire. Participants were required to be at least 10 years old and self-report that they play golf multiple times per year. A total of 42 youth and adult golfers (age: 25.29±12.71 years; 18-hole score: 93.08±16.60 strokes; golf days per week: 2.26±1.48) completed this survey. Participants were either placed in the frequent LBP (reported suffering from LBP most days of the week, n=17) or infrequent LBP (reported LBP, but not on most days of the week, n=20) group. Individuals who did not report at least occasional LBP were excluded from this study, reducing the analysis to 37 golfers. Participants completed demographics, ODI, GLBP, NPRS for current, worst, and average pain, and the FABQ physical activity subscale (FABQ-PA). Mann-Whitney U tests were used to compare LBP outcome measures between groups with significance set at $p \leq 0.05$.

**Results:** The frequent LBP and infrequent LBP groups had no significant differences between demographics including years of golf played, golf days per week, and average 18-hole score. Group comparisons of LBP outcome measures presented in Table 1 show statistically significant differences in all outcome measures between groups. The frequent LBP group had higher rates of episodes of LBP, ODI, NPRS, and FABQ, with a lower GLBP score, showing consistently poorer pain and disability PROMs overall compared to the infrequent LBP group.

**Conclusions:** Golfer's responses to the ODI, GLBP, NPRS, and FABQ-PA may be impacted by their LBP frequency. Golfers with frequent LBP reported more episodes of LBP, greater disability in activities of daily living, worse sport-specific disability, higher pain levels, and greater kinesophobia than those with infrequent LBP. Clinicians should consider using these patient-reported outcome measures when treating golfers with low back pain, especially those experiencing more frequent episodes of pain.

Table 1. Comparison of outcome measures between golfers with frequent and infrequent low back pain

| Outcome measure | Frequent LBP (n=17) | Infrequent LBP (n=20) | *p-value* |
|---|---|---|---|
| Episodes of LBP (past 12 months) | 108.82±151.25 | 6.45± 7.04 | <.001* |
| Oswestry Disability Index (%) | 19.87±9.51 | 7.44±6.66 | <.001* |
| Golf-specific Low Back Pain questionnaire (%) | 58.56±16.18 | 87.44±9.32 | <.001* |
| Numeric Pain Rating Scale (current) | 3.47±2.60 | 0.90±0.97 | .003* |
| Numeric Pain Rating Scale (worst) | 7.88±1.62 | 4.45±2.48 | <.001* |
| Numeric Pain Rating Scale (average) | 4.35±1.62 | 1.60±1.19 | <.001* |
| Fear Avoidance Beliefs Questionnaire-Physical Activity | 10.41±5.22 | 4.45±4.05 | .001* |

* Indicates statistical significance ($p \leq .05$). LBP: low back pain.

**Self-Reported Knee Symptoms Influence Emotional Responses Post-ACL Reconstruction**

Reiche ET, Genoese FM, Coffman CA, Pontifex MB, Baez SE: University of North Carolina, Chapel Hill, NC, and Michigan State University, East Lansing, MI

**Context:** Assessment of fear after anterior cruciate ligament reconstruction (ACLR) often relies on self-reported measures which may not be truly representative of an unconscious fear response a patient may exhibit post-injury. Psychophysiological data (e.g., electroencephalogram [EEG]) provides event-related data for objective evaluation of emotional responses, like fear. Self-reported knee function has been associated with self-reported injury related fear. However, the association between self-reported knee symptoms and changes in event-related potentials (i.e., late positive potential [LPP]) is unknown. The LPP is an index of emotional response with higher amplitudes indicating a more intense evaluation of the emotional content of the stimulus. The purpose of this study is to examine the association between LPP amplitude in neutral, threatening, and sport-related injury visual stimuli conditions and self-reported knee symptoms. We hypothesized that worse self-reported knee function would be associated with increases in LPP amplitude in threatening and sport-related injury conditions.

**Methods:** EEG was completed on 9 females with a history of primary, unilateral ACLR (21.4±4.7 years old, 27.2±13.2 months since surgery). Participants randomly viewed visual stimuli in three conditions: neutral (e.g., a stationary person), threatening (i.e., actions that could induce potential knee injury), and sports-related injury (e.g., knee with obvious deformity). EEG activity was recorded from 32 electrode sites arranged in an extended montage based on the International 10-10 system. Data were preprocessed offline using EEGLab. Continuous data were filtered using a 0.05 Hz highpass 2nd order Butterworth IIR filter and mastoids removed prior to ICA decomposition to remove eye blink artifact. Continuous data was then epoched by condition. Amplitude was averaged over 400 to 1200 ms for each trial. Patient reported outcome measures included the Knee Injury and Osteoarthritis Outcome Score (KOOS) symptom subscale which is a valid and reliable measurement. Higher scores on the KOOS Symptom subscale indicate better self-reported knee function. Separate linear regressions were performed with average amplitude for each trial within each condition as the dependent variable and KOOS Symptom subscale as the independent variable. Alpha was set a priori to $< 0.05$.

**Results:** KOOS symptoms scores explained 10% of the variance observed in LPP amplitude from during threatening sport stimuli ($F(1,135)=16.27$, adj $r2=0.1010$, $p=0.0001$). For every one-point decrease in KOOS symptoms subscale scores, there was negative change ($\beta$ =-0.525 [-0.783 - -0.268]) in LPP amplitude. The models for neutral ($F(1,121)=4.22$, $p=0.0420$) and sport-related injury ($F(1,139)=5.37$, $p=0.0220$) conditions were significant but only explained 2 and 3% of the variance seen, respectively.

**Conclusions:** A diminished emotional response associated with worse knee symptoms may have been observed because of the directed attention on their physical symptoms. Self-reported knee symptoms may affect emotional regulation and cognitive load in individuals post-ACLR. Future research should examine changes in LPP amplitude throughout the rehabilitation process.

**Table 1. EEG Amplitude Data**

| EEG Data by Condition | | | |
|---|---|---|---|
| **Condition** | **LPP Amplitude (μV)** 400 to 1200 ms | **Arousal Rating** | **Valence Rating** |
| Neutral | 3.95 (6.33)<br>-11.82 – 20.17<br>N=123 | 3.84 (1.4)<br>N=110 | 5.6 (1.3)<br>N=110 |
| Threat | 6.48 (8.49)<br>-15.71 – 29.19<br>N=137 | 5.6 (1.3)<br>N=123 | 4.8 (1.3)<br>N=123 |
| Sport Injury | 7.96 (10.31)<br>-20.87 – 33.01<br>N=141 | 7.2 (1.1)<br>N=127 | 2.6 (1.1)<br>N=128 |

Data presented as mean (SD) with range and number of trials below. After EEG preprocessing, some trials were discarded because of noise. Total trials available for the descriptive EEG data is provided. Abbreviation: LPP, late positive potential.

**The Association Between Sociodemographic Factors and Social Support in Adolescent Athletes**

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**Context:** Prevalence of psychological concerns continues to increase in adolescents. The need to identify intrinsic and extrinsic factors that can protect mental health is warranted. Social support acts as a resource in the development of productive coping strategies and lowers the risk of psychological concerns. For athletes, social support can be derived from family, peers, teammates, and coaches. However, sociodemographic factors can alter the perception and application of social support as a coping resource. The purpose of this study was to investigate the association between sociodemographic factors and social support in adolescent athletes.

**Methods:** This study utilized a cross-sectional design. A total of 219 adolescent athletes from five high schools completed an electronic survey via iPad. Demographic information including age, biological sex, race/ethnicity (White, Black or African American, Other including Asian, Hispanic and 2+ races), and socioeconomic status (SES) were collected. Participant's SES was assessed using the MacArthur Subjective Social Status Scale for Youth which has been found to be a reliable measure and proxy for SES in adolescent populations. Subjective social status/SES could range from 1-10. Social support was assessed using the National Institutes of Health Toolbox Emotional Support Scale (Ages 8-17). This scale was comprised of 7-items, with scores ranging from 7-35. Scores for each measure were summated separately and higher scores indicated more of the perceived construct. Data were analyzed using descriptive statistics and ANCOVA analyses in SPSS. Statistical significance was set a $p \leq .05$.

**Results:** There were 148 male and 71 female participants (N=219). The mean age was 15.49±1.2 years, and the sample predominantly identified as Black or African American (n=200; 91.3%), followed by White (n=11; 5.0%) and Other (n=8; 3.7%). Approximately 86% of participants reported ≥5 on the subjective social status/SES measure. In univariable analyses, race/ethnicity was significantly associated with social support ($F[2,216]=5.162$, $p=.006$) such that White participants ($\mu=28.455$) reported higher levels of social support compared to Black or African American ($\mu=26.110$), and Other participants ($\mu=20.050$). Race and ethnicity was also significantly associated with social support after adjusting for age, sex, and SES ($F[1,204]=4.484$, $p=.012$).

**Conclusions:** Despite being of similar athlete status, racial and ethnic minorities perceive less social support compared to their White counterparts. Previous research suggests racial/ethnic minority adolescents may face increased discrimination, peer-victimization and bullying which can weaken their social support network and create emotional distress which often precedes psychological concerns. Age, sex, and SES may play a less critical role to social support in adolescent populations, a finding that differs from research in adults, but may benefit adolescents. Individuals who work with adolescent athletes must be cognizant of sociodemographic factors that may influence availability and application of positive coping resources such as social support for the preservation of mental health.

### Athletic Trainers' Assessment of Blood Pressure Using a High-Fidelity Manikin


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**Context:** Blood pressure (BP) assessment is a staple of pre-participation examinations and may assist athletic trainers (ATs) with diagnosing different cardiac conditions, such as hypertension. Current pedagogical techniques of practicing BP assessment on healthy individuals may limit healthcare providers' ability to recognize Korotkoff sounds at abnormal pressures during clinical practice. The purpose of this study was to examine the ability of ATs to detect Phase I and V Korotkoff sounds to correctly assess systolic and diastolic BP, interpret the findings, and report their confidence.

**Methods:** We recruited ATs through conferences, in-services, and postprofessional athletic training programs. In total, 100 ATs from various job settings (age=31±11 years; men=37, women=63, clinical experience=8±10 years; self-identified hearing concerns=31; previous simulation experience=36) completed the cross-sectional study. First, participants verbally reported the professional guidelines they used in clinical practice to interpret findings. Second, ATs completed a practice trial BP assessment to familiarize themselves with the provided stethoscope, cuff, and high-fidelity manikin. Then, ATs completed 3 randomized BP assessment trials out of 11 pre-set BP cases. For each trial, participants reported the systolic, diastolic, and interpretation (hypotension, hypertension, normal) and their confidence (0%=no confidence, 100%=complete confidence) assessing the BP and the interpretation for that case. Reported BP was categorized as correct if within ±5 mmHg of the case's systolic and diastolic measures. Interpretation data were classified as correct if they were in alignment with the professional guidelines identified by the participant. We calculated assessment correctness scores by case, with each correct systolic or diastolic value within the range counting as 1 and each incorrect value as 0. The total score was then calculated and transformed into a percentage out of 100% for each case and overall (100 participants x 3 trials).

**Results:** Most participants (n=48) used the American Heart Association BP interpretation guidelines. Table 1 provides an overview of results by case. Participants had a low overall assessment correctness score (42.67±20.88%) with only 50% of the systolic values (n=150; mean difference=-5.85±13.32) and 68.7% of the diastolic values (n=206; mean difference=-0.34±9.60) reported within ±5 mmHg. Participants were most accurate with Case 5 (normal) and least accurate with Case 2 (hypertensive). The participants correctly interpreted the BP by their reported guidelines in 56.3% of the trials (n=169). Despite the poor performance, participants expressed high confidence in BP assessment (80±16%) and interpretation (87±16%).

**Conclusions:** We identified a confidence-to-practice gap, with ATs reporting high confidence levels in assessing and interpreting BP but performing poorly in both areas. Most ATs could accurately assess and interpret a normal blood pressure case; however, participants struggled with assessment and interpretation for hypertensive cases. Our results suggest that high-fidelity simulators could be a valuable professional development tool to improve confidence and accuracy in assessing BP without the consequences of misdiagnosis.



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**Table 1**. Correctness and Confidence in Blood Pressure Assessment and Interpretation

| Case and Interpretation | Overall Assessment Correctness (%) | Systolic Mean Difference (mmHg) | Systolic Reported Correct (n, %) | Diastolic Mean Difference (mmHg) | Diastolic Reported Correct (n, %) | Assessment Confidence (%) | Interpretation Correct (n, %) | Interpretation Confidence (%) |
|---|---|---|---|---|---|---|---|---|
| **Overall (n=300)** | 42.7±20.9 | -5.9±13.3 | 150, 50.0 | -0.3±9.6 | 206, 68.7 | 80±15.9 | 169, 56.3 | 87±16.3 |
| **1:** Hypertensive; 150/100 (n=21) | 71.4±37.3 | -3.4±13.1 | 12, 57.1 | -1.2±8.4 | 18, 85.7 | 85±9.5 | 20, 95.2 | 94±7.2 |
| **2:** Hypertensive; 168/110 (n=29) | 41.4±37.9 | -16.2±14.5 | 7, 24.1 | -7.9±17.6 | 17, 58.6 | 81±15.2 | 22, 75.9 | 88±21.1 |
| **3:** Hypertensive; 148/98 (n=27) | 57.4±38.5 | -4.2±5.7 | 10, 37.0 | -2.7±6.6 | 21, 77.8 | 84±11.4 | 18, 66.7 | 95±8.0 |
| **4:** Normal; 120/70 (n=28) | 58.9±33.5 | -3.4±5.2 | 19, 67.9 | 0.1±8.4 | 14, 50.0 | 83±14.7 | 18, 64.3 | 87±12.1 |
| **5:** Normal; 114/70 (n=29) | 75.9±34.4 | 0.2±10.4 | 22, 75.9 | 2.6±7.2 | 22, 75.9 | 79±18.1 | 14, 48.3 | 84±20.4 |
| **6:** Normal; 120/68 (n=28) | 69.6±31.5 | -5.4±7.1 | 18, 64.3 | 2.0±4.9 | 21, 75.0 | 82±10.5 | 20, 71.4 | 86±13.7 |
| **7:** Hypertensive; 180/68 (n=31) | 43.5±42.3 | -18.3±20.6 | 10, 32.3 | 5.7±10.2 | 17, 54.8 | 71±20.6 | 22, 71.0 | 81±20.5 |
| **8:** Varied; 148/86 (n=27) | 53.7±27.5 | -9.1±10.2 | 9, 33.3 | 2.6±6.3 | 20, 74.1 | 79±20.2 | 13, 48.1 | 84±19.7 |
| **9:** Varied; 140/80 (n=20) | 70.0±37.7 | -5.1±14.3 | 11, 55.0 | 1.3±4.3 | 17, 85.0 | 82±17.3 | 1, 5.0 | 88±14.6 |
| **10:** Varied; 130/86 (n=30) | 58.3±39.6 | -2.9±5.7 | 15, 50.0 | -2.9±8.5 | 20, 66.7 | 75±12.8 | 5, 16.7 | 87±13.8 |
| **11:** Hypertensive; 120/100 (n=30) | 60.0±38.1 | 4.7±12.4 | 17, 56.7 | -3.1±7.6 | 19, 63.3 | 79±15.7 | 16, 53.3 | 82±14.5 |

**Note:** Varied=interpretation changed depending on guidelines used; Confidence=0%=no confident,100%=complete confidence; Correct=±5mmHg

**Attentional Focus and Cardiopulmonary Resuscitation Motor Skill Performance in Athletic Training**

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**Context:** Literature within motor behavior specific to attentional focus (AF) has established that an external focus of attention (EFA; attention directed toward the effect of the movement) is more beneficial than an internal focus of attention (IFA; attention directed toward the characteristics of the movement) for learning and performance of motor skills. Cardiopulmonary resuscitation (CPR) is commonly taught utilizing music as an externally focused cadence cue versus cues focusing on the depth of compressions, which could be EFA, IFA, or neutral. This study examines AF instructions on CPR performance for both a distracting and distraction-free environment. We hypothesized that participants receiving EFA instructions would perform CPR better in both conditions than those receiving IFA.

**Methods:** In this quasi-randomized controlled study, 14 Certified Athletic Trainers (certified 13±11.6 years) and 24 graduate athletic training students (n = 38; 24 females, 12 males; age 38±9.5 years, 66.6±3.8in, 183.5±44.8lbs) certified in CPR participated following recruitment through convenience sampling. Using block randomization, participants received EFA or IFA instructions before performing 3 minutes of CPR compression and breath cycles on a Prestan Professional Adult Manikin. In addition to depth cues, the EFA group heard 44s of "Stayin' Alive" by the Bee Gees before each trial. Trial 1 was performed in a quiet research laboratory with noise-canceling headphones playing white noise. Trial 2 was performed on a basketball court and incorporated a distracting augmented reality simulation of bystanders. CPR quality measures were calculated including compression rate, compression depth, and chest compression fraction (CCF). Compression rate was analyzed by chi-square and separate one-way ANOVAs. Compression depth and CCF were analyzed using mixed ANOVA and chi-square, respectively. Alpha level was set at .05.

**Results:** Descriptive data for CPR quality measures can be found in Table 1. Compression rate increased significantly in Trial 2 compared to Trial 1 ($p < .001$). In Trial 2, EFA participants performed CPR compressions at the correct rate of 100-120 bpm more than IFA participants based on the average trial rate ($p = .049$) and based on the percentage of correct cycles within the trial ($p = .027$), but there was no significant difference in Trial 1 ($p = .283$; $p = .526$). Significant differences were not observed within or between trials for compression depth ($p = .459$, $p = .673$) or CCF ($p = .252$; $p = .209$).

**Conclusions:** Using EF cues for cadence may be an effective strategy for enhancing CPR compression rate quality in a distracting environment; however, EF cues do not enhance compression depth or CCF. Furthermore, AF cues do not improve CPR quality performed in a distraction-free environment. We recommend that athletic trainers and students practice CPR in realistic environments and utilize EFA cues, such as music.

**Table 1: Descriptive Data for CPR Quality Measures**

| | Trial 1 | | Trial 2 | |
|---|---|---|---|---|
| Quality Measures | EFA | IFA | EFA | IFA |
| Compression rate [a] | $\bar{x}$ = 109.28, SD = 10.03 | $\bar{x}$ = 107.53, SD = 12.94 | $\bar{x}$ = 112.46, SD = 11.18 | $\bar{x}$ = 113.11, SD = 11.05 |
| Compression depth [b] | $\bar{x}$ = 48.36, SD = 41.65 | $\bar{x}$ = 67.90, SD = 40.61 | $\bar{x}$ = 47.50, SD = 45.93 | $\bar{x}$ = 64.77, SD = 43.41 |
| CCF [c] | $\bar{x}$ = 62.78, SD = 5.13 | $\bar{x}$ = 64.60, SD = 5.04 | $\bar{x}$ = 64.32, SD = 5.56 | $\bar{x}$ = 65.02 SD = 4.30 |

[a] Average compression rate in compressions per minute (cpm).
[b] Average percentage of compressions reaching the correct depth.
[c] Average CCF (ratio of time spent on compressions to total resuscitation time).

**Barriers Prohibiting Uses of Simulation and Standardized Patients in Athletic Training Education**

Walker SE, Brown AN, Woofter BL, Armstrong KJ: Ball State University, Muncie, IN; University of Lynchburg, Lynchburg, VA; James Madison University, Harrisonburg, VA

**Context:** Using simulations and standardized patients (SPs) improves clinical skills, interpersonal skills, and learners' confidence. Despite these benefits, some AT faculty are still not using simulations or SPs. Thus, this investigation aimed to identify barriers prohibiting the implementation and use of simulations and SPs in AT professional education.

**Methods:** A cross-sectional survey design was used. We emailed the "Methods of Simulation and Standardized Patient Use in Athletic Training Professional Education" survey to all program directors (September 2022, n=245) of CAATE-accredited professional AT programs. The survey was accessed by 72 program directors, and 43 responded (59.7%). The survey contained 8 demographic questions, 2 Likert items (1 = strongly disagree - 5 = strongly agree) regarding barriers to simulations and SP use, and one item examining faculty collaborators for implementing simulations and SPs. Additionally, 2 open-ended questions identified additional barriers preventing the use of simulations and SPs. Cronbach α determined internal consistency, α=0.911. Descriptive statistics were computed for all items. A Krusal-Wallis and Mann Whitney U analyzed differences between barriers of simulations and SP use and selected demographic variables. The α level was set at 0.5.

**Results:** A lack of faulty knowledge to implement (4.40 + 0.989) and develop (4.33 + 0.979) simulations and SPs were identified as programmatic barriers, along with a lack of faulty time to implement simulations and SPs (4.36 + 0.727). 66.7 (n=28) strongly agreed that there is a lack of evidence to support the use of simulations and standardized patients for both teaching and evaluation. A Mann-Whitney U test revealed that individuals identifying as a man reported a lack of student buy-in for simulation-based teaching (Z =-3.088, P=.002) and evaluation (Z = -2.662, P=.008) more than individuals identifying as a woman. Regarding institutional barriers, a lack of financial resources to implement simulations and SPs (4.24 + 1.100), a lack of simulation equipment (4.24 + 1.100), and a lack of available trainees to serve as patients (4.38 + 0.909) were identified. Table 1 highlights the prevalence of barriers. A Krusal-Walis revealed respondents from baccalaureate and master's colleges/universities reported a lack of simulation technology (H5 =11.930, P=.036) and a lack of technology equipment for recording (H5 =12.816, P=.025) significantly more others.

**Conclusions:** Professional education in AT has evolved over the last few years; however, the teaching and assessment methods have not paralleled the growth. Many educators still perceive a lack of evidence to support the use of simulations and SPs, while reporting a lack of time and financial resources. Professional programs should seek professional development opportunities regarding simulations and standardized patients. Collaborating with other healthcare programs on campus could also provide some support and resources.

**Exploring the Use of a Focused History Script for the Social Determinants of Health to Facilitate Patient Conversations**

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**Context:** Screening for social determinants of health (SDOH) factors is fundamental to addressing barriers to health outcomes and identifying resources needed to provide patient-centered care. However, SDOH can be a difficult area of patient care to navigate without a screening tool. The purpose of this study was to explore athletic training students' abilities to screen for SDOH factors via standardized patient (SP) encounters and to describe the experience of screening for SDOH factors.

**Methods:** Fifty-four post-baccalaureate professional athletic training students (women=43, men=11; age=23±1 years) from two cohorts of athletic training students participated in the same SP encounter with the intervention cohort (n=29) screening for the SDOH without an aide, and the control cohort (n=25) screening with the mandatory use of a previously validated SDOH focused history script. The SP encounters were evaluated using an SDOH evaluation tool by domain and Athletic Training Milestone competencies. Following the SP encounter, each learner completed a post-learning survey. Data were analyzed using descriptive statistics, Mann-Whitney U tests, and thematic qualitative analysis.

**Results:** Table 1 provides the SDOH evaluation by domain. We identified a significant difference ($p \leq 0.001$) for the overall screening for the SDOH with the intervention cohort that was required to use the focused history script scoring significantly higher than the control cohort. The intervention cohort scored significantly higher ($p \leq 0.001$) on the Athletic Training Milestones as compared to the control cohort, but the intervention cohort self-rated their performance as lower during the reflection. Data analysis revealed four themes for the control cohort and five themes for the intervention cohort related to screening for the SDOH during the SP encounter. The themes for the control cohort responses included superficial screening, selective screening, unfamiliar screening, and no screening. The themes for the intervention cohort responses included unnatural screening, needing additional practice, recall of specific SDOH, resources provided, and script facilitated.

**Conclusions:** Using a focused history script increased screening of SDOH factors but decreased the students' self-confidence in the process. We identified a confidence gap for SDOH screening abilities, with athletic training students having a high self-confidence in their ability to screen as compared to their actual performance. Using the focused history script during the SP encounter highlighted the need for a screening tool to be present during the evaluation to facilitate a conversation about the SDOH. When healthcare students were not required to use the focused history script to screen for the SDOH, most failed to elicit information about the SDOH factors or performed poorly during the screening.

This study was fully funded by the National Athletic Trainers' Association Research & Education Foundation.

Table 1. SDOH Evaluation by Groups

| SDOH | Frequency | |
|---|---|---|
| | Control Cohort | Intervention Cohort |
| **Healthcare Access & Quality** | | |
| Performed very well | 3, 10.3% | 17, 6.8% |
| Performed with weakness | 4, 13.8% | 8, 32.0% |
| Performed incorrectly | 0, 0% | 0, 0% |
| Did not perform | 22, 75.9% | 0, 0% |
| **Education Access & Quality** | | |
| Performed very well | 0, 0% | 11, 44.0% |
| Performed with weakness | 3, 10.3% | 9, 36.0% |
| Performed incorrectly | 3, 10.3% | 0, 0% |
| Did not perform | 23, 79.3% | 5, 20.0% |
| **Social & Community Context** | | |
| Performed very well | 3, 10.3% | 9, 36.0% |
| Performed with weakness | 15, 51.7% | 13, 52.0% |
| Performed incorrectly | 2, 6.9% | 0, 0% |
| Did not perform | 9, 31.0% | 3, 12.0% |
| **Economic Stability** | | |
| Performed very well | 1, 3.4% | 8, 32.0% |
| Performed with weakness | 5, 17.2% | 13, 52.0% |
| Performed incorrectly | 1, 3.4% | 2, 8.0% |
| Did not perform | 22, 75.9% | 2, 8.0% |
| **Neighborhood & Built Environment** | | |
| Performed very well | 3, 10.3% | 10, 40.0% |
| Performed with weakness | 7, 24.1% | 10, 40.0% |
| Performed incorrectly | 2, 6.9% | 0, 0% |
| Did not perform | 17, 58.6% | 5, 20.0% |

**Orientation Using Standardized Patients Increases Athletic Training Student Communication Effectiveness When Transitioning to Clinical Education Experiences**

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**Context:** Transitioning from didactic to clinical education overwhelms novice athletic training students. The learning environment change often causes anxiety as students get acquainted with the clinical site, preceptor expectations, and demonstrating clinical skills during patient care. Learning to communicate provides additional challenges as students must convey information to their patients, practice active listening, relay patient information to their preceptor, and possibly navigate conflict management. Simulation-based orientations have been effective in other healthcare professions to ease this transition; however, it has not been examined in professional athletic training students.

**Methods:** The study used a convenience sample of 17 first-year athletic training students (3 men, 14 women, age= 22.59 + / - 0.99) enrolled in a CAATE-accredited professional master's program. Students had completed one didactic semester in the program and were preparing to transition to clinical education. A two-day simulated-based orientation was completed before beginning their first clinical education experience. Orientation was designed to introduce the role of clinical education, define student roles and responsibilities, examine how to navigate clinical learning, review policies and procedures, review clinical skills, and practice effective communication. The orientation delivery framework included lectures, facilitated discussion, clinical skill practice, 3 standardized patient (SP) encounters, and two facilitated debrief sessions (one debrief immediately following the orientation and a second debrief two weeks after orientation). A 15-item pre- and post-orientation communication confidence survey was completed. Eight Likert items evaluated confidence communicating with a preceptor, seven questions evaluated confidence communicating with patients. Descriptive statistics were calculated for all items. Paired samples t-tests were used to compare pre- and post-orientation communication confidence ratings. Alpha levels were set at 0.05. A semi-structured debrief guide stimulated self-reflection during the two debriefs. Qualitative analysis of respondents' comments was completed using interpretive coding.

**Results:** A paired sample t-test revealed that students' confidence significantly improved in communicating with preceptors (t=3. 697, df=14, P < 0. 001) and communicating with patients (t= 2. 344, df=14, P < 0. 017) after participating in simulation-based orientation. Three themes were established from debrief data: (1) Improved Communication, including comments regarding increased confidence asking questions and expressing day-to-day concerns with preceptors; (2) Improved Clinical Skills, including comments highlighting that orientation with skill review improved students' confidence in clinical skill application despite that some apprehension persisted when new skills were presented; and (3) Role Clarity, including comments regarding increased role clarity and confidence presenting patients to their preceptors and performing evaluations.

**Conclusions:** A simulation-based orientation effectively improved professional AT students' communication skills. AT educators should focus on orientation strategies to prepare students to transition from didactic to clinical education. Orientations that include simulations or standardized patients and facilitated debriefs help ease the transition to clinical education.

**Progressive Autonomy in Athletic Training Clinical Education**

Jeffery GS, Rivera MJ, Young JP, Eberman LE: Indiana State University, Terre Haute, IN

**Context:** Progressively offering autonomous clinical experiences, based on learner skill, education, and experience level are reported to develop clinical decision-making skills, a sense of responsibility and patient ownership, readiness for independent practice, and professional identity. The CAATE has established that programs must offer students progressively autonomous clinical experiences throughout the ATP. However, little is known about how preceptors learn to and go about offering progressively autonomous clinical experiences.

**Methods:** We used a consensual qualitative research design for this study using a semi-structured interview. We had 19 participants (age= 32±5y; Men=7 Women=12; years of experience=8±5y) with an average of 5 years as a preceptor (range=1-10y) complete the online semi-structured interview (Zoom, San Jose, CA), which were audio-recorded and transcribed. The interview script was designed to investigate preceptor perceptions about creating progressively autonomous learning opportunities and strategies they employ to develop autonomous decision-makers among their students. The interview script was reviewed by external auditors with experience in qualitative research and their feedback was incorporated into the final script. A data analysis team of 3 individuals used a multi-phase process to identify core ideas among the participants' responses and create a consensual codebook represented by domains and categories. Trustworthiness and credibility of the consensus codebook were established by member checking, multi-analyst triangulation, and auditing.

**Results:** Two domains (Figure 1) emerged regarding preceptor experiences: 1) Preparation and 2) Implementation. Preparation represented data about how preceptors valued the importance of progressively autonomous experiences, as well as how they engaged in personal development as a preceptor to create these experiences. As part of their preceptor development, the mentioned both their own student experiences as well as the continuing education they selected to improve as a preceptor. When asked specifically about preceptor development from the programs they serve, none of the preceptors indicated that programs provided development on offering progressively autonomous practice experiences. Relative to the implementation domain, preceptors described using initiative and confidence as a means to measure readiness for more autonomy. Similarly, where students are in terms of curricular progression, specifically what students have been taught, also prompted them to provide autonomous experiences. Execution was the specific tactics that preceptors used in their day-to-day interactions to provide a progressively autonomous clinical experience for students. These tactics included providing students a safe space to grow their skills, decision making, and professional identity. Additionally, debrief was discussed as a means to enhance student learning through progressively autonomous experiences. Finally, preceptors described a range of assessment they used to rate their students' ability to practice with degrees of autonomy or to make adjustments in how much autonomy the student received. Preceptors reported using both subjective and objective measures to assess their students including tools such as the Athletic Training Milestones, program specific measures, and observation of student performance.

**Conclusions:** Progressively autonomous experiences are critical to the development of autonomous clinicians in athletic training practice. Properly providing progressively autonomous clinical experiences prepares students to transition into certified athletic trainers. First, athletic training programs should establish clear communication and expectations for preceptors related to progressive autonomy. Next, athletic training programs should provide preceptors with training in providing progressively autonomous experiences for students in clinical education. Preceptor training should include proper debriefing strategies to implement with their students, including ways to track progress and address problems in real-time to shape the direction of student progression. Athletic training programs should also provide examples of high quality application of progressively autonomous clinical experiences should be shared with preceptors. Finally, programs should provide clear direction on assessment of students with objective assessments related to progressive autonomy.

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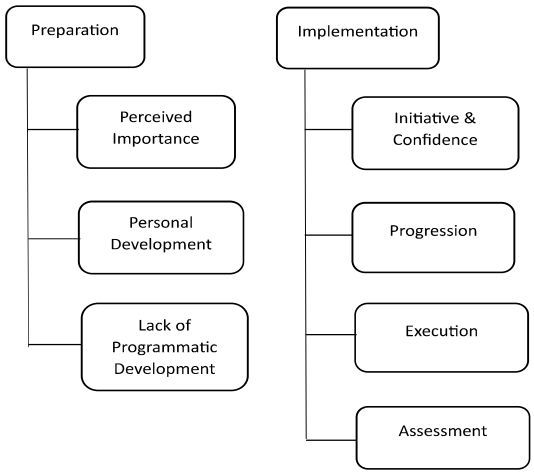
**Figure 1.** Domains and Categories: How Preceptors Learned About and Offer Progressively Autonomous Experiences



**Quality Improvement: Creating a System for Ongoing Evaluation of Students' Clinical Experiences**

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**Context:** Athletic training clinical education sites are typically evaluated summatively at the end of student clinical experiences. The current body of knowledge throughout medical education also supports the completion of summative clinical site evaluations after the student has transitioned out of the clinical site. However, this may lead to areas for improvement going unaddressed until after the student has transitioned out of the clinical site. Therefore, the purpose of this quality improvement project was to develop a mechanism to gain valuable formative feedback from the students during their clinical placement to allow the program to improve the student experience while they are still in their clinical placement.

**Methods:** The Plan, Do, Study, Act (PDSA) cycle was used to implement change. The director of clinical education for the athletic training program investigated which qualities of a clinical experience were most conducive to positive learning outcomes. An instrument was then created to assess these qualities, which was completed weekly by 38 students at 42 clinical sites. The instrument required the student to complete 5-Point Likert Scale questions regarding their communication with stakeholders at their clinical site, self-perceived rating of the clinical experience, and open-ended response for students to explain their Likert Scale ratings, speak about unique experiences, and voice areas of concern. Data were qualitatively analyzed weekly to determine if interventions were necessary. When students voiced areas of concern or indicated low scores on their communication with key stakeholders, the director of clinical education would intervene by speaking with key stakeholders and working together to address areas of concern.

**Results:** Of the 1558 completed instruments, there were 134 concerns raised by students. Of the concerns raised, 68 were related to the clinical site, and 17 required direct intervention. All 17 direct interventions successfully resolved the concerns based on qualitative feedback from key stakeholders. In addition to the clinical site concerns, there were an additional 47 programmatic and 19 personal concerns raised through this mechanism. Students' self-perceived student experience improved upon addressing areas of concern.

**Conclusions:** The significance of this quality improvement plan was to improve clinical experiences for students in real-time so that their feedback can be addressed for their benefit and to have multiple data points of assessment for each clinical site beyond the summative assessment. Challenges encountered during this process were students' willingness to assess their clinical site honestly for fear of repercussions. However, this was addressed through communication and group buy-in through the experiences of those who successfully experienced the results of the process. If this project were to be conducted again, it should be communicated to the students that what is reported on the form will serve to improve their clinical experience for their benefit in real time.

**Self-Authorship of Masters of Athletic Training Students: A Path Toward Professional Identity Formation**

Rivera MJ, Eberman LE, Games KE, Powers SM: Indiana State University, Terre Haute, IN

**Context:** The development of a strong professional identity is imperative to aide in transition to practice, improve patient outcomes, and increase retention in healthcare professions. Self-authorship is the internal ability to define and act on one's beliefs, identity, and social interactions, whereby one moves away from following formulas toward integrating knowledge and making decisions based on one's own choices rather than those of authority.
**Methods:** We used mixed methods design with a web-based survey and follow-up interview to investigate the self-authorship and professional identity formation in professional-level masters of athletic training (MAT) students. We used the previously validated self-authorship questionnaire version-2 (SAQv2), a 27-item assessment of four constructs ranked by items on a 5-point Likert scale (1=not like me, 5=like me): situational coping, interpersonal leadership, self-efficacy, and knowledge creation. The constructs are summed, with higher scores indicating greater self-authorship. Participants could opt-in to a follow-up semi-structured interview. We used a consensual qualitative research (CQR) approach with a multi-phased process creating a consensus codebook that represented the common domains. Trustworthiness and credibility were established by member checking, multi-analyst triangulation, and auditing. We recruited through program administrators of MAT ATPs to distribute the survey to students in their final year and a random sample of NATA non-certified student members (n=3,768) to secure a representative, criterion sample. A total of 189 people opened the survey, of which 104 participants (age=24±3y, women=78, men=24, transgender=2) competed the entire survey (completion rate=104/189, 56%). Descriptive statistics and measures of central tendency were used to analyze the demographic variables and SAQv2 scores. We used a Kruskal-Wallis to compare SAQv2 scores and constructs across age, gender, and race/ethnicity. Participants were classified as traditional masters age (18-25y, n=78) and nontraditional (25+ years, n=26) as well as white (n=84) or nonwhite (n=20). Twelve participants completed the follow-up interview (11 women, 1 man; age=24±2y).
**Results:** The average SAQv2 score was 114±11 indicating MAT students perceive themselves to have high levels of self-authorship. A significant difference existed between students of traditional age and nontraditional age on interpersonal leadership (p=.016), self-efficacy (p=.002), knowledge creation (p=.011) and overall SAQv2 (p≤.005), where students of traditional age scored higher. There was a significant difference between race/ethnicity where nonwhite students scored significantly lower than white students on interpersonal leadership (p=.04). Three domains emerged: developing trust, growing/maintaining confidence, and forming identity (Table). Participants described how preceptors provided autonomy and performance feedback to develop a trusting relationship. In contrast, even though students were given a degree of autonomy, their described actions and behaviors indicated they consistently relied on following formulas and external authority to make care decisions. When asked about questioning authority when confronted with disagreements, participants described evenly, doing so in both direct and indirect manners. Participants more often shared that debriefing was critical to developing their confidence and advancing them toward autonomous practice. Participants characterized themselves as soon to be autonomous clinicians by sharing about both internal attributes they came to the profession with and acquired attributes they developed as part of their training. Participants saw themselves as curious and humanistic, while also sharing that social learning and clinical teaching helped them develop themselves as holistic and collaborative. That said, they are also not immune to the struggles ATs have with professional recognition and burnout; all of which characterize their professional identity.
**Conclusions:** Athletic training students scored highly on the SAQv2, meaning they feel they are self-authoring and not following formulas. Nontraditional-aged students demonstrated more openness to question beliefs and external formulas. However, all students shared instances of formula following in the follow-up interview. ATPs should explore self-authorship as a means to develop the professional identity of learners.

**Table**. Domain, Categories, and Frequencies

| Domain, Category | Frequency | CQR Characterization |
|---|---|---|
| Developing Trust | | |
| Patient Care | 12 | General |
| Procedural | 10 | Typical |
| Feedback | 8 | Typical |
| Growing/Maintaining Confidence | | |
| Rule Following | 12 | General |
| Questioning Authority – Direct | 8 | Typical |
| Questioning Authority – In-direct | 9 | Typical |
| Questioning Knowledge | 7 | Typical |
| Debriefing | 10 | Typical |
| Creating Identity | | |
| Acquired Attributes – Holistic | 11 | General |
| Acquired Attributes – Collaborative | 9 | Typical |
| Acquired Attributes – Professional Recognition | 9 | Typical |
| Acquired Attributes – Burnout/Compassion Fatigue | 10 | Typical |
| Internal Attributes – Curiosity | 11 | General |
| Internal Attributes – Humanistic | 12 | General |
| Instructional Strategies – Social Learning Theory | 12 | General |
| Instructional Strategies – Clinical Teaching | 12 | General |

*Note*. General = 12 – 11 cases, Typical 6 – 10 cases, Variant 2 – 5 cases

**The Effect of Collaborative Patient Simulation on SPICE-R Scores of Health Education Students: A Critically Appraised Topic**

Melick A, Tierney RT, Russ AC, Mansell JL: Concordia University, Ann Arbor, MI, and Temple University, Philadelphia, PA

**Context:** Patient simulations are one pedagogical strategy that educators use to prepare students for interprofessional practice. Students must work in multidisciplinary teams to enhance patient care. What is the efficacy of collaborative patient simulation for increasing Students' Perceptions of Interprofessional Clinical Education-Revised (SPICE-R) scores in health education students?

**Methods:** A search of PubMed and CINAHL was conducted in June of 2023 using the Boolean phrases: interprofessional education, interprofessional education AND athletic training, interdisciplinary AND healthcare education, interprofessional education AND simulation training AND SPICE-R. Studies were included if they were conducted in the last 5 years, with 2 or more undergraduate or graduate health professional student groups engaged in an interprofessional activity and using the SPICE-R. Studies were excluded if the IPE simulation was performed electronically or passively and if numerical data was not provided. The SPICE-R is a 10- item self-report that measures interprofessional teamwork and team-based practice, roles and responsibilities for collaborative practice, and patient outcomes from collaborative practice. The outcome measure of interest was the change in SPICE-R scores between pre and post-IPE activity.

**Results:** The search yielded 121 articles, and 3 were selected for inclusion after reviewing for eligibility. Active interprofessional learning activities increased students' perceptions of interprofessional clinical education measured by the SPICE-R. Carmack et al., used a diabetes escape room with nursing and athletic training students. Post-test SPICE-R scores increased significantly across all subscales. Morell et al., utilized a variety of active learning opportunities from students in at least seven health care profession programs, including athletic training. Post-test SPICE-R scores increased significantly across all subscales ($p < .001$). Fusco et al., used a hospital-based high-fidelity simulation with nursing and pharmacy students. Scores for all 10 questions significantly increased in pharmacy students and for 9/10 in nursing students.

**Conclusions:** Active simulation activities yielded statistically significant increases in all scale dimensions, including roles and responsibilities, team-based practice, and patient outcomes. Simulation is a valuable educational tool to enhance interprofessional clinical education and collaboration. SORT B

**Use of Standardized Patient Encounters and Simulation to Teach and Learn About Behavioral/Mental Health in Athletic Training**

Ward KL, Drescher MJ, Young JP, Winkelmann ZK, Walker SE, Eberman LE: Indiana State University, Terre Haute, IN; North Dakota State University, Fargo, ND; University of South Carolina, Columbia, SC; Ball State University, Muncie, IN

**Context:** Simulations (SIM), which include standardized patient encounters (SPE), are teaching tools used within educational programs to provide authentic learning experiences for students to develop the knowledge, skills, and abilities in athletic training. ATPs have begun integrating these techniques into their curricula; however, behavioral/mental health (BMH) encounters are complex to re-create authentic experiences, and fewer programs report engaging in BMH SIM compared to orthopedic and primary care SIM. Further, how programs use SIM to assess student competence on BMH curricular content is unknown. This study explored how athletic training faculty use SIM to teach and learn about BMH in athletic training.

**Methods:** Athletic training faculty from CAATE-accredited institutions were recruited via email to participate in an online, semi-structured interview. Faculty were included in this study if they actively incorporated BMH SIM within their program within the past 12 months. Faculty were excluded if they did not incorporate BMH SIM within the past 12 months. The interview protocol included 8 broad questions incorporating SIM with specific follow-up questions about integrating BMH SIM into the curriculum. For example, one item asked how the program delivered SIM relative to case development and fidelity, followed up with a question about BMH SIM case development and fidelity. The script was externally reviewed by 5 content experts trained in qualitative research and BMH SIM for face validity. The primary investigator conducted 2 practice interviews with participants otherwise not eligible for the study to optimize interview flow before data collection. All interviews were audio-recorded and transcribed. A consensual qualitative research (CQR) approach was used to analyze the data specific to the integration of BMH SIM. A coding team consisting of 3 research team members used a multi-phase data triangulation process to construct a consensus codebook.

**Results:** Ten participants met the inclusion criteria and data saturation guided the number of necessary interviews. From the analyzed interviews (n=10), 1 domain with 7 categories emerged from the data; the domain characterized how programs design BMH SIM within their programs (Table 1). Participants noted that BMH SIM experiences were often implemented after students had experience with other types of SIM and that students were provided with a range of stakes for their performance, including teaching SPEs and non-graded, formative experiences. Participants also described integrating BMH components into traditional SIM experiences, such as an SPE for orthopedic exams. Participants described the debriefing process leading to transformative thinking followed by planned action for the future. Some participants identified that BMH SIM offered opportunities to incorporate interprofessional and collaborative practice opportunities for students by engaging with counseling services and other healthcare professions. Further, many participants used these BMH SIM experiences to fill gaps in student clinical experiences. That said, there were overall fidelity concerns, with participants describing procedures that do not align with SIM best practices. Lastly, participants were largely inconsistent in their assessment approaches to these BMH SIM experiences.

**Conclusions:** Some ATP are designing SIM to teach and help students learn BM concepts. Program faculty acknowledged the need to scaffold these experiences after students had already experienced SIM for other curricular content. BMH SPEs and SIM offer interprofessional learning opportunities and BMH elements could be integrated into other SPE and SIM experiences. Most ATPs described formative BMH SIM experiences with ranging stakes and challenges relative to ensuring fidelity with these experiences. Programs may need more training to adhere to SIM best practices, specifically to enhance BMH SPE fidelity and ensure psychological safety.

**Table 1.** Design Domain and Categories

| Design | Count | CQR Value |
|---|---|---|
| Experience Practice Gap | 10 | General |
| Concerns with Fidelity | 10 | General |
| Transformation Through Planned Action | 10 | General |
| Range in “Stakes” | 9 | General |
| Scaffolding | 8 | Typical |
| Integration of BMH Into a More Traditional SPE | 6 | Variant |
| Interprofessional and Collaborative Practice | 6 | Variant |

**Legend:** General: 9-10, Typical: 6-9, Variant: 2-5 cases

**Terms:** BMH=behavioral/mental health, SPE= standardized patient encounter

**Uses of Simulation and Standardized Patients in Athletic Training Education for Teaching and Evaluation**

Armstrong KJ, Woofter BL, Walker SE, Brown AN: James Madison University, Harrisonburg, VA; Ball State University, Muncie, IN; University of Lynchburg, Lynchburg, VA

**Context:** In healthcare education, students prefer active modes of teaching and assessment that allow for integrating knowledge, skills, active thinking, and clinical decision-making. Since learning is contextual, teaching and evaluation methods should align with patient care. Previous researchers established that simulations were predominantly used to teach and evaluate athletic training (AT) student's clinical skills. Thus, this follow-up investigation aimed to identify the current uses of simulations and standardized patients (SPs) for teaching and assessment within professional AT programs.
**Methods:** We used a cross-sectional survey design. CAATE-accredited graduate professional AT program directors (September 2022, n=245) were emailed the "Methods of Simulation and Standardized Patient Use in Athletic Training Professional Education" survey. A total of 72 program directors accessed the survey, with 43 responding (59.7%). The survey consisted of 8 demographic questions, 3 items regarding the frequency of use of simulations and SPs for teaching and evaluation, 1 question regarding administrative release time, and 2 open-ended questions regarding additional uses for teaching and evaluation. Cronbach's α determined internal consistency, α=0.891. Descriptive statistics were computed for all items. A Krusal-Wallis analyzed differences between use of simulations and SP and selected demographic variables. The α level was set at 0.5.
**Results:** Nearly all respondents reported using simulations for teaching (n = 41, 97.6%) and evaluation (n = 38, 95.0%), while most reported using SPs for teaching (n = 32, 76.2%) and evaluation (n = 32, 82.1%). Regarding teaching or evaluation, simulation use occurred most in the curricular content areas of non-orthopedic evaluation (n = 40, 97.6%), emergency care and life-threatening injuries (n = 38, 95.0%), and orthopedic evaluation (n = 36, 87.8%). Regarding teaching or evaluation, SP use occurred most in the curricular content areas of orthopedic evaluation (n = 32, 76.2%), non-orthopedic evaluation (n = 32, 76.2%), and emergency care and life-threatening injuries (n = 28, 66.7%). Table 1 includes the frequency of use. A Krusal-Wallis revealed respondents from Doctoral (R2) and Doctoral/Professional classifications reported more uses of SPs for evaluation purposes (H = 11.205, P = .024) than others. Additionally, a Krusal-Wallis revealed respondents with administrative release time to oversee simulations and SPs significantly used these techniques more frequently (H = 6.673, P = .036) than others.
**Conclusions:** The use of simulations and standardized patients has increased over the last 18 years within professional AT programs for improving student's clinical skills, communication skills, and confidence. These strategies provide opportunities for real-time patient encounters in a safe learning environment. AT educators need to seek out mechanisms to increase the use of simulations and SPs, as these teaching and assessment techniques are important for preparing students for the rigors of professional practice.

### Athletic Training Services in Collegiate Student-Athletes for Acute, Overuse, Time-Loss and Non-Time-Loss Injuries by Gender

Choe S, Simon JE, Soucy M, Fredericson M, Bovbjerg VE, Brown CN: Oregon State University, Corvallis, OR; Ohio University, Athens, OH; Stanford University, Stanford, CA

**Context:** Athletic trainers (AT) spend substantial effort providing preventative care and injury management in collegiate athletics. While the need for appropriate care is evident, little has been reported about the workload of these clinicians, nor the distribution of care across types of injuries. The purpose of this study is to describe AT workload for acute and overuse injuries, stratified by time-loss (TL) status and gender in collegiate student-athletes.
**Methods:** De-identified electronic medical records, authorized by student-athletes for research use, were collected from July 2018 to June 2022 in a Division I conference for this cross-sectional study. The data represent a total of 1,005 team seasons (454 men's and 551 women's). Clinician counts were collected annually using publicly available data for each institution. A clinician was defined as an individual holding an AT credential and employed by the institution in full or part-time capacity with any clinical (not solely administrative) assignment. Clinicians were counted once, and if team assignments were across genders, effort was assigned at 50% each, regardless of team assignment(s). AT services (ATS) were categorized based on injury mechanism (acute or overuse), and TL status (TL or non-time-loss (NTL)) stratified by gender (men or women). ATS was defined as any type of evaluation, testing, or therapeutic intervention session. We calculated the rates per year of clinician workload such as ATS per injury, injuries per AT, and ATS per AT per year, reporting mean, median, and interquartile range (IQR).
**Results:** Out of 271,872 ATS provided (men: 144,301; women: 127,571), the overall mean ATS per injury was 11.1 (median: 3) for women compared to 8.5 (median: 3) for men (Table 1). Notably, overuse-TL injuries had the highest mean ATS per injury for both genders, with women at 16.1 (median: 6; IQR: 1, 18), followed by men at 13.8 (median: 6; IQR: 1, 17). The overall injuries per AT were 41.8 for men compared to 34.3 for women. Injuries per AT and ATS per AT per year are reported by mechanism and TL status for genders in Table 1.
**Conclusions:** In this preliminary work, ATS per injury, injuries per AT, and ATS per AT per year varied by mechanism and TL status. The means, medians and IQRs indicated highly skewed data. The values support literature reports of women receiving greater mean ATS per injury than men, though medians and IQRs were similar, and TL injuries receiving more mean ATS per injury. Per-clinician workload measures indicated acute-TL necessitated the most AT attention. Future research should incorporate sport-specific full-time equivalent allocation of AT. A more accurate estimation of clinician workload across sports and seasons could lead to improved patient outcomes through appropriate clinician staffing in collegiate athletics.

This project was supported by the Pac-12 Conference's Student-Athlete Health and Well-Being Initiative. The content of this abstract is solely the responsibility of the authors and does not necessarily represent the official views of the Pac-12 Conference, or its members.

**Table 1**. Mean ATS per injury, Injuries per AT, and ATS per AT in Collegiate Student-Athletes

| | | Acute TL (median; IQR) | Acute NTL (median; IQR) | Overuse TL (median; IQR) | Overuse NTL (median; IQR) | Grand Total (median; IQR) |
|---|---|---|---|---|---|---|
| Mean ATS per Injury | W | 12.4 (4; 0, 12) | 6.5 (2; 0, 6) | 16.1 (6; 1, 18) | 12.4 (5; 1, 14) | 11.1 (3; 0, 11) |
| | M | 10.6 (4; 0, 12) | 4.4 (1; 0, 5) | 13.8 (6; 1, 17) | 8.0 (3; 0, 9) | 8.5 (3; 0, 9) |
| | Total | 11.2 (4; 0, 12) | 5.2 (2; 0, 5) | 15.1 (6; 1, 18) | 10.6 (4; 1, 12) | 9.6 (3; 0, 10) |
| Injuries per AT per year | W | 13.1 (13; 11, 15) | 10.4 (10; 9, 12) | 4.7 (5; 4, 5) | 6.1 (6; 5, 7) | 34.3 (33; 29, 38) |
| | M | 20.7 (20; 17, 23) | 14.4 (14; 12, 16) | 3.2 (3; 3, 4) | 3.5 (4; 3, 4) | 41.8 (41; 35, 46) |
| | Total | 17.3 (17; 15, 19) | 12.6 (12; 11, 14) | 3.9 (4; 3, 4) | 4.7 (5; 4, 5) | 38.4 (38; 33, 43) |
| ATS per AT per year | W | 162.3 (157; 139, 181) | 68.2 (66; 58, 76) | 75.8 (73; 65, 85) | 75.6 (73; 65, 84) | 381.9 (370; 326, 427) |
| | M | 218.4 (215; 184, 242) | 63.2 (62; 53, 70) | 44.6 (44; 38, 49) | 28.4 (28; 24, 31) | 354.5 (349; 299, 392) |
| | Total | 193.1 (189; 164, 215) | 65.4 (64; 56, 73) | 58.7 (57; 50, 65) | 49.6 (49; 42, 55) | 366.9 (358; 311, 408) |

**Evolution of Athletic Training Services in US Secondary Schools: A Comprehensive 5-Year Analysis (2018-2019 to 2022-2023)**

Kim D, Defino AM, Coleman KC, Filep EM, Yoshihara A, Olson MB, Casa DJ, Huggins RA: Korey Stringer Institute, Department of Kinesiology, University of Connecticut, Storrs, CT

**Context:** Despite the 2013 NATA Inter-Association Task Force for Preventing Sudden Death in Secondary School (SS) Athletics Programs: Best Practices Recommendations, recent reports stated that 33% of SSs with interscholastic athletic programs in the US lack access to athletic training (AT) services. Since 2015, the status of AT services in SSs has been tracked via Athletic Training Locations and Services (ATLAS) to quantify the services in each state, determine the factors that influence access to AT services, and influence SS sport safety policy adoption however, the changes in these services over time is yet to be reported.

**Methods:** Data regarding AT services for the 2018-2019 and 2022-2023AY were extracted from the ATLAS database. National averages of the following variables were extracted by state and school type (public (PUB) and private (PVT)); the number of student-athletes (SAs), sports, ATs, ATs covering football, and the level of AT service (full-time (FT) or part-time (PT)). Additionally, SA:AT ratio, sports:AT ratio, and the proportion of schools offering AT services for football were investigated. States with less than 10 total survey responses were excluded from the analyses. Descriptive statistics and independent t-tests compared the findings from the two AYs. Statistical significance was set a priori at $p<0.05$. Data are presented as mean +/- standard deviation (SD).

**Results:** Response rates for 2018-2019AY and 2022-2023AY were 66.48% (n=7,144) and 65.92% (n=6,808) for 2018 and 2022, respectively. Key findings are displayed in Table 1. There were significant increases in the number of sports (5.1%), ATs (3.0%), FT AT (7.2%), sports:AT ratio (1.5%) while PT ATs significant decreased (-6.9%). PUB schools demonstrated an increase in the number of sports (4.7%), FT ATs (7.5%), and SA:AT ratio (1.2%) while the number of PT ATs decreased (-4.3%). PVT schools experienced a rise in the number of SAs (10.9%), sports (4.7%), ATs (7.0%), and the SA:AT ratio (4.6%). AK was excluded from both nationwide and PUB school comparisons, and an additional fourteen states (AR, AK, CO, ID, KS, MT, NV, NM, ND, OR, SD, UT, WV, WY) were excluded from the PVT school comparison due to insufficient survey responses.

**Conclusions:** Over the past five years, both the average number of sports per school and the total number of ATs have increased, independent of school type. Sports:AT ratio has also risen, especially in PUB schools, indicating that SS ATs are covering more sports. In PVT schools, there has been a notable increase of ~30 SA per school, leading to an additional 10 athletes per AT compared to five years ago. These findings will serve as foundational data for future research aimed at enhancing the safety of SS athletes.

| School Type | AY | Total Schools with AT Access (n) | ATLAS Response Rate (%) | SAs (n) | Sports (n) | ATs (n) | Full time ATs (n) | Part time ATs (n) | ATs covering football (n) | SA:AT (ratio) | Sports:AT (ratio) | AT Services Provided to Football:School with AT Services (ratio) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PUB** | 18-19 | 221.46 | 65.81 | 406.34 (120.66) | 18.06 (3.49) | 1.26 (0.20) | 0.80 (0.29) | 0.45 (0.18) | 110.96 (91.72) | 326.40 (102.17) | 14.60 (3.36) | 0.93 (0.76) |
| **PUB** | 22-23 | 184.28 | 66.46 | 409.67 (103.69) | **18.93 (3.28)*** | **1.29 (0.22)*** | **0.87 (0.26)*** | **0.40 (0.18)*** | 108.08 (86.48) | 323.72 (92.66) | **15.08 (3.65)*** | 0.93 (0.05) |
| **PVT** | 18-19 | 60.72 | 58.74 | 284.07 (74.79) | 17.39 (2.77) | 1.35 (0.28) | 0.89 (0.30) | 0.47 (0.22) | 21.22 (13.75) | 209.48 (38.41) | 13.05 (1.92) | 0.70 (0.16) |
| **PVT** | 22-23 | 48.97 | 62.60 | **313.41 (89.49)*** | **18.44 (3.39)*** | **1.45 (0.37)*** | 0.94 (0.28) | 0.48 (0.30) | 19.36 (14.51) | **219.55 (49.65)*** | 13.10 (2.54) | 0.70 (0.15) |
| **PUB + PVT** | 18-19 | 288.42 | 66.48 | 385.74 (109.65) | 17.77 (3.17) | 1.28 (0.20) | 0.82 (0.26) | 0.46 (0.16) | 127.30 (101.91) | 302.92 (85.24) | 14.05 (2.74) | 0.89 (0.09) |
| **PUB + PVT** | 22-23 | 221.80 | 65.92 | **394.80 (98.14)** | **18.72 (3.09)*** | **1.32 (0.22)*** | **0.88 (0.23)*** | **0.42 (0.16)*** | 123.08 (97.09) | 303.62 (80.99) | **14.48 (2.97)*** | 0.89 (0.07) |

Table 1. Characteristics of the public, private, and national secondary school athletic training setting in the 2018-2019 and 2022-2023 academic years. All data presented as M±(SD) *Significant changes compared to the 2018-2019 academic year ($p<.05$) AT=Athletic Trainer, SAs=student athletes, SA:AT= student athlete to athletic trainer ratio, Sports:AT=sports to athletic trainer ratio

**Incidence of Achilles Tendon Ruptures and Associated Factors in Women's Artistic Gymnastics**

Horton KM, Hawkes AR: Southern Utah University, Cedar City, UT

**Context:** Achilles tendon rupture risk appears to be higher in women's artistic gymnastics compared to other collegiate sports, however little is understood about personal, training, and performance factors potentially associated with this elevated risk. Previous research has only examined gymnasts who have sustained Achilles ruptures while in an NCAA environment and the overall incidence of Achilles ruptures among gymnasts has not been assessed. This study aims to identify injury factors, Achilles rupture incidence and training habits related to Achilles tendon ruptures in current and former women's artistic gymnastics.

**Methods:** A cross-sectional study design was performed using snowball sampling. Current and former competitive women's artistic gymnasts aged 18-40 years were recruited to voluntarily complete an anonymous online survey (Qualtrics®). The survey was reviewed by an expert panel for content validity and piloted on a group of individuals. Seventy collegiate women's gymnastics programs were contacted via athletic trainers, coaches, athletic directors and social media postings. Three hundred and ten (age 24.5±5.4 years) gymnasts completed the survey (completion rate=87.3%) and were included in the analysis. Information was collected about participant demographics, past Achilles injury, injury prevention strategies and training habits. Comparisons between groups with and without Achilles tendon rupture history were analyzed using a two proportion z-test and 95% CIs (p values ≤ 0.05). Linear regression analysis was used to measure the strength of correlation between calendar years and ruptures.

**Results:** Fifty-six participants (15.9%) reported having suffered an Achilles tendon rupture that required surgical repair in the past 15 years. Most ruptures (86.0%) occurred during floor exercise and 87.2% of these occurred during a back tumbling punch. Most ruptures happened during the competitive season (72.2%). Compared to participants without ruptures (Table 1), a greater percentage of gymnasts with ruptures performed difficult skills ($p < 0.001$), performed plyometric exercises 2-3 days / week ($p=0.03$), tumbled on the floor 2-3 days / week ($p=0.05$), and did not get their ankles taped consistently ($p=0.04$). There is a positive correlation between calendar years and ruptures, showing increased reported Achilles tendon ruptures since 2008 ($R2=0.68$, $F=29.3$, $p < 0.001$).

**Conclusions:** In this study, there was an increased incidence of reported Achilles tendon ruptures. Female competitive gymnasts were more likely to report a history of Achilles tendon rupture if they performed difficult skills, engaged in plyometric exercises 2-3 days / week, tumbled on the floor 2-3 days / week, and did not get their ankles taped consistently before activity. Most Achilles tendon ruptures happened during the competitive season, floor exercise, and the back tumbling punch. Clinicians working with gymnastics should consider implementing a way to monitor time performing difficult skills and plyometric exercise load to recognize gymnasts who may need prophylactic intervention or strategies to mitigate the risk of Achilles tendon rupture.

Table 1: Comparative data between Achilles rupture and no Achilles rupture groups

| Question | Descriptor | No Achilles Rupture n(%) | Achilles Rupture n=52, n(%) | 95% CI of Differences | P value |
|---|---|---|---|---|---|
| **On average, how many days/week did you tumble on the hard floor?** | | Total number=258 | | | |
| | 0-1 | 15 (5.81) | 3 (5.77) | -14.32, 15.12 | 0.99 |
| | 2-3 | 146 (56.59) | 37 (71.15) | -28.28, -0.84 | **0.05** |
| | 4-5 | 92 (35.66) | 12 (23.08) | -0.28, 25.44 | 0.08 |
| | 6-7 | 5 (1.94) | 0 (0.0) | 14.57, 24.23 | **0.0005** |
| **Did you train/compete "difficult" skills on vault or floor prior to injury?** | | Total number=277 | | | |
| | Yes | 209 (75.45) | 51 (98.08) | -28.94, -16.26 | **0.0002** |
| | No | 68 (24.55) | 1 (1.92) | 16.32, 28.88 | **0.0002** |
| **How many days/week were plyometric exercises implemented into your workouts prior to injury?** | | Total number=267 | | | |
| | 0-1 | 50 (18.73) | 5 (9.62) | -0.17, 18.39 | 0.112 |
| | 2-3 | 140 (52.43) | 36 (69.23) | -30.70, -2.90 | **0.026** |
| | 4-5 | 71 (26.59) | 10 (19.23) | -4.59, 19.31 | 0.265 |
| | 6-7 | 6 (2.25) | 1 (1.92) | -3.80, 4.46 | 0.882 |
| **Did you get your ankles taped consistently? (>3 days/week)** | | Total Number=283 | | | |
| | Yes | 158 (55.83) | 21 (40.38) | 0.91, 29.99 | **0.040** |
| | No | 125 (44.17) | 31 (59.62) | -29.99, -0.91 | **0.040** |

*Boldface indicates those with P values ≤0.05.

**Is Best Practice Always Current Practice? From the COPA Analytics and Outcomes Committee**

Barber Foss KD: Emory University, Atlanta, GA

**Context:** Documentation of athletic injuries and encounters is an important component of the athletic training program. In fact, appropriate documentation is deemed so essential that it is specifically identified as its own task within Domain 5: "Use established documentation procedures to ensure best practice" (0504). In addition, the NATA established the Best Practice Guidelines for Athletic Training Documentation in 2018. These practices are essential for appropriate care, professional expectation, liability mitigation, and demonstrating AT value. However, there appears to be a disconnect between best practice guidelines and current clinical application. The objective of this study is to present findings from the Analytics and Outcomes committee documentation survey.

**Methods:** The study design was a cross-sectional study. The survey link was sent via email to a representative sample of 4,934 NATA members across practice settings. The survey consisted of two parts. Part one comprised twelve questions related to the AT perceptions of Value and worth (three of these questions also contained a documentation component). Part two consisted of fourteen questions about EMR and data collection. The final eight questions were participant demographics. The focus of this study will be on Part two of the survey. A total of 581 certified athletic trainers completed the survey for a response rate of 11.8%.

**Results:** 94% of respondents answered that they document at least some injuries or encounters whereas only 75% document all injuries and 68% document all encounters. Almost 23% of respondents relate injury documentation to time loss/referral only. 80% of ATs currently use some form of EMR for their documentation system. Only 56% of respondents perceived documentation impacted their value. 26% answered that patient care documentation and daily tracking contributed the least value to their practice as an athletic trainer.

**Conclusions:** There was missed opportunity to identify potential barriers to determine why ATs are not documenting all injuries and encounters. Despite the professional importance of thorough documentation there appears to be a disconnect with current AT clinical practices. We need to do better in educating ATs on the value of data and documentation, for personal gain and growth but also for the profession as a whole.

**Occupational Stress and Injury History in Career Firefighters**

Tinsley Kubala JE, Uhl TL, Heebner NR, Abel MG, Hoch JM: University of Kentucky, Lexington, KY

**Context:** Stressful experiences are inevitable among firefighters as they secondarily experience their victim's crises when performing occupational demands. Firefighters also understand that poor occupational performance can result in serious injury or death of those involved in these encounters. The continued exposure to these stressors is thought to be associated with firefighter musculoskeletal disorder(MSD) occurrence. Previous cross-sectional and retrospective research has demonstrated that firefighters who reported greater occupational stress also demonstrated greater odds of MSD reports. However, these investigations employed measures not designed for tactical athletes, such as firefighters. Therefore, this study examined the impact of MSD history on firefighter occupational stress using a population-relevant questionnaire. We hypothesized firefighters reporting an MSD occurrence in the last 5 years would have higher occupational stress.

**Methods:** This cross-sectional, descriptive analysis is part of a larger prospective cohort study. Participants included 89 male-sex career firefighters (Age: 36.1±6.3 yr) who completed demographic and injury history questionnaires. A musculoskeletal injury was defined as the participant reported suffering and injury or experiencing musculoskeletal pain, damage, or dysfunction involving joints, bones, ligaments, tendons, nerves, and/or soft tissues, including, but not limited to, low back pain, dislocations, strains, sprains, and/or fractures in the last 5 years. Occupational stress was measured using the Sources of Occupational Stress 14 item(SOOS-14), a 14-item reliable measure of occupational stress specifically among firefighters ($\alpha$=0.86). The SOOS-14 is scored on a 5-point Likert scale, where higher scores indicate greater perceived stress. Questionnaires were delivered via REDCap(Research Electronic Data Capture), a secure, web-based platform. As data presented normally, independent samples t-tests and Cohen's d effect sizes were used to examine between-group differences ($p \leq 0.05$).

**Results:** The 59 participants who reported an MSD history had a SOOS-14 score of 26.54±8.03, which was not different from the 34 who did not(26.44±7.14, p=0.952).

**Conclusions:** Despite previous findings that occupational stress relates to firefighter MSDs occurrence, our results did not support this using the SOOS-14, a firefighter-specific occupational stress measure. The primary difference between our investigation and previous studies is the use of a population-relevant occupational stress measure. The contrast between our findings and previous relationships found between firefighter occupational stress and injury reports highlights that factors influencing occupational-stress and psychological symptoms may be more pertinent to examine than overall occupational stress. Additionally, comparisons between injury history and current occupational stress may not reflect the relationship between occupational stress and future injuries. Prospective examination of this relationship is likely necessary as stress experience is thought to hinder tissue healing capacity, increasing the risk of injury occurrence, and our findings do not suggest a relevant cross-sectional/retrospective relationship and cannot identify causal relationships. To better understand the relationship between occupational stress and firefighter MSDs, future investigations should be prospective and include potential covariates of occupational stress.

Study was supported by funding from the Endowed University Professor in Health Sciences at the University of Kentucky and the 2023 Pilot funds from the Central Appalachian Regional Education Research Center.

**Patient Perceptions of Psychological and Rehabilitation Experiences After ACL Reconstruction: A Qualitative Study**

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**Context:** The impetus of anterior cruciate ligament reconstruction (ACLR) is to restore knee function and stability to allow individuals to return to sport (RTS). Approximately 80% of patients anticipate a full RTS after ACLR; however, research shows only 24% of patients achieve this goal. Injury-related fear, athlete burnout, and self-determined motivation are psychological factors that may negatively impact athlete engagement during rehabilitation, leading to failure to RTS. Further characterizing how these psychological factors impact a patient's perceived success in rehabilitation may improve ACLR outcomes. The purpose of this qualitative study was to describe how patient perceptions of injury-related fear, athlete burnout, and self-determined motivation were associated with individual psychological and rehabilitation experiences in patients 4- to 6-months post-ACLR.

**Methods:** This study was conducted within a phenomenological-constructivist paradigm. Eight participants (age= 16.1±1.8 years, sex= 4 female, 4 male, time since surgery= 4.3±0.4 months) were recruited from an ongoing study through a local sports medicine clinic and were deemed eligible if they were between 4- to 6-months post-unilateral, primary ACLR, were between 14-25 years old, had not yet returned to sport, and injured their knee playing or training for organized sports. Participants completed a single, semi-structured interview through videoconferencing platform (Zoom) and video and audio were recorded for interview transcription. The principal investigator (PI) conducted the interviews and used within-interview participant-checking strategies to allow participants to correct researcher interpretations, aiding in validity of the results. The interview guide was developed based on previous qualitative work examining psychological responses to recovery after ACLR. Participants were asked open-ended questions regarding experiences during ACLR rehabilitation and how the participant perceived their current levels of injury-related fear, burnout, and self-determined motivation. Participants were asked to provide explanation for their self-reported levels of injury-related fear, burnout, or self-determined motivation through follow-up interview questions and probes. Data were interpreted through thematic analysis after interviews were transcribed verbatim to accurately interpret participant responses and allow for thematic coding. Interview transcripts were anonymized through participant pseudonyms. The PI and second author analyzed transcriptions separately and utilized line-by-line coding to formulate themes and subthemes. They resolved coding discrepancies by reviewing code definitions and determining code assignments. They assessed if themes worked in relation to coded data and refined themes to ensure a clear definition and name for each theme. A critical friend, who was not involved in transcription or coding, reviewed thematic structure and provided feedback. Themes were revised and finalized based on this feedback.

**Results:** Three primary themes and nine subthemes (Table 1) were found relating to participants' perceptions of their rehabilitation experience following ACLR. Results suggest that increasing positive psychological perceptions may improve rehabilitation experiences after ACLR due to the countering effect positive perceptions have on recovery stressors. All participants experienced injury-related fear throughout early stages of rehabilitation, and most continued to experience it throughout the process. Participants noted injury-related fear increased when introduced to functional and sport-specific activities. Athlete burnout symptoms were present when participants thought about the effort to RTS or reported a reduced sense of accomplishment in their sport due to their injury. Participants adapted to feelings of burnout by seeking accomplishment in other contexts. Self-determined motivation was driven by progressing in rehabilitation (i.e., competence), setting goals for recovery outcomes (i.e., autonomy), and positive social support (i.e., relatedness).

**Conclusions:** Participants described positive shifts in their psychological perceptions that impacted recovery and rehabilitation experiences. Rehabilitation specialists may increase positive psychological perceptions by offering social support to their patients during the recovery process. Future research should examine patient perceptions of psychological responses at different time points during recovery to gain better understanding of how these responses change throughout the recovery process.

Table 1: Themes and Subthemes Generation from Participant Interviews (N=8)

| Theme | Subtheme | Participant Quotes |
|---|---|---|
| 1. Acknowledging recurring struggles during recovery | Negative feelings surrounding injury and motivation | Nick: "Sometimes it's like, I can't squat with one leg, which I used to be able to do, so it's frustrating. And then it's also hard, because I can't squat…because it hurts."<br>Ashlyn: "When [motivation levels] are lower, I definitely dread going in [to physical therapy]…it's like, 'Do I have to go?,' that kind of feeling." |
| | Experiencing injury-related fear | David: "There's that fear that it's just gonna like snap or something…Before that [injury], I would never think about that. But now that's like a thing in my head."<br>Nick: "There are certain things where I get nervous about something, just kind of like, one in a million happening…like what if I find the one little piece of floor in the whole gym that's wet and I just like slip on my right leg…and retear" |
| | Recognizing symptoms of athlete burnout | Katy: "When I got hurt…it definitely hit me for a second that I kinda liked not having anything to do… and like I want to be back, but now that I'm thinking about going back…it's reminding me of like, how like tired I was."<br>Craig: "Some days I feel like, I feel like [sport devaluation], yeah. Like I feel like I'm not really getting anywhere because I'm not lifting enough weight, and like, I haven't moved in weight." |
| 2. Developing drive to return to sport and normal life | Understanding the rehabilitation process | Nick: "I've watched some of these [professional] athletes have the same injury, and like…they've got professionals looking at them every day and I see a physical therapist twice a week, so I shouldn't expect to be back any sooner."<br>David: "Just talking with my [athletic] trainer and him being like, realistic with me, he's like, 'You have to- like you'll have to relax, like you can't accelerate the process,'" |
| | Recognizing value in recovery | Lisa: "In the long run, if you put in more work like, outside of [rehabilitation] and in [rehabilitation], it does really help in the long run."<br>Joe: "I'd say just push through it cause it's going to all, it's going to all pay off in the end…you'll be able to go back to your sport hopefully, if that's your goal." |
| | Finding motivation for sport | Craig: "I feel like I can still be like an athletic kid, like I was before, and I really want to play football in the future, so I want to get back to sports."<br>Katy: "I have one year left of playing sports and that's, my knee and being scared of re-tearing it, is not going to stop me from being back." |
| 3. Successfully navigating the recovery process | Maintaining motivation | Ashlyn: "I just try to look forward to my next doctor's appointments…just finding out my progress, that has definitely helped."<br>Nick: "After a little bit of physical therapy, I started to see my leg working better and I was like, okay…this is motivating to see." |
| | Using social support | Lisa: "All of my friends telling me that like, I'll get better soon…just having a support system around me has really helped."<br>Melissa: "I actually know a few people who tore their ACL at the same time as me. So that kinda helped me too because we…went through it together," |
| | Adopting a positive and resilient mindset | Nick: "Being able to acknowledge the shortcomings you might have without getting frustrated, you need to be able to do that"<br>Lisa: "Since I do have such a positive state of mind, it made my experience with rehab a lot better" |

**Patient, Treatment, and Cost Characteristics Associated With Sport-Related Elbow, Forearm, Wrist, and Hand Injuries: A Report From the Athletic Training Practice-Based Research Network**

Ruiz RC, Marshall AN, Lam KC: A. T. Still University, Mesa, AZ, and Appalachian State University, Boone, NC

**Context:** Elbow, forearm, wrist, and hand (EFWH) injuries are common during sport participation, particularly in overhead athletes. Yet, little is known about the overall management and direct cost of care (DCC) associated with the management of these injuries. Thus, our objective was to describe patient, treatment, and cost characteristics for athletic training services (ATS) provided to patients with EFWH injuries.

**Methods:** This was a retrospective analysis of electronic medical records from the Athletic Training Practice-Based Research Network. Patient records were created by 191 athletic trainers (ATs) (female=64.4%, age in years=29.5±9.0, years certified=6.8±8.2, years employed at site=3.4±5.6) within the CORE-AT EMR between 2009-2023. The ATs practiced at 110 facilities (high school=91, collegiate=12, other=7) across 27 states. Complete patient cases (ie, cases with completed injury demographic, injury evaluation, daily treatment, and discharge forms) were identified using ICD-10 diagnostic codes and reviewed. Summary statistics were calculated for patient demographics (sex, height, weight, sport, diagnosis), treatment characteristics, and DCC. Treatment characteristics included the type of ATS (CPT code), duration of care (days between intake and discharge), episodes of care (EOC; number of documented patient encounters), and amount of care (number of ATS provided). DCC were estimated by applying the Centers for Medicare and Medicaid Services Physician Fee Schedule for non-facility (ie, non-hospital) organizations for each year of the study period. Codes were priced in accordance with the number of units recorded and the DCC for each patient case and EOC was estimated.

**Results:** Four hundred eighty-seven (male=348, female=139, age=16.2±2.9 years, height=172.1±11.7 cm, weight=72.2±16.4 kg) patient cases were identified for this study. The most common injuries were hand or finger sprain / strain (17.0%, n=83), wrist sprain (12.5%, n=61), hand contusion (11.5%, n=56), and elbow / forearm contusion (10.7%, n=52). Injuries occurred most frequently during football (43.1%, n=210), basketball (12.5%, n=61), and baseball (9.2%, n=45). A total of 7,625 ATS were recorded across all patient cases with AT re-evaluation (CPT-97006=45.0%), hot / cold pack (CPT-97010=11.7%), AT evaluation (CPT-97005=10.1%), and therapeutic exercise (CPT-97140=8.4%) most frequently reported. The median amount of care was 10 ATS per patient case across a median of 3 EOC and a median duration of care of 19 days. The median total cost of care was $394.20 per patient case and $99.56 per EOC.

**Conclusions:** Injuries of the EFWH exhibit a shorter duration of care, lower amount of care and lower DCC than other injuries (ie, shoulder, knee, ankle). However, AT re-evaluations account for nearly half of the ATS provided to patients with these injuries, demonstrating a great demand for AT involvement in their management. Future research should identify specific management strategies for these injuries that improve the effectiveness of treatment, reduce costs, and improve patient outcomes.

**School District Poverty Rate Impacts Athletic Training Services in Public Secondary Schools Within the Mid-Atlantic Athletic Trainers' Association District**

Defino AM, Kim D, Coleman K, Filep E, Yoshihara A, Olson MB, Casa DJ, Huggins RA: Korey Stringer Institute, Department of Kinesiology, University of Connecticut, Storrs, CT

**Context:** Previous research examining disparities in Athletic Training (AT) services in secondary schools (SS) has shown that median income, locale, school size, and distance from level 1 and 2 trauma centers influence access to AT services. The Census Bureau recommends the Small Area Income and Poverty Estimate (SAIPE) as the best estimate for poverty in school districts. To date, access to AT services has not been examined based on SAIPE.
**Methods:** Data were acquired and continually updated from September of 2019 through June of 2021 via one or more of the follow methods; completion of an online survey-based questionnaire by the SS AT, phone call or email to school administration or AT, or cross-referencing from current SS AT and athletics directories provided to the researchers or was publicly available online. Schools with and without AT services were retrieved from the Athletic Training Locations and Services (ATLAS) Project database as of June 2021. Schools (n=1147) within Maryland, DC, Virginia, West Virginia, North Carolina, and South Carolina were included in the analyses. Schools with unknown status at the time of export (n=156) and those without SAIPE IDs (n=83) were excluded from analysis. SAIPE rate was merged with ATLAS data via National Center for Education Statistics school district ID. Each school was categorized into four levels of poverty based on the state's median poverty rate (MPR) and quartile ranges as follows: Thriving (<25% of the MPR), Safe (≥25% to <50% of MPR), At-Risk (≤50% to >75% of MPR), and Crisis (≥75% of the MPR). Descriptive statistics and separate 2x2 chi-square analyses were calculated. Data are presented as percentage of access to AT services by poverty level and odds ratios (OR) with 95% confidence intervals.
**Results:** Of 1064 public SS analyzed, schools in crisis have the lowest access to AT services (60.8%) while thriving schools had the highest (95.6%). Thriving schools were 1.9 times greater odds of having AT services vs. schools in Crisis (OR=1.929 [95% CI=1.861-1.964]; P<0.001), At-Risk (OR=1.796; [95% CI=1.688-1.866]; P<0.001) and Safe (OR=1.364; [95% CI=1.082-1.559]; P=0.017). Safe schools had the second highest access to AT services (88.4%) and greater odds compared to Crisis (OR=1.888 [95% CI=1.775-1.944]; P<0.001) and At-Risk schools (OR=1.679 [95% CI=1.491-1.797]; P<0.001). Of At-Risk schools, 70.9% have access to AT services and greater odds compared to schools in Crisis (OR=1.652; [95% CI=1.279-1.832]; P=0.004).
**Conclusions:** Public SS in the MAATA who are in crisis and have high levels of poverty are at reduced odds of having access to AT services. These findings elucidate the inequities that exist regarding access to AT services in SS in this region. Analyses of poverty rate and access nationally is needed to strategically allocate federal and state funds to improve access to healthcare via AT services.

Proposal fees funded by the Korey Stringer Institute.

Table 2

*Odds Ratios of AT Services Compared Between Poverty Index Quartiles*

| Comparison | OR | 95% CI | Fisher's Exact Test |
|---|---|---|---|
| Thriving vs. Crisis | 1.929 | 1.861-1.964 | <0.001 |
| Thriving vs. At-Risk | 1.796 | 1.688-1.866 | <0.001 |
| Thriving vs. Safe | 1.364 | 1.082-1.559 | 0.017 |
| Safe vs. Crisis | 1.888 | 1.775-1.944 | <0.001 |
| Safe vs. At-Risk | 1.679 | 1.491-1.797 | <0.001 |
| At-Risk vs. Crisis | 1.652 | 1.279-1.832 | 0.004 |

**The Association Between Athletic Trainers and Frequency of Pediatric Orthopedic Clinic Visits**

Field AC, Meyer CM, Yeargin SW, Mensch JM: University of South Carolina, Columbia, SC

**Context:** Previous research has determined the employment level of athletic training services is related to the risk of injury in high school athletics and Soldiers' return to duty. However, there is sparse research on the relationship between athletic trainer (ATs) employment and the number of athletes presenting to a specialty clinic with sports-related injuries. Therefore, the purpose of this study is to determine if athletic training services provided by high schools is associated with the frequency of first time orthopedic office visits for sports-related injuries.

**Methods:** A retrospective chart review, collected injuries between January 1, 2018, and December 31, 2020, from the electronic health records system for a large hospital network. The network was in the Southeast region of the United States with six orthopedic clinics and included 48 high schools hosting 20 sports with at least 1 AT at each school. Patients kept within the dataset were enrolled in grades 7 through 12. Presence of an AT was quantified using a composite score of number and employment status. Full-time (FT) ATs were 1.0, and part-time (PT) and per diem (PRN) ATs were 0.5. Only sports-related injuries, presenting to the orthopedic clinic for the first time, were included in the dataset. A Spearman's rank correlation was used to determine if a relationship between the frequency of ATs and injuries reported to the orthopedic clinics existed.

**Results:** Patients (n=7082) were 16±2y, presented primarily with acute injuries (54.9%, n=3889)), which mostly involved the lower extremity (50.8%, n=2696). The top four sports that resulted in injuries for this population were football, soccer, basketball, and cheer accounting for 60% (n=4246) of the sports related injuries that reported to the orthopedic clinics. The average AT composite score was 1.6±0.9 (range: 0.5 to 4.0). The average frequency of FT ATs was 1.4±1.1 (range: 0.0 to 4.0), the average frequency of PT ATs was 0.4±0.5 (range: 0.0 to 1.0), and the average frequency of PRN ATs was 0.1±0.2 (range: 0.0 to 1.0). The Spearman's rank correlation indicated there was a positive but moderate association ($r_s$= 0.638, $p<0.001$) between AT presence and frequency of sports-related injuries reporting to the orthopedic clinic.

**Conclusions:** High schools had a large range of composite AT scores. A positive relationship between the presence of an AT and the frequency of pediatric sports-related injuries reported to orthopedic clinics existed. The higher the composite AT score at a high school, the higher the number of sports-related injuries reporting to a specialty orthopedic clinic. Many factors could affect this relationship, such as the high frequency of acute injuries in the dataset.

**The Frequencies of Injuries Sustained to Elite Fencers During National Competitions During the 2018-2019 Season**

Freedman AD, Dompier TP, Brumitt J, Martin MM: University of Illinois Springfield, Springfield, IL; Lebanon Valley College, Annville, PA; George Fox University, Newberg, OR; Rocky Mountain University of Health Professions, Provo, UT

**Context:** Fencing is an open-skilled combat sport that uses blunt-ended swords. Two fencers fight indirectly through their weapons. The sport is practiced with three different weapons (foil, epee, and sabre), with each discipline having slightly different rules, skills, actions, and objectives. Membership in the United States Fencing Association (USFA) has increased from 23,000 in 2013 to more than 40,000 in 2022.

**Methods:** The subject pool for this study was a convenience sample of elite fencers who competed in the 2018-2019 North American Cup (NAC) championship series sponsored by the United States Fencing Association. Competitors may have participated in 1 or more events, over 1 or more days, and in more than 1 event over the course of the season. Athletes compete by sex and weapon. Injuries were reported in real time through the customized Sport Event Medical Encounter System (SEMES) injury surveillance application system. Injuries recorded have multiple data points focusing on basic injury mechanisms, when and where the injury occurs during the event, the body part injured, the type of injury, the diagnosis, the measure of severity, and weapon, gender, age, and dominant hand. ORCHARD diagnostic codes were used to better identify the injuries.

**Results:** During the 2018 – 2019 season, 18,377 entrants participated (men = 10,395, women = 7982), with a total of 70,404 bouts and 140,808 AEs. One-thousand two hundred and twelve acute injuries (men = 686, women = 526) were sustained over the course of the season. More injuries were sustained by men's sabre (24.9%) followed by men's foil (17.7%), women's foil (16%), women's sabre (14.4%), men's epee (14.0%), and women's epee (13.0%). Of overall injuries, the most common body region injured was the thigh, comprising 17.1% of all injuries. This was followed by the lumbar spine (12.6%), ankle (9.7%), and the wrist/hand (9.4%).

**Conclusions:** This study demonstrates injury frequencies were similar between sexes and weapons. Utilizing ORCHARD diagnosis codes provides a better picture of the types of injuries sustained and could lead to better understanding injuries across the lifespan. Fencing has seen a large growth in participation. With this growth, there is an increased need to identify common injuries, consistently report those injuries so comparisons can be made between sports and begin to identify trends and risks associated with those injuries.

**Utilization of a Free Athletic Training Clinic for University Employees and Students**

Wright CJ, Fermin SL, Wibel SC, Baker EE: Whitworth University, Spokane, WA

**Context:** Athletic training services at many universities are only available to university student-athletes. The general student population and university employees do not commonly have access to athletic training care. There is limited discipline specific evidence available regarding the need for athletic training services in these populations. Therefore, the purpose of this research was to track utilization of athletic training services by employees and the general student population at a free university athletic training clinic over the academic year.

**Methods:** This study was a retrospective chart review between September 13-December 8, 2022 (fall semester) and February 7-May 4, 2023 (spring semester). Data from a newly opened free on-campus athletic training clinic accessible to all employees and the general student population (excluding university student-athletes) at a small university (total enrollment=2592, full-time equivalent employees=553) was extracted from the scheduling software (Microsoft Bookings) and electronic medical record (Core-AT, Athletic Training Practice Based Research Network). Variables extracted included patient demographics, injury location, mechanism, date of injury, diagnosis, and number of visits. Data were analyzed descriptively.

**Results:** A total of 45 patients (27 employees, 18 students; 25 males, 20 females; age 35.9±14.0 years, range: 19-63 years old) were served during the academic year. The average patient had 2.0±1.3 appointments (range: 1-6). Appointment length ranged from 30-45minutes. During each semester the clinic was open 2 days/week for 1.5 hours each day; 52.4% (44/84) of available new patient appointment slots and 64.3% (54/84) of return patient appointment slots were reserved. The most commonly injured body parts were the knee (n=13, 28.9%), shoulder (n=10, 22.2%), hip/thigh (n=10, 22.2%), neck/back (n=7, 15.6%), elbow/wrist/hand (n=4, 8.9%), and ankle (n=1, 2.2%). Thirty-three percent (15/45) of injuries were seen within 14 days of initial injury. Injuries occurred during work activity (n=3, 6.7%), sport activity (n=20, 44.4%), non-sport activity (n=16, 35.6%), and other (n=6, 13.3%). The most common diagnoses were sprains/strains (n=21, 46.7%), overuse conditions (e.g. epicondylitis, impingement, tendonitis; n=8, 17.8%), and nonspecific joint pain (knee joint pain; n=5, 11.1%; shoulder joint pain, n=4, 8.9%).

**Conclusions:** Services at a free university athletic training clinic were utilized by a small portion of the campus population during its first year of operation. There was greater capacity than demand, possibly due to low campus awareness of this new resource. Despite the relatively small total number of patients served, the data provides preliminary insight into the most common pathologies and types of services needed within the unique population served (general student body and university employees). This insight might aid the development of similar access to affordable care through the provision of athletic training services at other organizations who employ athletic trainers.

### Assessing Ankle Eversion and Dorsiflexion Strength in Individuals With Chronic Ankle Instability Using a Handheld Dynamometer With External Fixation: A Reliability Study

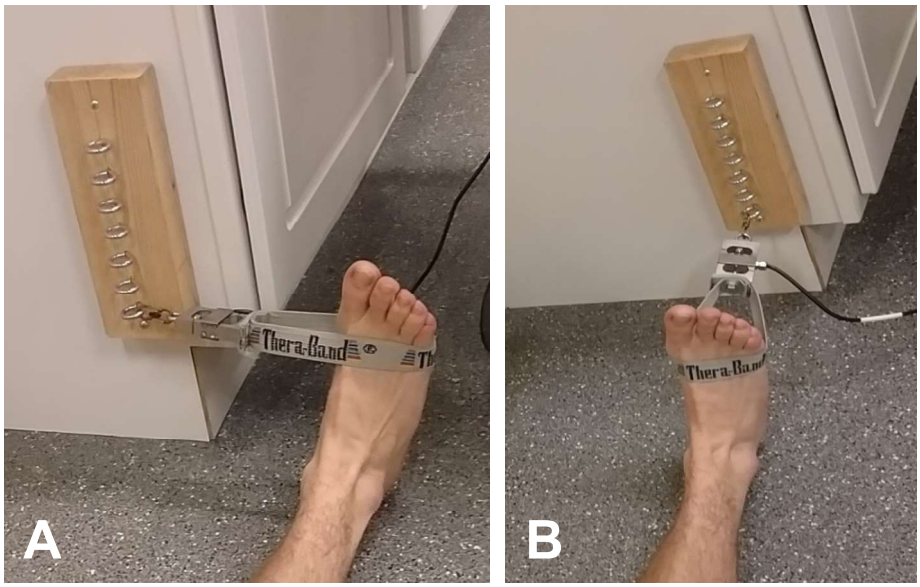
Goetschius J: James Madison University, Harrisonburg, VA

**Context:** Objective measures of ankle muscle strength are used to identify impairment and track rehabilitation progress in patients with a history of chronic ankle instability (CAI). Ankle strength is commonly measured using handheld dynamometers (HHD) with manual resistance provided by the clinician; however, manually resisted strength measures may be difficult for some clinicians and may introduce measurement bias / error. The purpose of this study was to assess the test-retest reliability of ankle eversion and dorsiflexion strength measures in individuals with CAI using a HHD and an external fixation method that minimizes the need for clinician to manual resist contractions.

**Methods:** This was a controlled laboratory study and data were collected over two visits (24-48 hours apart) in a laboratory setting. Participants included N=20 individuals with a history of CAI based on International Ankle Consortium criteria (22.0±2.9 years, 11 female/9 male, 78.2±15.7 kilograms, 1.74±0.11 meters, 4.4±3.8 ankle sprains). The participant's CAI ankle was used for testing. If the participant reported bilateral CAI, the most dysfunctional ankle, based on self-report, was used for testing. At each visit, participants completed measures of isometric eversion then dorsiflexion strength using a pull (tension) HHD. One end of the HHD was fixed to a table via a series of eye-hooks, which allowed adjustment of the HHD depending on the size of the participant's foot (Figure 1). The other end of the HHD was secured to a standard rehabilitation strap that was looped around the participants foot just proximal to the head of the 5th metatarsal (Figure 1). The ankle was in neutral position and the lower leg was manually stabilized to isolate the ankle and minimize contributions from proximal muscle groups. For each strength measure, participants completed warm-up contractions followed by three maximum isometric contraction test trials with 30-seconds rest between trials. The average of three eversion and dorsiflexion contractions at each visit was used for analyses. Two-way mixed, absolute agreement, average measures, intraclass correlation coefficients (ICC) with 95% confidence intervals (>0.90=excellent, 0.75-0.90=good, 0.50-0.75=moderate, <0.50=poor reliability), standard error of measurement (SEM=standard deviation×√(1-ICC)), and coefficient of variation (CoV=SEM / Grand Mean) were calculated to assess reliability.

**Results:** There was "good" to "excellent" reliability between testing visits for eversion strength (ICC= 0.93; 95% CI=0.83 to 0.97; $P < 0.001$) and dorsiflexion strength (ICC= 0.93; 95% CI=0.81 to 0.97; $P < 0.001$). For eversion, SEMs and CoVs were 11.4 N and 11%, respectively. For dorsiflexion, SEMs and CoVs were 18.9 N and 10%, respectively.

**Conclusions:** Eversion and dorsiflexion strength measures using a pull HHD and external fixation methods demonstrated good-to-excellent test-retest reliability in individuals with CAI. These testing methods may be preferable for some clinicians as it minimizes the need for clinicians to provide manual resistance during ankle strength testing.



**Biomechanical Analysis of The Army Combat Fitness Test Standing Power Throw**

Earl-Boehm J, Reckelberg R, Mach M, Stone B, Lally E, Hanson A, Ericksen H: University of Wisconsin-Milwaukee, Milwaukee WI; Texas State University, San Marcos, TX; Illinois State University, Normal IL

**Context:** The Army Combat Fitness Test (ACFT) is multi-event test of physical military readiness. It is essential to optimize performance on each event because total score informs cadet scholarship opportunities and soldier assignment. The standing power throw (SPT) is designed to measure total body power, a requirement of combat tasks (e.g. throwing equipment over an obstacle, assisting a buddy over a wall). The non-modifiable factor of limb length has been related to ACFT performance, however, there is no information about how modifiable factors such as lower extremity biomechanics are related to SPT performance. The purpose of this study was to identify how much sagittal plane trunk, hip, and knee biomechanics contribute to SPT performance, after controlling for height, in Army Reserve Officer Training Corps (ROTC) cadets.

**Methods:** Cross-sectional design, field research setting. ROTC cadets from a single battalion were included if they had no training restrictions (Male n=47: 20.1±1.3yrs, 1.79±.06m, 80.7±11.7kg; Female n=19: 20.4±19yrs, 1.68±.77m, 65.2±8.4kg) The ACFT was conducted per Army protocol. For the SPT cadets threw a 10 lb. medicine ball overhead backwards for maximal distance. A high-speed camera 10 ft lateral to the participant recorded 2D video during the throw. Each video was analyzed with Dartfish software by a researcher with extensive experience. The moment of interest was the lowest point during the countermovement phase. Trunk flexion (relative to vertical), hip flexion (trunk relative to thigh) and knee flexion (thigh relative to shank) angles were measured. Hierarchical regression was used to identify which of the independent variables (height, knee flexion, hip flexion, trunk flexion) were the most important predictors of SPT distance (m). ($p < .05$)

**Results:** The first model was significant ($p < .001$) and showed height explained 42% of the variance in SPT distance (TABLE). Knee flexion angle did not significantly explain additional variance in SPT distance when controlling for height. Hip flexion explained ~2% more of the variance in SPT distance after controlling for height and knee flexion. Additionally, for every 1 degree increase in hip flexion, there is a .034 increase in SPT raw score. Together, height and hip flexion explain ~48% of the variance in SPT distance. ($p=.04$). Trunk flexion did not significantly explain additional variance in SPT distance when controlling for height, knee and hip flexion.

**Conclusions:** Cadet height is predictive of SPT performance with taller individuals throwing farther. After controlling for height, greater hip flexion during the countermovement phase of the throw contributes a small amount to the predictive model. Therefore, training ROTC cadets to hinge at the hips more to increase hip flexion during the countermovement phase is a method to increase SPT throw distance regardless of height.

**TABLE**

| | F(df) | p | R2 | *B* |
|---|---|---|---|---|
| **Model 1:** | | | | |
| **Height** | 50.13 (1,64) | <.001 | .439 | .162 |
| **Model 2:** | | | | |
| **Height** | .51 (1,63) | .48 | .444 | .160 |
| **Knee flexion** | | | | .10 |
| **Model 3:** | 4.3 (1,62) | .04 | .480 | |
| **Height** | | | | .152 |
| **Knee flexion** | | | | -.002 |
| **Hip flexion** | | | | .034 |
| **Model 4:** | .85 (1,61) | .36 | .487 | |
| **Height** | | | | .150 |
| **Knee flexion** | | | | -.026 |
| **Hip flexion** | | | | .068 |
| **Trunk flexion** | | | | -.043 |

**Changes in the Medial Joint Gap and Medial Collateral Ligament Widths During the Anterior Medial Rotation Test**

Canterbury BC, Lacy BM, McIlvain GW, Timmons MK: Marshall University, Huntington, WV

**Context:** The deep fibers of the MCL (dMCL) provide transverse and frontal plane knee stability. The anterior medial rotation (ANTMED) stress test is used to evaluate the dMCL. Little literature is available to describe the medial knee during the ANTMED stress test. The current study explored the relationship between the width of the MJG and the medial collateral ligament (MCL) on ultrasound imaging during the ANTMED test. The hypothesis that a negative correlation would be found between MCL width and an increase in the MJG during the ANTMED was tested and an increase in the width of the MJG would be found during the ANTMED test.

**Methods:** A repeated measures design was employed in this laboratory-based study to test the study's hypothesis. Thirty-six participants without a history of medial knee injury participated in this laboratory-based study. The project was approved by the University IRB and participants proved consent before testing. The MJG and the MCL widths were measured on ultrasound images collected during an ANTMED test. Two images were collected of each knee, and the mean MJG and MCL width measurements were entered into statistical analysis. Pair T-tests and Pearson correlation analysis were used to determine the relationship between the MJG and MCL width.

**Results:** Mean MJG was 7.6±1.4mm and 7.9±1.3mm on the right and left knee in the unstressed condition. With the applied ANTMED stress the MJG increased to 10.4±1.7mm on the right side and to 11.4±1.6mm on the left side, the MJG during the ANTMED was statistically greater in the stressed condition on the left (difference=1.1±2.0mm, P=0.002) compared to the right side. The MCL width was 1.7±0.07 mm and 1.7±0.10 mm on the right and left sides. The width of the MCL decreased during the ANTMED test on the right (difference = 0.08±0.05mm, P<0.001) and left (difference = 0.08±0.04mm, P<0.001) sides. The MCL/MJG ratios were 0.23±0.04 and 0.22±0.03 on the right and left sides in the unstressed condition and 0.16±0.03 and 0.15±0.02 on the right left sides in the stressed condition. The decrease in MCL/MJG ratio was statically significant on both sides (P<0.001). The correlation between the unstressed MCL width and MJG change was not statistically significant on the right (r=-0.311, P=0.069) and left (r= -.143, P=0.405).

**Conclusions:** The results of this study supported the hypothesis that the MJG would widen during the ANTMED stress test. The hypothesis that the widening of the medial joint space would be negatively correlated with the thickness of the MCL was not supported. This study was executed on people with healthy knees and in the future this study should be reevaluated on a population with acute or chronic medial knee pain to determine the utility of the ANTMED to assess dMCL injury.

**Cognitive-Motor Dual-Task Performance of the Landing Error Scoring System: A Clinical Model**

McWethy M, Norte GE, Bazett-Jones DM, Murray AM, Rush JL: University of Toledo, Toledo, OH; University of Central Florida, Orlando, FL; Ohio University, Athens, OH

**Context:** The LESS is a common assessment used to determine biomechanical landing errors. However, this assessment is completed as a single motor task, which does not require additional attentional resources. It is unclear if the LESS can detect cognitive-motor interference (i.e., dual-task cost) in biomechanical errors associated with knee injury. Our purpose was to determine if the LESS is a suitable clinical assessment of dual-task performance in uninjured females and to evaluate whether specific landing criteria are more affected by an additional cognitive load than others. We hypothesized there would be greater landing errors during dual-task performance, with items relating to knee flexion angles and patellar positioning most affected.

**Methods:** We used a crossover design to assess twenty uninjured, physically active females (age: 22.4±2.5 years, Tegner Activity Scale: 5.9±1.1) in a research laboratory. Participants performed the LESS under three randomized conditions: baseline landing with no cognitive distraction (Single), a visual-based dual-task (Visual), and a number-based dual-task (Number). Sagittal, frontal, and total LESS scores were compared between conditions using a one-way ANOVA with repeated measures and post hoc Tukey corrections. Cohen's d effect sizes with 95% confidence intervals were used to determine the magnitude of observed differences. The frequencies of LESS item-specific errors under each condition were compared using chi-squared analyses. We utilized bivariate correlations to investigate relationships between baseline and change scores to determine whether baseline performance affected dual-task cost.

**Results:** LESS errors are reported per condition in Table 1. Participants exhibited more sagittal (P=.013, d=0.91 [0.26-1.56]) and total (P=.008, d=1.03 [0.37-1.69]) errors during the Visual condition compared to Single. Frontal errors were significantly greater in the Number condition compared to Single (P=.019, d=1.03 [0.37-1.69]). The frequency of errors observed for each LESS item did not statistically differ between conditions (all P > .05). Greater baseline sagittal plane errors associated with lesser dual-task cost during the Number (r=-.530, P=.016) and Visual (r=-.490, P=.028) conditions. Greater baseline frontal plane errors associated with lesser dual-task cost during the Visual condition (r=-.606, P=.005). Greater baseline total errors associated with lesser dual-task cost during the Visual condition (r=-.580, P=.007).

**Conclusions:** The LESS is a viable assessment to combine with either a number- or visual-based cognitive distraction to assess dual-task performance in uninjured, physically active females. The Number and Visual conditions used in this study affected unique aspects of landing patterns in the sagittal and frontal planes. Although summed LESS scores differed between conditions, individual LESS items were not consistent across participants. This suggests that females adapt to cognitive loading differently, which supports the need for individualized assessment and subsequent treatment to target unique patterns of landing errors. Collectively, our findings support use of the LESS as a clinical model of dual-task performance in physically active females.

This work was supported by the Gordy Graham Research Assistance Award from the Great Lakes Athletic Trainers' Association.

**Collegiate Athletic Trainers' Assessment of Health Literacy and Delivery of Patient Education**

Neil ER, Mitchell AM, Armstrong TA, Eberman LE, Greffly TJP, Winkelmann ZK: Temple University, Philadelphia, PA; University of South Carolina, Columbia, SC; Drake University, Des Moines, IA; Indiana State University, Terre Haute, IN; Illinois Bone and Joint, Morton Grove, IL

**Context:** The collegiate setting is unique for athletic trainers (ATs) due to the varying volume of patients, sports and the novel injuries that result, and access to care. Due to the uniqueness of this job setting, collegiate ATs should create a patient-centered environment in their clinical practice. A patient-centered climate allows ATs to develop trusting relationships and individualized patient education to enable patients to make the most informed decisions about their care. To provide patient-centered care, the AT must assess the patient's health literacy and how patient education is delivered. Therefore, this study aimed to explore the lived experiences of ATs from the college/university setting to identify how they are creating a patient-centered environment specific to health literacy and patient education.

**Methods:** We used a grounded theory approach to conduct individual virtual interviews to interview college / university ATs. We recruited a criterion sample of college ATs through the NATA Research Survey Service and social media. We created a semi-structured interview protocol consisting of 15 questions, which was content validated by 4 experts. In total, 9 ATs completed the one-on-one interview (women=5, men=4; age=36±9 y; clinical experience=13±9 y). During the interview, participants shared how they created a patient-centered environment, assessed health literacy, and delivered patient education during daily interactions specific to a patient case vignette. Interviews were completed until data saturation was achieved. Each interview was audio recorded via a web-conferencing platform, transcribed verbatim, and returned to each participant for member-checking. Three researchers coded the transcripts following the consensual qualitative research three-phase analysis process. The coding team created a consensus codebook with domains and categories. A scenario checklist was established consisting of 34 behaviors for the case vignette that was coded as described or not described in the participant's response. Trustworthiness was achieved through multi-analyst triangulation and internal auditing.

**Results:** Four domains emerged during the analysis: work environment, essential traits and skills, health literacy assessment strategies, and patient education materials and delivery. The collegiate ATs described their work environment as challenging based on the patient-provider ratio, resources, and facilities that led to time and space concerns. In addition, the ATs stated that access to patients daily and concurrent interprofessional practice allowed for continuity of care. Collegiate ATs suggested that rapport with the student-athletes facilitated a trusting relationship that influenced their interpersonal communication. These essential traits and skills created a patient-centered environment that allowed them to explore the student-athlete's life outside and after sport. Regarding health literacy assessment, most participants noted they had no formal process but used non-verbal perceptions such as reading facial expressions to gather information. The ATs also expressed confirmation bias in that they often overlooked health literacy assessments for those athletes with insurance or a health-related academic major. Collegiate ATs used their self-perception of the patient's health literacy to guide the patient education they delivered. The participants often used plain language, health informatics, and question prompting to ensure patient education was well received. Table 1 provides an overview of the situational responses to the case vignette.

**Conclusions:** Collegiate ATs have a unique opportunity to know their patients from a work environment that allows for daily connections. Our findings suggest that additional emphasis must be given to ensure that patients receive information appropriate to their health literacy levels. Despite the increase in time for patient care and a belief that they are creating a patient-centered environment, collegiate ATs did not describe the behaviors associated with health literacy and patient education within the provided scenario.

**Table 1.** Patient Scenario Behavior Checklist

| Participant Number | Patient-Centered Environment (out of 15) | Health Literacy (out of 10) | Patient Education (out of 9) | Overall Case Vignette (out of 34) |
|---|---|---|---|---|
| Participant 1 | 6/15 (40.0%) | 3/10 (30.0%) | 6/9 (66.6%) | 15/34 (44.1%) |
| Participant 2 | 9/15 (60.0%) | 2/10 (20.0%) | 3/9 (33.3%) | 14/34 (41.2%) |
| Participant 3 | 2/15 (13.3%) | 2/10 (20.0%) | 0/9 (0.0%) | 4/34 (11.8%) |
| Participant 4 | 3/15 (20.0%) | 2/10 (20.0%) | 3/9 (33.3%) | 8/34 (23.5%) |
| Participant 5 | 8/15 (53.3%) | 2/10 (20.0%) | 3/9 (33.3%) | 13/34 (38.2%) |
| Participant 6 | 2/15 (13.3%) | 1/10 (10.0%) | 4/9 (44.4%) | 7/34 (20.6%) |
| Participant 7 | 0/15 (0.0%) | 1/10 (10.0%) | 2/9 (22.2%) | 3/34 (8.8%) |
| Participant 8 | 2/15 (13.3%) | 1/10 (10.0%) | 3/9 (33.3%) | 6/34 (17.6%) |
| Participant 9 | 2/15 (13.3%) | 2/10 (20.0%) | 5/9 (55.6%) | 9/34 (26.5%) |
| **Average** | 3.78/15 (25.2%) | 1.78/10 (17.8%) | 3.22/9 (35.8%) | 8.78/34 (25.8%) |

**Comparison Of RED-S and Triad Injury Risk Assessment Tools: A Critically Appraised Topic**

Seitz SM, Tierney RT, Mansell JL, Russ AC: Temple University, Philadelphia, PA

**Context:** In 2014, the Relative Energy Deficiency in Sport cumulative risk assessment (RED-S CAT) was introduced as tool to replace the Female Athlete Triad clinical assessment tool (Triad CRA) for injury risk classification. Confusion has emerged with healthcare professionals about which tool to utilize. In physically active females, is the RED-S CAT in agreement with the Triad CRA for injury risk classification?

**Methods:** PubMed and CINAHL were searched in June 2023 using the Boolean phrase: ("physically active female" OR female) AND ("relative energy deficiency in sport clinical assessment tool" OR "RED-S clinical assessment tool" OR "RED-S CAT") AND ("female athlete triad cumulative risk assessment tool" OR "female athlete triad CRA" OR "triad CRA") AND risk. Articles were included based on their ability to answer the research question and matching clinical outcome measures. Only studies from the previous five years and with at least 10 study participants were considered. Reviews, consensus statements, and commentary articles were excluded. The Strobe Checklist for cross-sectional studies was used to address internal and external validity. Outcome measures portrayed low, moderate, or high injury risk classification for both the RED-S CRA and Triad CAT. Percent difference between low, moderate, and high-risk classification was calculated between the tools.

**Results:** The search returned 80 articles and 3 were included. For each injury risk classification level, a calculated difference was noted. In one cross-sectional study with 35 endurance athletes, the Triad CRA classified participants as 31% low, 51% moderate, and 17% high risk categorization whereas the RED-S CAT classified 43% low, 43% moderate, and 14% high risk categorization with differences of 12%, 8%, and 3% respectively. In a second cross-sectional study with 1000 participants completing 4+ hours of physical activity per week, the Triad CRA classified participants as 16.8% low, 69% moderate, and 14.2% high risk categorization whereas the RED-S CAT classified 37.4% low, 54.7% moderate, and 7.9% high risk categorization with differences of 20.6%, 14.3%, and 6.3% respectively. The final cross-sectional study with 166 participants completing 2+ hours per week of physical activity, the Triad CRA classified participants as 23.5% low, 62% moderate, and 12.7% high risk categorization whereas the RED-S CAT classified 71.7% low, 18.7% moderate, and 9.6% high risk categorization with differences of 48.2%, 43.3%, and 3.1% respectively. Appraisal scores were 18, 19, and 22 out of 22.

**Conclusions:** Preliminary research on the comparison of the RED-S CAT and Triad CRA showed disagreements in injury risk classification. Varied study populations may contribute to differences, as scores were in greater agreement in the endurance athlete study. Healthcare professionals should exercise caution and factor in clinical judgement while utilizing both tools for injury risk classification for physically active females. SORT B.

**Consistency in Patient-Reported Outcomes Survey Response**

Beck ME, Johnson J, Garrett WZ, Lavender C, Hewett TE, Konz SM: Marshall University, Huntington, WV

**Context:** Patients returning from ACL or other knee injuries must be physically ready to return to activity and mentally. Patient-reported outcome measures are important means to evaluate the level of patient readiness. Many healthcare providers utilize multiple surveys as part of their intake process to determine current status. The distribution of multiple surveys related to one joint may be problematic. A question of completeness and consistency among participants is a limitation of most measures. The purpose of this study was 1) to determine the level at which people will persist in multiple surveys and 2) to determine the consistency in participant response across questions repeated across surveys, similar questions, or movement patterns.
**Methods:** The study design for this research was a qualitative survey of a convenient sample. Participants were recruited via their university, asking for participation in the study. The survey was distributed through the host's school email system, and Qualtrics hosted the survey. To be included in the study, participants had to be either a student, faculty, or staff member of the university. The study included general demographic information (age, gender, ethnicity, and history of injury or pain in the knee) and four knee-related quality-of-life surveys, which included the Anterior Cruciate Ligament Return to Sport After Injury (ACL-RSI) scale, International Knee Documentation Committee (IKDC), Knee Injury and Osteoarthritis Outcomes Scores (KOOS), and Lysholm Knee Scoring Scale. Ran interclass correlation coefficient to determine Cronbach's Alpha. Significance was set at the 0.05 level.
**Results:** The number of participants who consented to participate in this survey was 663. Of these 663 participants, only 292 (45.34%) completed all 4 surveys. A total of 152 (22.93%) participants stopped after the demographics, 85 (12.82%) completed at least 1 survey, 84 (12.67%) completed at least 2 surveys, and 15 (2.26%) completed at least 3 surveys. Seventy percent of participants complained of knee injury or pain and 27% occurred more than 5 years ago. Response consistency was seen with question looking at confidence in knee ($p<.001$, Cronbach's Alpha .869), confidence to perform ($p<.001$ Cronbach's Alpha .94), locking and catching in the knee ($p<.001$, Cronbach's Alpha .479), use of stairs ($p<.001$, Cronbach's Alpha .93), kneeling (.003, Cronbach's Alpha .885), squatting ($p<.001$, Cronbach's Alpha .895), and sitting ($p<.001$, Cronbach's .731).
**Conclusions:** These results support response consistency across the four surveys. Survey compliance overall was low, but because it didn't impact the consistency of responses, using one survey encompassing questions from all four surveys might increase survey compliance while still gathering sufficient information.

**Content Validation of the Satisfaction With Athletic Healthcare Services Survey**

Stuckey D, Cahoon MS, Welch Bacon CE, Snyder Valier AR: A.T. Still University, Mesa, AZ

**Context:** Evaluation of patient experience is infrequent in athletic healthcare because no validated assessment tools exist that are specific to athletic settings. The Satisfaction with Athletic Healthcare Services Survey (SAHSS) was created to evaluate patients' satisfaction with athletic healthcare and includes 4 subscales: provider, facility, personal experience, and over-the-counter medications (optional). While face and content validity of the SAHSS have been established, a rigorous content validity index (CVI) is necessary to ensure a sufficient number of items to appropriately assess the healthcare experience are included. Validation of the SAHSS will strengthen the confidence that the instrument is an appropriate measure of the patient care experience in athletic healthcare settings. The purpose of this study is to establish a CVI for the SAHSS.

**Methods:** Athletic Trainers, with at least 3 years of clinical experience and who currently worked clinically in high school and university athletic healthcare settings, served as content experts. Content experts received a copy of the 27-item SAHSS, an Excel file for CVI ratings, and rating directions. Once familiar with the SAHSS purpose/directions, questions, and subscales, content experts completed the content validity assessment and recorded item ratings in Excel. Each item was rated on a 4-point Likert scale (1=not relevant-4=highly relevant). An individual item CVI for each item (I-CVI: number of raters in agreement with a >= 3 rating divided by total number of raters), mean I-CVI for each subscale (average of all I-CVIs per subscale), average content validity for the overall survey (S-CVI-Ave: average of all I-CVI ratings for every item), and universal agreement for all survey questions (S-CVI-UA: number of survey items that all content experts rated >= 3) were computed. Ratings of > .78 were indicative of acceptable levels of validity.

**Results:** 10 athletic trainers (female= 60% [n=6], age: 34.6±8.1 years; clinical experience: 11.6±8.4 years) representing clinic/hospital outreach (40%, n=4), high school (30%, n=3), professional sports (10%, n=1), performing arts (10%, n=1), and clinical (10%, n=1) participated. Across the SAHSS (Table), the I-CVIs ranged from 0.8-1.0, and universal agreement was found for 27 / 33 (S-CVI-UA= .82) items, suggesting high validity of the overall content of the instrument. Each subscale demonstrated high validity, with mean I-CVI ratings ranging from .93-1.0. The S-CVI-Ave was high (.98).

**Conclusions:** The SAHSS is a valid patient-based assessment of the care experience that provides insight into care delivery and facilities, patient health, and use of over-the-counter medication best practices. Patient perception of care should be routinely collected so areas of strength can be championed and areas to strengthen can be identified and improved. Clinicians interested in maintaining and improving the quality of the patient care experience provided in their athletic training clinics should be confident using the SAHSS as an assessment tool.

**Pelvic Rotation and Overhead Deep Squat Tests Predict Titleist Performance Institute Screen Composite Score**

Skibski A, Vanguri P, Stout JR, Ingersoll CD, Mangum LC: University of Central Florida, Orlando, FL, and Nova Southeastern University, Fort Lauderdale, FL

**Context:** Movement assessment tools are commonly used when evaluating specific groups of athletes. In golf, the Titleist Performance Institute (TPI) screen is a popular assessment meant to test for sport-specific movement capabilities. Evidence suggests impairments found with the TPI screen relate to specific swing characteristics, affecting golf performance. If certain tests are predictive of composite scores, they could be used as a more time-efficient screening tool in clinical practice. Therefore, the purpose of this study was to examine whether the pelvic rotation and overhead deep squat tests are predictive of composite scores.

**Methods:** Twenty-four adult golfers (19 male / 5 female, age: 44.0±15.4 years, height: 171.3±8.6 cm, weight: 82.5±16.3 kg, average 18-hole score: 90.7±10.3 strokes) completed a single laboratory visit. The TPI screen was completed by participants in the following order: pelvic tilt, pelvic rotation, torso rotation, overhead squat, toe touch, 90 / 90 external rotation, single leg balance, lat length, lower quarter rotation, seated trunk rotation, bridge with leg extension, cervical rotation, forearm rotation, wrist flexion/extension, and wrist hinge. A TPI-certified clinician demonstrated each test prior to the participant's attempt and scored the movement in real-time. Individual components were scored from 0-2, 0-3, or 0-4, depending on the test criteria, with higher scores indicating better performance. Correct techniques for the pelvic rotation and overhead deep squat tests are visualized in Figure 1. The maximum composite score was 45 points. To maintain independence of observations, the pelvic rotation and overhead squat were excluded from the composite score, resulting in an adjusted maximum of 39 points. A linear regression was used to predict adjusted composite TPI score from performance on the pelvic rotation and overhead squat tests with significance set at $p \leq .05$.

**Results:** Performance on the pelvic rotation and overhead deep squat tests predicted adjusted composite TPI scores ($R2=.52$, $p<.001$). Both pelvic rotation ($B=3.991$, $p=.003$) and overhead deep squat ($B= 2.139$, $p=.022$) were significant predictors of overall performance on the TPI screen. There was no significant relationship between pelvic rotation and overhead deep squat scores ($r=.24$, $p=.129$).

**Conclusions:** Pelvic rotation and overhead deep squat tests both predict performance on the remaining tests of the TPI screen. Performance on the pelvic rotation and overhead deep squat were not related which suggests they are independent predictors of overall performance. The pelvic rotation tests the ability to dissociate upper and lower body rotation, while the overhead deep squat examines lower body and upper body mobility. Therefore, clinicians may consider using these 2 tests as an initial assessment tool rather than the entire TPI screen when evaluating golfers. While the TPI screen is relatively quick to perform, utilizing 2 tests as an initial screening could be beneficial when testing a large group of athletes.

**Figure 1.** Correct form for the pelvic rotation (A) and overhead deep squat (B) tests

**Reliability and Validity of Hip and Thigh Muscle Strength Assessment Using Low-Cost Tension Dynamometers**

Jacques D, Batista NP, Garcia MC, Norte GE, Murray AM, Bazett-Jones DM: University of Toledo, Toledo, OH, and University of Central Florida, Orlando, FL

**Context:** Hip and thigh muscle strength is important for activities of daily living and is associated with lower extremity injury. Many forms of muscle strength assessment are well studied such as isokinetic and handheld (HHD) dynamometry. While the HHD is generally lower in cost and has greater mobility, it may still be cost prohibitive. Tension dynamometers have gained popularity and can be low-cost. However, there is still a lack of knowledge regarding their reliability and validity. The objective of this study was to investigate the intra-rater reliability and concurrent validity of two low-cost tension dynamometers compared to a HHD in tension mode for measuring hip and thigh muscle strength.

**Methods:** We used a test-retest study design to assess hip and thigh strength using three different devices. Nineteen adults (8 males, age 24.2±3.32, height: 1.7±0.08m, mass: 77.4±14.8kg) completed two sessions of muscle strength assessment. We used a HHD ($1,454.25; ErgoFET) as the reference standard device and compared it to the low-cost Tindeq Progressor ($150) and Crane Scale ($30). We measured hip extension (HEXT), hip abduction, hip internal rotation, hip external rotation, and knee extension force (N). The order of muscle group and devices was randomized. At the beginning of each session, participants performed a standard warm-up by walking 5 minutes on a treadmill at a self-selected speed. For strength assessments, participants completed a familiarization trial (50% of maximum effort) followed by three maximal voluntary isometric contractions. We averaged the peak force of three trials. We measured reliability by using intraclass correlation coefficient (ICC) and classified strength as poor ( < .04), fair (.4-.7), good (.7-.9), and excellent ( > .9). Device standard error of measurement (SEM) was calculated. We assessed the validity and agreement of the Tindeq Progressor and Crane Scale compared to the HHD by using Pearson correlations (r) and Bland-Altman plots, respectively. Correlation strength was classified as small ( < .30), moderate (.3-.5), large (.5-.7), and very large ( >.7). Devices were in agreement when the Bland-Altman bias values fell within the SEM.

**Results:** All three devices showed excellent reliability for all motions at the hip and knee (ICC = 0.904-0.989; Table 1). Both low-cost devices showed very large correlations with the HHD (r = 0.892-0.976; Table 1). The Tindeq Progressor showed agreement in all motions compared to the HHD (Bias=4.4-0.1 N, SEM=0.4-4.9), while the Crane Scale showed agreement only for HEXT (Bias=4.0 N, SEM=4.5).

**Conclusions:** The Tindeq Progressor and Crane Scale are reliable and valid low-cost devices for measuring hip and thigh muscle strength. Clinicians working in a low-budget setting should consider utilizing these devices for objective strength measurement. The Tindeq Progressor may be a better option than the Crane Scale considering its better agreement with HHD.

**Winner of the Post-Professional Advanced Clinical Track Student Category**

**Table 1.** Reliability and validity of low-cost tension dynamometers compared to a handheld dynamometer in tension mode

| | ***ErgoFET HHD*** | ***Tindeq Progressor*** | ***Crane Scale*** |
|---|---|---|---|
| *Reliability – Intraclass Correlation Coefficient (95%CI)* | | | |
| HEXT | .977 (.942 - .991) | 970 (.888 - .990) | .963 (.897 - .986) |
| HABD | .924 (.805 - .971) | .958 (.890 - .984) | .960 (.896 - .984) |
| HIR | .949 (.868 - .980) | .940 (.844 - .977) | .904 (.725 - .963) |
| HER | .978 (.943 - .992) | .989 (.972 - .996) | .932 (.819 - .974) |
| KEXT | .915 (.767 - .968) | .929 (.819 - .972) | .951 (.874 - .981) |
| *Validity – Pearson's Correlation Coefficient* | | | |
| HEXT | - | 0.976 | 0.976 |
| HABD | - | 0.904 | 0.892 |
| HIR | - | 0.926 | 0.921 |
| HER | - | 0.958 | 0.955 |
| KEXT | - | 0.906 | 0.900 |

Abbreviations: HEXT, hip extension; HABD, hip abduction; HIR, hip internal rotation; HER, hip external rotation; KEXT, knee extension; CI, confidence interval; HHD, handheld dynamometer

**Translation and Cultural Adaptation of a Traditional Chinese Short Version of the Anterior Cruciate Ligament-Return to Sport after Injury Scale**

Han YS, Yao WR, Chou TY, Leung W, Chang YT, Chi LK, Huang YL: National Taiwan Normal University, Taipei, Taiwan; San Francisco State University, San Francisco, CA; University of Delaware, Newark, DE; University of Tampa, Tampa, FL

**Context:** Previous studies have identified the significant impact of psychological aspects on an individual's successful return to sports after anterior cruciate ligament (ACL) reconstruction. Moreover, a lower level of psychological readiness predicts a higher risk of second ACL injuries upon resuming sports. The ACL-Return to Sport after Injury (ACL-RSI) scale serves as a valid tool for evaluating psychological readiness post ACL injury and reconstruction. A concise 6-item version was specifically developed to enhance its practicality. However, a published Traditional Chinese short version of the ACL-RSI scale is currently unavailable. The purpose of this study was to translate, cross-culturally adapt, and validate the short version of the ACL-RSI scale into Traditional Chinese (ACL-RSI-TC).

**Methods:** The initial version of the ACL-RSI-TC was developed using the back-translation method. To validate the final version, a two-stage pre-testing process was conducted involving a total of 10 eligible participants, with 5 participants in each stage. To ensure sufficient statistical power for factor analysis, a minimum sample size of 120 participants was needed. A total of 152 physically active participants (62 males and 90 females, age= 25.16 ± 4.71 years; post-ACLR=41.56 ± 36.64 months), participated in the validation and reliability assessment of the ACKL-RSI-TC. Participants completed an online questionnaire, which included the ACL-RSI-TC, Knee Injury and Osteoarthritis Outcome Score (KOOS), and Tampa Scale for Kinesiophobia-11 (TSK-11). Reliability was assessed using Cronbach's alpha, which measured the internal consistency among items within the ACL-RSI-TC. Structural validity of the ACL-RSI-TC was determined through exploratory factor analysis (EFA) utilizing principal axis factoring with varimax rotation. Additionally, criterion-related validity was established by analyzing the correlations between ACL-RSI-TC, KOOS, and TSK-11. All statistical analyses were carried out using IBM SPSS Statistics 26.0 software, with alpha level set at .05.

**Results:** The ACL-RSI-TC scale demonstrated good internal consistency (Cronbach's alpha= .84). All back-translated items exhibited factor loadings within an acceptable range (factor loadings = .50 to .79) in EFA. ACL-RSI-TC scores demonstrated small to moderate correlations with KOOS subcategories ($r = .18$ to $.51$, $p < .01$ to $.05$) and displayed a negative and moderate correlation with the TSK-11 scores ($r = –.45$, $p < .01$), consistent with findings from prior research.

**Conclusions:** The ACL-RSI-TC has decent reliability and construct validity indices in individuals with ACL reconstruction. We recommend clinicians integrate the ACL-RSI-TC into practices to enhance decision-making in rehabilitation and return-to-play following ACL reconstruction while working with Traditional Chinese users.

**Validation of a Stability Test Using a Cross-Line Laser in Individuals With Chronic Ankle Instability**

Swails MS, Hardy E, Dury J, Thomas AC, Donovan L: University of North Carolina at Charlotte, Charlotte, NC, and University of Franche-Comté, Besançon, France

**Context:** CAI is a condition characterized by a feeling of instability and/or recurring ankle sprains that lasts longer than 1-year following the initial injury. Balance deficits are a hallmark impairment of CAI. Patients who complete balance training report fewer CAI-related symptoms. Thus, monitoring balance in a clinical setting is crucial. Currently, the gold standard to assess balance is using an expensive force plate. The expense likely diminishes the clinical utility of the instrument. Therefore, the purpose of this study was to validate a low cost cross-line laser to objectively assess balance in individuals with CAI.

**Methods:** Twenty-one participants (21.3 ± 3.1years, sex (M:9;F:12), 170.3 ± 8.8cm, 76.7 ± 14.7kg) who were classified as having CAI in accordance with the International Ankle Consortium completed this descriptive laboratory study. Following consent, participants had a cross-line laser fixed to the dorsal surface of their non-shod foot. Next, participants were instructed to stand in the center of a force plate (60 Hz) positioned 40 cm away from the wall on their involved limb, maintain their hands on their hips, and raise their contralateral limb off the ground. Next, the laser was adjusted so that the vertical axis of the cross-line laser overlaid a plumb-line in front of the wall. A camera (60 Hz) was placed in front of the force plate to capture a recording of the cross-line laser. Then, the plumb-line was removed and participants were instructed to balance on their involved limb for 10 seconds for 3 trials during both eyes-open and eyes-closed conditions. During each trial, the force plate measured the center of pressure (COP) average velocity while the camera recorded the movement of the cross-line laser. Using Kinovea and a custom-Matlab code, the number of times the cross-line laser changed horizontal position was determined. Pearson's Correlation Coefficients were calculated to measure the relationship between the number of changes in the horizontal position of the cross-line laser and the COP velocity.

**Results:** Change in horizontal position of the cross-line laser was positively related to COP average velocity during the eyes-closed condition (r=0.63, p=0.007) Figure 1. However, there was no significant relationship between the variables during the eyes-open condition (r=0.22, p=0.33).

**Conclusions:** The results of our study found the number of changes in horizontal position of the laser is related to COP average velocity during eyes-closed single-limb balance. As such, there may be clinical utility to assess balance among individuals with CAI using the cross-line laser. Additional research to further validate the relationship between the cross-line laser and the force plate should include combining more variables from the laser output (i.e. vertical position, velocity of the laser movement, distance traveled) with additional measures from the force plate.

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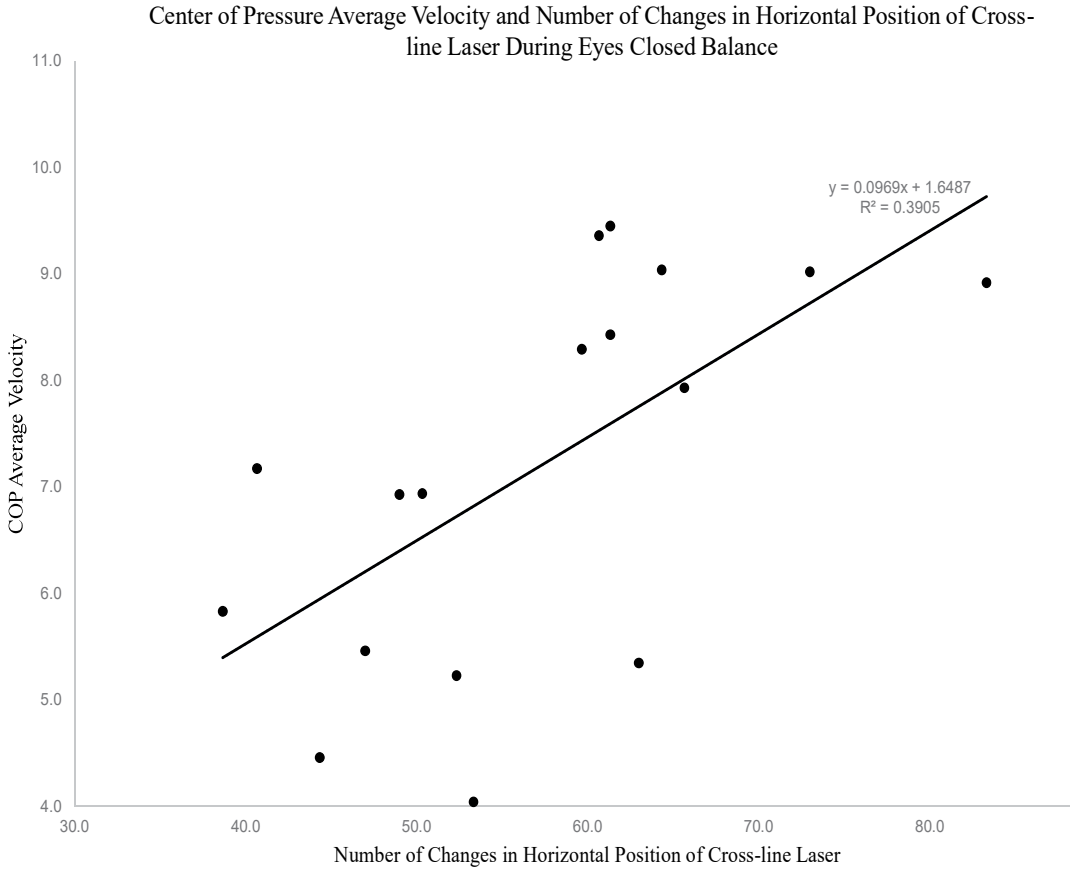

### Credibility and Expectancy of Core Exercise Therapy for Treating Non-Specific Low Back Pain

Devorski L, Suppiah A, Fukuda DH, Stout JR, Ingersoll CD, Mangum LC: Saint Joseph's University, Merion Station, PA, and University of Central Florida, Orlando, FL

**Context:** Strong evidence of core muscle endurance, specific trunk muscle activation and multimodal exercise interventions have been recently recommended for low back pain rehabilitation. Exercises held until discontinuation, such as the dead bug, bird dog and plank variations may be completed autonomously in different environments. These exercises increase feasibility for the low back pain population by reducing economic burden and increasing availability. Chronic low back pain influences physical and mental health, and results in a societal burden. Considering a patient's beliefs throughout rehabilitation permits athletic trainers to prescribe proper interventions to their patients. The purpose of this study was to measure the credibility and expectancy of individuals with non-specific low back pain (NSLBP) completing at-home core exercise for 6 weeks.

**Methods:** Forty individuals (17 male, 23 female, age=23.8±5.6years, height=168.4±8.6cm, weight=72.3±14.4kg) with self-reported NSLBP were randomized either into the intervention group (gamified) or the control group (packet). Thirty participants completed the 6-week at-home exercise program that included 7 core exercises held until discontinuation (Table 1). The gamified group was provided on-demand videos and weekly exercise leaderboards to encourage competition and engagement. The packet group was provided a printed take home packet of exercise descriptions without videos or leaderboards. The Credibility and Expectancy questionnaire (CEQ) was distributed at baseline, after 3 weeks, and after 6 weeks. The independent variables included group and time (baseline, 3 weeks, 6 weeks), and the dependent variables were the credibility and expectancy scores within the was the CEQ. The maximum score for credibility or expectancy is 9, which separately measures intervention success, logicality, and recommendation. A mixed-ANOVA was used to observe effects and interactions. Alpha was set a priori at $p<.05$ and an intention-to-treat analysis was conducted for missing data. Cohen's d effect sizes were calculated for significant findings to determine magnitude of difference.

**Results:** For all participants, regardless of group there was a significant time effect for credibility score ($F(2,76) = 7.89$, $p<.001$, $\eta 2=.172$). There was a significant decrease from baseline (6.96±1.13) to 3 weeks (6.26±1.23) ($p=.002$, $d=.204$). There was a significant increase from 3 weeks (6.26±1.23) to 6 weeks (6.97±1.14) ($p<.001$, $d=.169$). There was not a significant effect from baseline (6.96±1.13) to 6 weeks (6.97±1.23) ($p>.05$). There was no group effect observed and no significant interactions for credibility or expectancy scores.

**Conclusions:** The participants in our study reported approximately 2 points below the maximum credibility score possible. The participants reported lower scores of intervention credibility at 3-weeks compared to baseline, but their credibility scores increased similar to baseline scores at 6-weeks. Regardless of group allocation, as the rehabilitation progressed, the participants felt strongly that the exercise intervention was successful, logical, and that they would recommend to someone suffering from NSLBP.

**Table 1** At-home Exercise Protocol

| Exercise | Weeks 1 - 2 | Weeks 3 - 4 | Weeks 5 - 6 |
|---|---|---|---|
| Plank | 1 repetition 3 days a week | 2 repetitions 3 days a week | 3 repetitions 3 days a week |
| Side Plank (R) | | | |
| Side Plank (L) | | | |
| Foot elevated side plank (R) | | | |
| Foot elevated side plank (L) | | | |
| Dead bug | | | |
| Bird dog | | | |

R, right: L, left

**Does Extended Reality Intervention Improve Patient-rated Outcomes in Musculoskeletal Injuries Compared to Traditional Intervention? A Critically Appraised Topic**

Oh JH, Christian ME: Missouri State University, Springfield, MO

**Context:** Extended reality (XR) is a global term referring to augmented reality (AR) and virtual reality (VR). XR has been used as a tool for providing sensory information. While it is more commonly used in neurological injuries, there is a lack of analysis in musculoskeletal injuries. If the utility of XR interventions is proven, it could be used as a beneficial tool to improve return to function. We aimed to investigate whether XR interventions influence patient-rated outcomes (PRO) by contrasting musculoskeletal injury rehabilitation in treatment-as-usual (TAU) groups with XR intervention experimental groups over the past six years.

**Methods:** A search was conducted in Pubmed, SPORTDiscus, MEDLINE, and Google Scholar. The terms 'Virtual reality', 'Augmented reality' and 'musculoskeletal injury' were searched, with a focus on studies written in English, published within the past six years, and using PRO as their research outcomes. PRO were consistently used to compare the effects of these interventions. Systematic reviews and meta-analyses were excluded in this analysis, and studies not examining the effects of PRO were also excluded. All but one study used generic PRO measurement tools with the addition of area-specific tools.

**Results:** Out of twenty articles screened, four randomized controlled trials were included in this critical appraisal. XR helped patients return quickly to their daily activities and significantly improved their activity levels compared to the traditional rehabilitation groups. Significant differences were found between XR and TAU groups in three studies. One study reported a significant difference between XR intervention and TAU in pain from the 7th day after surgery, and the time to reach weight bearing was also significantly different between the two groups. Additionally, another study found that the VR group has lower disability scales than the AR group. One article found similar results in XR rehabilitation compared to regular physical therapy sessions. All articles were ranked at a 1b level, with an average Physiotherapy Evidence Database (PEDro)scale of 6.5/10, and a Strength of Recommendation Taxonomy (SORT) scale ranking of A.

**Conclusions:** Through this appraisal, XR intervention has a positive effect on various musculoskeletal injury rehabilitation. This emerging intervention tool can bring significant improvement in a patient's rapid return to function and movement in their daily life. The shortage of XR intervention software and the absence of standardized treatment methods are areas for future research. Furthermore, the possibility of applying it to various body parts and injuries was shown. The application and expansion of XR interventions can increase the speed of musculoskeletal rehabilitation and lead to positive responses and outcomes for patients.

**Effectiveness of Traction for the Treatment of Low Back Pain: A Critically Appraised Topic**

Rigden EM, Jutte LS: Xavier University, Cincinnati, OH

**Context:** Approximately 60%-80% of people will experience low back pain (LBP) in their lifetime. Clinicians often use traction to treat LBP. It's imperative for clinicians to understand the effectiveness of treatments they use for LBP; therefore, we asked does traction decrease pain and increase function in individuals with LBP?

**Methods:** A literature search was conducted in September 2023 using four electronic databases: CINHAL Plus, MEDLINE, SPORTDiscus, and Academic Search Premier. The keywords included "lumbar spine," "traction," and "low back pain." Articles were included if they were randomized controlled trials (RCT), used traction, and reported outcomes for pain, on a numerical scale, and function, as measured by the Oswestry Disability Index (ODI). Articles were excluded if they were not written in English, did not use a RCT design with human patients, or were published more than five years ago. Two independent reviewers reviewed each article using the PEDro Scale. The reviewers compared their scores for each study and came to a consensus.

**Results:** The initial search returned 144 articles. After applying the inclusion and exclusion criteria and removing duplicates, five RCT remained and were included in the final analysis. Their PEDro scores ranged from 7/10 to 10/10 with an average PEDro score of 8/10; therefore, we considered all of them SORT Level-1 evidence. Three of the articles compared supine traction to a control group. A singular article compared the use of traction in individuals with disc protrusion compared with extrusion injuries. The final article compared traction delivered in a supine verse prone position. Traction was highly effective at decreasing pain (average Cohen's d: 1.24 + 0.31) when compared to controls. Traction reduced pain slightly better for those with protrusion versus extrusion disc injuries (Cohen's d: 0.8). When comparing the position during traction application, there was little difference in the decrease of pain (Cohen's d: 0.24). The ODI scores for the traction groups showed a strong to moderate effect for improved function compared to the control groups (Cohen's d: 0.83 + 0.26). Traction was more effective at restoring function in individuals with extrusion disc injuries compared to protrusion disc injuries (Cohen's d: 1.04). The position during the traction application has little effect on improvements in functional ability (Cohen's d: 0.17).

**Conclusions:** Although limited, the available high-quality evidence supports our SORT Level A clinical recommendation for the use of traction to reduce pain. Clinicians should consider traction a highly effective treatment for reducing pain and moderately effective at restoring function in patients with LBP. There is minimal evidence to suggest that the position of traction application has little impact on its effectiveness. Additionally, individuals with protrusion disc injuries may find traction more effective than those with extrusion injuries.

**Effects of Self-Administered Gait Retraining on Running Biomechanics and Compliance**

Lally EM, Ericksen HM, Earl-Boehm JE: Texas State University, San Marcos, TX; Illinois State University, Normal, IL; University of Wisconsin-Milwaukee, Milwaukee, WI

**Context:** Running-related injuries (RRIs) have long recovery times and high reoccurrence rates, so interventions to prevent and treat RRIs are imperative. Gait retraining includes increasing step-rate, which can reduce potentially harmful running biomechanics. Self-administered gait retraining is less time-consuming for clinicians and can be done during typical running routines. Many runners prefer to listen to music and removal of music may impact compliance. No studies have investigated if music can be used to increase step-rate, change running biomechanics, and/or improve compliance to self-administered gait retraining. Therefore, this study compared differences in running biomechanics and likelihood of compliance between music and metronome self-administered gait retraining groups.

**Methods:** Thirty individuals (29±7.49 years; 70.23±14.07 kg; 1.73±.10 m; average weekly mileage:12.30±10.48 miles) were assigned to either the music (MUS) or metronome (MET) group. Pretest step-rate, peak positive tibial acceleration (PPA) and peak stance phase hip adduction (HipADD) were collected using inertial measurement units (Noraxon USA, Scottsdale, AZ). Target step-rate was calculated (+5% of pretest step-rate). The WeavRun phone app was used to deliver auditory cueing via earbuds. The MUS group self-selected music tracks. The MET group used only a metronome track. Participants were instructed to match footfalls to either adjusted tempo music or metronome auditory cueing while running. Participants were then told to continue the gait retraining on their own for ~1-month. WeavRun collected detected step-rate and distance of all runs completed by participants during the month. Data exports from WeavRun were submitted online for analysis. Detected step-rate and running miles of each run were averaged across the month. Compliant meant the monthly average step-rate met ± 2 steps per minute (spm) of the target step-rate and average running miles were at or above self-reported typical running miles. A posttest identical to the pretest was collected at the end of the 1-month period. A 2 X 2 repeated-measures analysis of variance was performed to determine differences in step-rate and running biomechanics. A Fisher's exact test and odds ratio examined the relationship between group and compliance. Alpha was set at .05.

**Results:** Both groups increased step-rate (mean difference ± standard deviation (SD): 8.9 ± 5.60spm, $p<.001$) and decreased HipADD (mean difference ± SD: -2.4 ± 4.54°, $p=.008$) from pretest to posttest. No differences were found for PPA (mean difference ± SD: .318 ± 1.08gs, $p=.12$). A significant association between group and compliance was found ($p = .05$). The MUS group was more likely to comply (Table 1).

**Conclusions:** Both music and metronome cues were effective to increase step-rate and decrease HipADD during running. Thus, music and metronomes are both effective auditory cueing methods. However, compliance was better when using music, therefore we recommend using music cueing for step-rate gait retraining interventions.

This project was funded by the Great Lakes Athletic Trainers' Association Doctoral Student Grant.

**Table 1:** Compliance analysis results

| Group | "compliant" | "noncompliant" |
|---|---|---|
| MET | 14% | 86% |
| MUS | 50% | 50% |
| **Statistical Test** | **p-value** | **OR (95% CI)** |
| Fisher's Exact Test | .05* | 6 (1.30-35.91) |

MET= metronome group, MUS= music group, * = statistically significant, OR= odds ratio, CI= confidence interval

**Influence of Blood Flow Restriction Therapy on Quadriceps Weakness in Females Post-Anterior Cruciate Ligament Reconstruction: A Randomized Pilot Study**

Stephens SL, Bruce Leicht AS, Thompson X, Hertel J, Cross K, Hart J, Saliba SA: University of Virginia, Charlottesville, VA, and Plymouth State University, Plymouth, NH

**Context:** Despite participation in post-surgical rehabilitation, many individuals suffer from persistent quadriceps weakness and substantial limb asymmetries following ACL reconstruction (ACLR). While there is no true standard of care for patients failing to respond to traditional rehabilitative methods during the mid-to-late stages of recovery, low load exercise with blood flow restriction therapy (LL-BFRT) may offer clinicians a complementary approach for improving muscle weakness in patients post-ACLR. Therefore, the aim of this study was to examine the effects of LL-BFRT on quadriceps strength and limb symmetry index (LSI=[surgical limb strength /nonsurgical limb strength]*100) in patients with quadriceps strength deficits post-ACLR compared to a true control condition.

**Methods:** Ten females post-ACLR with quadriceps strength deficits (LSI<80% for at least 1 baseline quadriceps strength assessment) were recruited for participation in this laboratory-based pilot study via convenience sampling and randomly assigned to either a LL-BFRT group ([n=5]: age=23.52+/-9.16yrs, mass=69.38+/-10.35kg, time since surgery [TSS]=16.31+/-16.86mo) or control group ([n=5]: age=21.88+/-3.91yrs, mass=69.13+/-11.64kg, TSS=48.03+/-41.34mo). Bilateral quadriceps strength was assessed isometrically at 90º of knee flexion and isokinetically at 90º/s and 180º/s using an isokinetic dynamometer at baseline, 1-week post-intervention, and 1-month post-intervention. Those in the LL-BFRT group were required to complete 2 supervised sessions of LL-BFRT each week for 4 weeks. Participants performed 4 sets (30x15x15x15 repetitions) of 5 unilateral exercises (surgical limb knee extension, hamstring curl, hip abduction, hip extension, and leg press) using loads of 20-40% of their predicted 1-repetition maximum under 60% limb occlusion pressure. During the post-intervention visits, patient perceived change in the overall condition of their surgical limb with respect to their ACLR was evaluated using a Global Rating of Change (GRoC) scale ranging from +7 (very great deal better) to -7 (very great deal worse). To examine between-group differences for changes in LSI, surgical limb knee extension strength normalized to body mass, and GRoC scores, separate repeated measures analyses of variance and post-hoc tests were conducted with baseline values included as covariates when applicable. Alpha was set a priori to 0.05.

**Results:** Compared to participants in the control group, those treated with LL-BFRT experienced significant increases in LSI (Mean Difference [MD]=27.32+/-10.23%, p=0.032) and peak knee extension torque of the surgical limb during isokinetic testing at 90º/s ([MD]=0.36+/-0.14Nm/kg, p=0.040), as well as GRoC scores ([MD]=4.5+/-0.93, p=0.001). No significant between-group differences were identified for LSI or surgical limb strength during isometric and isokinetic testing at 180º/s (Table 1).

**Conclusions:** In females with lingering quadriceps strength deficits following an ACLR, the utilization of LL-BFRT elicited significant improvements in LSI, knee extension strength, and the overall condition of the surgical limb. The findings of this study provide preliminary support for the potential clinical benefits of utilizing LL-BFRT to ameliorate strength deficits during the mid-to-late stages of recovery in patients post-ACLR.

**Table 1. Post-Hoc Comparisons: Limb Symmetry Index, Knee Extension Strength, and Overall Surgical Limb Condition**

| Variable | Measure | Post-Intervention Comparison‡ (Mean (SE)) LL-BFRT | | Control | Mean Difference (SE) | p-value |
|---|---|---|---|---|---|---|
| Limb Symmetry Index – Knee Extension Strength ([%] controlling for baseline values) | **Peak Torque at 90º/s** | **96.50 (6.65)** | **-** | **69.18 (6.65)** | **27.32 (10.23)** | **0.032*** |
| | Average Peak Torque at 90º/s | 95.83 (8.17) | - | 70.95 (8.17) | 24.89 (12.47) | 0.086 |
| | Peak Torque at 180º/s | 85.62 (6.01) | - | 82.85 (6.01) | 2.77 (8.64) | 0.758 |
| | Average Peak Torque at 180º/s | 85.57 (7.32) | - | 82.39 (7.32) | 3.18 (10.64) | 0.774 |
| | Peak Torque at Isometric | 74.01 (10.37) | - | 72.06 (10.37) | 1.95 (14.73) | 0.899 |
| Involved Limb Knee Extension Strength ([Nm/kg] controlling for baseline values) | **Peak Torque at 90º/s** | **1.84 (0.10)** | **-** | **1.48 (0.10)** | **0.36 (0.14)** | **0.040*** |
| | Average Peak Torque at 90º/s | 1.72 (0.11) | - | 1.36 (0.11) | 0.35 (0.16) | 0.064 |
| | Peak Torque at 180º/s | 1.34 (0.08) | - | 1.29 (0.08) | 0.05 (0.11) | 0.641 |
| | Average Peak Torque at 180º/s | 1.24 (0.09) | - | 1.13 (0.09) | 0.11 (0.12) | 0.422 |
| | Peak Torque at Isometric | 1.71 (0.16) | - | 1.38 (0.16) | 0.32 (0.22) | 0.191 |
| Patient Perceived Condition of the Surgical Limb | **GRoC** | **5.60 (0.66)** | **-** | **1.10 (0.66)** | **4.50 (0.93)** | **0.001*** |

** Statistically significant at $p \leq 0.05$*

‡ *Main group effect: mean post-intervention value (i.e., average of both post-intervention visits) controlling for baseline group differences*

*Abbreviations: LL-BFRT, low load exercise with blood flow restriction therapy; SE, standard error; GRoC, Global Rating of Change scale*

**Serial Effects of Repeated Hip Mobilizations With Movements Vs. Self-Mobilizations in Individuals With Limited Hip Mobility**

Proffitt JT, Benz CE, Young JP, Rivera MJ: Indiana State University, Terre Haute, IN

**Context:** Mobilization with Movement (MWM) and Self-Mobilization with Movement (SMWM) are common interventions used to address hip internal rotation (IR) impairments. However, there is limited research comparing the effects of and dosage of MWMs and SMWMs. The aim of this study was to compare the application and dosage of MWM and SMWM on hip IR.

**Methods:** We used a single blind cohort study. A total of 20 adults (age=23.35±3.60 years; women=14 men=6; height=171.63±6.63 cm; weight = 83.20±15.71 kg) with less than 30° of hip IR participated. Participants were randomly assigned to an intervention group (MWM or SMWM) and completed a single data collection session consisting of 10 individual sets of MWMs or SMWM. The MWM was completed by a certified athletic trainer with training in MWM techniques. Patients were supine with the clinician applying a sustained lateral glide of the hip via mobilization belt, and participants completed active hip IR. The SMWM intervention completed a self-applied lateral glide via resistance band attached to an immobile object and performed active hip IR. We used the Seated Internal Rotation test (SIRT) and the Functional Internal Rotation Test (FIRT) at baseline and immediately after each intervention set (post1, post2, : : : post10). An independent t-test was used to ensure no intervention group differences exist at baseline for the SIRT (p=.700) FIRT (p=.701). Separate intervention by time ANOVAs examined differences for each outcome. Pairwise comparisons and Bonferroni post-hoc testing was completed when significant effects were identified. Significance was set a-priori at $p \leq 0.05$

**Results:** No significant intervention by time interactions were identified for the SIRT (p=.731) or the FIRT (p=.161). Significant time main effects were identified for the SIRT (p<.001). There were significant improvements in the SIRT at baseline and each of the subsequent 10 timepoints ($p \leq .001$). Significant pairwise differences were observed in the SIRT with increases between baseline (23.03±3.72°) and post1 (26.1±4.00), post1 and post2 (27.33±4.52°), post2 and post3 (28.53±4.90°). No other pairwise sequential comparisons were significant (p>.185) There were no time main effect for the FIRT (p=.074).

**Conclusions:** MWMs and SMWM have been shown to Improve hip IR. The findings from this study showed no significant differences between MWM and SMWM on the SIRT or FIRT. There were significant increases in seated internal rotation range of motion after the first three sequential sets of both MWM and SMWM, indicating there were no greater increases in hip IR after the third set. Future research should investigate the proper dosages of MWM and SMWM in for hip IR and the effects of joint mobilization on pathology in the hip.

**The Effect of Isopropyl Alcohol Versus Exfoliating Soap and Water on Skin Impedance**

Johnson AM, Bremner CB, Holcomb WR: Southern Utah University, Cedar City, UT, and Mercer University, Macon, GA

**Context:** Neuromuscular electrical stimulation (NMES) is often used to limit atrophy following injury. NMES treatment effectiveness is reliant upon the quality of induced muscular contractions, which are often limited by patient discomfort. Clinicians and researchers frequently employ strategies to improve patient comfort, and one such strategy is reducing skin impedance. Since dirty skin is a common source of impedance many studies clean the skin with alcohol prior to NMES treatments; but this method may dry the skin, which could increase impedance. Consequently, other methods have been used. Despite its common use, research is lacking with respect to the use of alcohol to clean the skin prior to NMES treatments and its impact on skin impedance. The purpose of our study was to examine the effects of cleaning the skin of healthy individuals with alcohol or exfoliating soap and water on skin impedance. We hypothesized that exfoliating soap and water would decrease skin impedance, while no such difference would occur with alcohol.

**Methods:** We used a randomized counterbalanced study design. A convenience sample of 30 healthy participants completed the study (5 males, 25 females, 21.5±1.7yr, 67.3±15.1kg, 167.5±8.1cm). Participants reported on one occasion to a research laboratory, with each leg used for one of the two treatment conditions (wetted wash cloth and exfoliating soap or 70% isopropyl alcohol pad). Participants were randomly assigned to permutations intended to alternate the leg used for each treatment condition and which to clean first. Treatment sites were marked at 2 and 5 inches above the superior pole of the patella on both legs. Legs were shaved with a disposable razor, cleaned for 30-seconds in a circular motion at each site using the assigned treatment condition, and allowed to dry for 2-minutes. Unused electrodes were placed on the respective sites after shaving the leg to obtain baseline measurements, as well as after each treatment condition's drying period. A digital multimeter (AstroAI, Brea, CA) was attached and three skin impedance measurements separated by 10-seconds each were taken. The mean values for baseline and post-test measures were recorded. Data were not normally distributed; thus, two Wilcoxon Signed Rank Tests were used to analyze the effects of each treatment condition.

**Results:** Relative to baseline, skin impedance was significantly lower following the exfoliating soap and water condition (baseline median=797.93kΩ, interquartile range=3486.60kΩ; post-test median=689.88kΩ, interquartile range=1919.94kΩ; T=105, z=-2.622, P= 0.009, r=0.478), however there was no difference following the alcohol condition (baseline median=910.45kΩ, interquartile range=4254.38kΩ; post-test median=1569.66kΩ, interquartile range=4613.94kΩ; T=281,z=0.998, P=0.318, r=0.182).

**Conclusions:** Lower skin impedance may improve patient comfort and subsequent NMES-induced contractions. Clinicians and researchers should consider using exfoliating soap and water rather than the traditional alcohol method to clean the skin prior to NMES treatments.

**The Effect of Physical Activity on Symptoms Associated With Premenstrual Syndrome: A Critically Appraised Topic**

Harris LN, Tierney RT, Mansell JL, Russ AC: Temple University, Philadelphia, PA

**Context:** Premenstrual syndrome (PMS) affects between 80-90% of menstruating women, which can limit daily activities. Medications used to treat PMS often have unwanted side effects. In females who experience premenstrual syndrome (PMS), does physical activity compared to no physical activity help reduce PMS symptoms?

**Methods:** PubMed and Medline were searched in June of 2023 using Boolean phrases: (PMS) AND (physical activity), (Premenstrual syndrome) AND (physical activity), (PMDD) AND (physical activity), and (Premenstrual Dysphoric Disorder) AND (physical activity). Studies were included if the participants had a diagnosis of PMS and/or premenstrual dysphoric disorder (PMDD), the participants were at the age of menstruation until the age of menopause, provided a physical activity intervention, and were randomized control trials. The studies were excluded if the participants had been diagnosed with female athlete triad or had a diagnosis of gynecological disorders. The outcome measures were for each study were represented by change in PMS symptoms assessed via questionnaires. The Physiotherapy Evidence Database (PEDro) Scale was used to critically appraise each article

**Results:** The search returned 266 articles; 3 articles met inclusion criteria. In Maged et al., the intervention group followed a 3-month swimming protocol and had a significant reduction in 14/17 PMS symptoms, with the control group having no significant reductions. Dehnavi et al. used a 2-month aerobic workout protocol and the intervention group had significant reductions in 9/11 PMS symptoms, with the control having no significant reductions. The intervention group in Kamalifard et al. followed a 10-week yoga protocol. All participants were assessed via the Premenstrual Syndrome Symptom Test (PSST). The intervention group showed significant improvements: Emotional: pre 62.34 ±16.26 vs post 26.2 ± 16.54 ($p < 0.001$), physical: pre 71.15 ± 22.39 vs post 32.69 ± 20.81 ($p<0.001$), behavioral: pre 45.51 ± 19.89 vs post 10.90 ± 14.10 ($p<0.001$). With the control group showing no significant differences: emotional: pre 54.32 ± 19.16 vs post 54.91 ± 21.31 ($p=0.86$), physical: pre 78.57 ± 14.95 vs post 72.01 ± 22.24 ($p=0.08$), behavioral: pre 44.04 ± 18.54 vs post 44.05 ± 22.32 ($p=1.00$). PEDro scores were 8/10, 8/10, 10/10.

**Conclusions:** Evidence shows consistent positive results for physical activity as an intervention to help reduce symptoms associated with PMS and PMDD. Physical activity is an effective treatment for individuals suffering from symptoms associated with PMS and PMDD. For those who experience moderate to severe premenstrual symptoms utilizing a symptom screening tool to track symptoms over the course of intervention is helpful to recognize changes. Further education should exist for individuals experiencing moderate to severe PMS regarding treatment options beyond medication. SORT A.

**Therapeutic Dry Cupping Induces Mechanical Changes in Underlying Soft Tissues**

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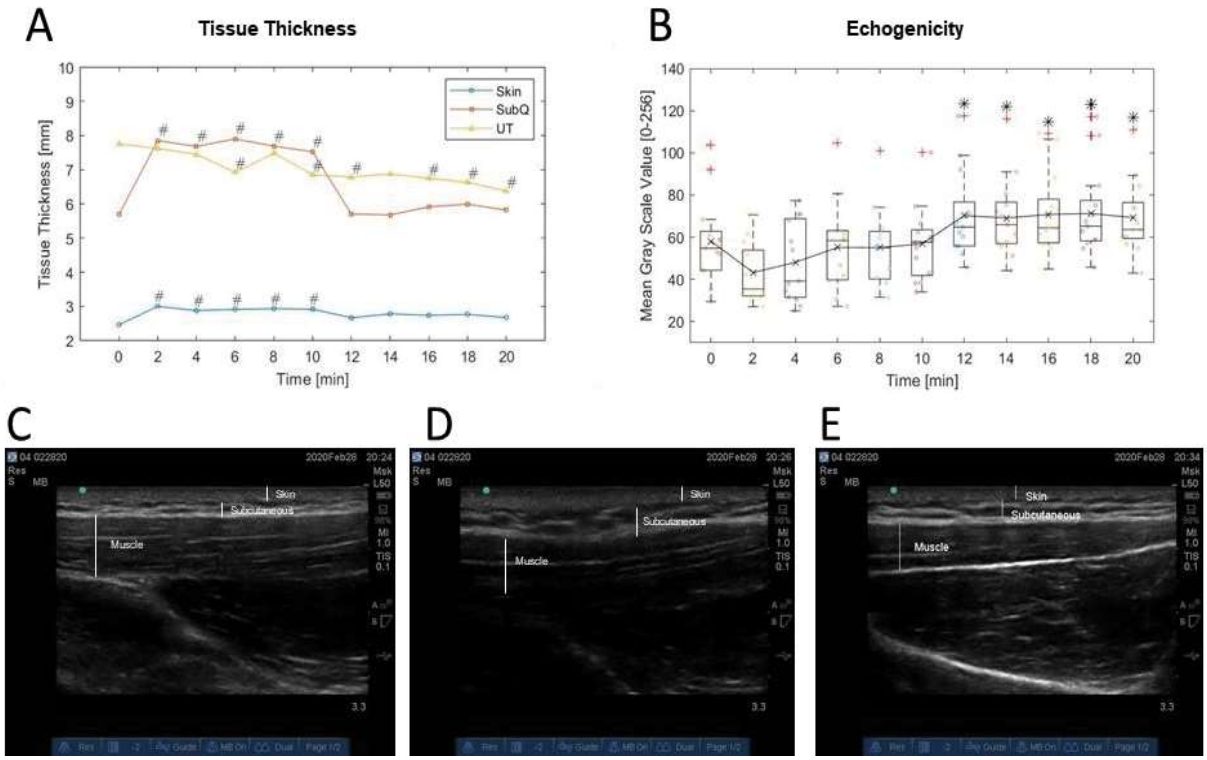
**Context:** While dry cupping has demonstrated improved pain and function clinically, the mechanical effect on soft tissues remains largely unexplored. The purpose of this study was to examine dry cupping's effect on tissue thickness (mm) and fluid changes of skin, subcutaneous (SubQ), and upper trapezius (UT) during and following treatment.

**Methods:** A cross-sectional study using a repeated measures design was conducted in an ATF. Thirteen healthy adults were tested (6 female, 7 male; 24.0 ± 2.0 yrs; BMI 25.38 ± 4.10). A standard 3.56 cm plastic dry cup with a curved rim (Beijing Kangzhu Medical Appliance Co. Ltd, Beijing, China) was applied with 3 pumps from a handheld vacuum over the UT (bisection of acromion process to C7 and mid-clavicle to mid-scapular spine) for 10 minutes. Region of interest was imaged with musculoskeletal ultrasound (M-Turbo, FUJIFILM Sonosite, Bothell, WA and 6 cm linear transducer, HFL50x, 15-6 MHz, FUJIFILM Sonosite, Inc, Bothell, WA) adjacent to the cup, every 2 minutes from Pre-Treatment (T0), during Treatment (T2-T10), and Post-Treatment (T12-T20) for a total of 11 timepoints. Tissue thickness (mm) was measured at the middle of each image using ImageJ (NIH, Bethesda, MD), and fluid changes (echogenicity) were quantified with mean grayscale value of pixels in image using MATLAB (R2020a, Mathworks, Natick, MA). Generalized estimating equations compared thickness changes over time (within factor) for skin, SubQ (covariate: BMI, r=0.65), and UT. Post-hoc testing used adjusted Bonferroni comparisons. Echogenicity differences were compared with one-way ANOVA, and Tukey-Kramer post-hoc test, where significance was detected at p≤.05.

**Results:** Figure 1 displays tissue thickness, echogenicity, and ultrasound image changes over time. Compared to pre-treatment, skin and SubQ thickness increased during the cupping treatment ($p < 0.001$) and decreased immediately toward pre-treatment thickness after treatment (p=0.10-0.83). During cupping treatment, UT thickness remained similar to pre-treatment (p=0.196) and decreased during post-treatment (p=0.014). Echogenicity decreased by 17.1±0.30% when the cup was applied (T2) and increased post-treatment (T12-T20), compared to treatment start (T2) (p=0.012-0.049).

**Conclusions:** A significant increase in skin and SubQ thickness supports theorized mechanical tissue changes occur during treatment, but the thickness changes do not remain after treatment ends. Interestingly, UT thickness did not change until post-treatment, at which time it was thinner than pre-treatment (T0), indicating that UT mechanical changes are delayed and last at least 10 minutes post-treatment. Decreased echogenicity indicates fluid influx during treatment, and increased echogenicity indicates fluid evacuation post-treatment. These changes reveal fluid exchange across all tissues. Our results support the long-held theory that dry cupping has a mechanical effect on soft tissue and promotes fluid exchange across multiple tissue layers.




Footnote: # =P<0.05 between timepoint and pre-treatment (T0), * = P<0.05 between timepoint and start of treatment (T2) . B) Boxplot displays mean (X), median (-), interquartile range (box), and interquartile to maximum/minimum range (whiskers), + indicates outlier (>1.5 interquartile range).

### Association of Hamstring Muscle Architecture and Strength in Adolescent Female Basketball Athletes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**Context:** The Biceps femoris long head (BFlh) is the most commonly injured hamstring muscle. Chronic microtrauma has the potential to modify muscle architecture and result in recurrent muscle malfunction/injury. However, little is understood how the geometric characteristics of muscle affect strength. The current purpose was to investigate baseline associations of BFlh architecture and hamstring muscle strength in healthy adolescent female basketball athletes.

**Methods:** This study was cross-sectional study and was conducted in a controlled laboratory setting. Twenty young division I female basketball athletes (1.63 ± 0.06m, 56.8 ± 6.4kg, 16.2 ± 1.0yrs) without current lower extremity injury or previous knee surgery were recruited. Participants underwent ultrasound imaging and measurements of BFlh muscle thickness and pennation angle. BFlh muscle thickness was defined as the distance between the superficial and intermediate aponeurosis. Pennation angle was defined as the angle between muscle fascicle and intermediate aponeurosis. Concentric and eccentric hamstring muscle strengths were obtained by commercial isokinetic dynamometer at 60°/s and 120°/s. All measures were on preferred supporting leg during kicking. Pearson's product-moment correlations were used to analyze the relationships of biceps femoris long head architecture and muscle strength.

**Results:** Biceps femoris long head muscle thickness (1.4 ± 0.3 cm) was significantly correlated with 60°/s (109.4 ± 23.5 Nm; $r = .451$, $p = 0.046$) and 120°/s (107.6 ± 24.8 Nm; $r = .501$, $p = 0.024$), average peak torque eccentric isokinetic hamstrings strengths. Concentric isokinetic hamstrings strengths were not significantly correlated with muscle thickness at 60°/s (69.3 ± 13.5 Nm; $r = .391$, $p = 0.088$) and at 120°/s (60.6 ± 13.0 Nm; $r = .319$, $p = 0.171$). Pennation angle (11.7 ± 3.3°) was significantly correlated with the eccentric isokinetic hamstrings strength at 120°/s ($r = .456$, $p = 0.043$), but not significantly correlated with the concentric isokinetic hamstrings strengths at 60°/s ($r = .165$, $p = 0.488$) and at 120°/s ($r = .194$, $p = 0.411$). Biceps femoris long head muscle thickness was significantly correlated with pennation angle ($r = .593$, $p = 0.006$).

**Conclusions:** Young female athletes with larger biceps femoris long head muscle thickness have greater eccentric hamstring muscle strength. Further, thicker biceps femoris long head muscle was related to higher pennation angle, indicating that fiber angle associated with force generation and excursion could partially contribute muscle geometry. These findings enhance the clinical understanding of muscle architecture measures and inform measures of future training or rehabilitation programs. Future research should continue to investigation the association of muscle architecture and injury rate.



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**Brain Activity Associated With Quadriceps Strength Improvement From 6-weeks to Return to Activity Following Anterior Cruciate Ligament Reconstruction**

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**Context:** Anterior cruciate ligament reconstruction (ACLR) is characterized by persistent quadriceps weakness that may stem from lower corticospinal excitability and greater brain activity in visuo-motor regions. However, prior reports were based on data obtained from patients months-to-years after ACLR. Observing the course of neuroplasticity in earlier stages of recovery could highlight neural adaptations that limit the recovery of quadriceps strength following ACLR. Thus, the purpose of this study was to determine the neural correlates of involved limb quadriceps strength improvements from six-weeks post-surgery to return to activity (RTA) in individuals with ACLR.

**Methods:** Six ACLR participants (three left ACLR, four males, 19.83±3.82 years, 180.23±15.32 cm, 85.05±19.70 kg, pre-injury Tegner: 7.17±0.75) were enrolled in a longitudinal study that collected strength and brain data at six-weeks post-surgery and RTA. Involved limb quadriceps isometric peak torque was assessed by an isokinetic dynamometer at 90° of knee flexion. The maximum value of six trials was used for analysis and normalized to body weight (Nm/kg). A paired samples t-test with Hedge's g effect size was calculated between timepoints for normalized strength. Brain activity was measured via functional magnetic resonance imaging. Participants performed a concentric/eccentric knee flexion/extension task for 30-second blocks (four movement blocks and five rest blocks) on their involved limb. Neuroimaging data were preprocessed using standard FSL (FMRIB, Oxford UK) procedures including 6-mm smoothing, denoising with Independent Component Analysis-based strategy for Automatic Removal of Motion Artifacts, high-pass filtering at 100 Hz, and non-linear registration. A general linear model with a second-level fixed-effect paired group analysis was performed to compute the change in brain activity for involved limb motor control between timepoints. A third-level mixed-effect analysis was performed to explore the positive and negative neural correlates of quadriceps strength improvements between timepoints. All analyses were conducted with an a priori threshold of z/>\3.1, p/<\.05 and cluster corrected for multiple comparisons.

**Results:** There was a significant improvement in involved limb quadriceps strength (6-weeks: 0.88±0.33 Nm/kg; RTA: 2.12±0.55 Nm/kg; t(5)=8.64, p/<\.001; g=3.26). A greater improvement in strength was associated with brain activity along anterior thalamic radiations and corticospinal tracts (voxels: 7846, zmax=8.16, MNIxyz= -16, -24, 18, p/<\.001). A lesser improvement in strength was associated with brain activity in the lingual gyrus, precuneus, and lateral occipital cortex (voxels: 393, zmax=9.91, MNIxyz= 2, -54, 6, p/<\.001) (Figure 1).

**Conclusions:** Greater improvements in involved limb strength were associated with brain activity along major white matter pathways necessary for executive function and quadriceps neuromuscular control. Additionally, lesser improvements in involved limb strength were associated with visual-motor and visual-cognitive brain activity, potentially indicating a compensatory neural strategy to cope with reduced quadriceps strength necessary for knee motor control. Targeting strength deficits early in rehabilitation may help reduce potential compensatory visual-cognitive brain activity following ACLR.

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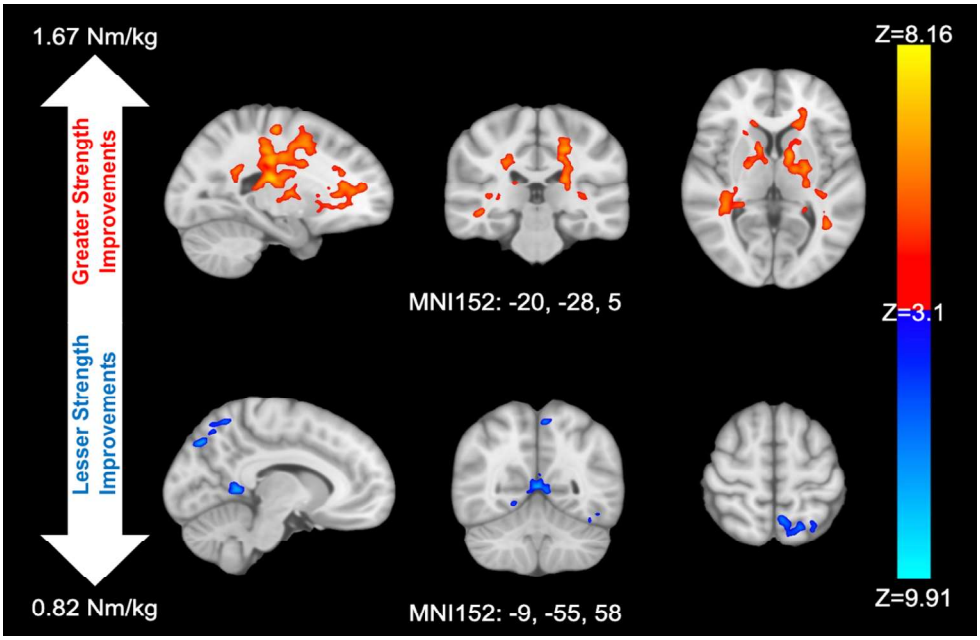


**Figure 1: Brain activity associated with improvements in involved limb quadriceps strength from 6-weeks to RTA.** Red brain activity was associated with greater improvements in involved limb strength. Blue brain activity was associated with lesser improvements in involved limb strength. Strength improvements ranged from 0.82-1.67 Nm/kg.

## Changes in Movement Efficiency and Lower Body Strength Among Firefighters

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**Context:** Firefighting is a demanding career requiring high levels of fitness, strength, and mobility. Repeated movement screening and strength testing can be useful in helping determine the efficacy of training and injury prevention interventions. The purpose of this study was to evaluate changes in movement efficiency and lower body strength in firefighters after a one-year movement-focused training program.
**Methods:** Forty-two structural firefighters (Age: 36.2 ± 10. 7 yrs.; Height: 1.81 ± 0.08 m; Weight: 89.4 ± 12.4 kg; BMI: 27.3 ± 3.0 kg/m2) participated in this longitudinal study. Firefighters completed an isometric mid-thigh pull (IMTP) test and movement screen before an after a 12-month training program. The IMTP test involves subjects generating force through their lower body pulling upward as forcefully as possible on a barbell locked at mid-thigh height, while vertical ground reaction force data were recorded for both limbs using a dual force plate system, sampling at 1,000 Hz. Firefighters also completed an automated movement efficiency test involving seven individual movements. The screening consisted of a two-hand overhead squat, single-leg squat, push up, shoulder motions (flexion, internal and external rotation, horizontal abduction), truck rotation/lateral flexion, and cervical rotation/lateral flexion. A movement efficiency score was calculated along with symmetry indexes from the right to left sides of the body. Between the two testing periods, mobility and accessory exercises were integrated into mandatory fitness time during their work period. These exercises focused on the "pillar," while emphasizing the shoulders and hips.
**Results:** Firefighters produced significantly higher movement efficiency scores in 2023 compared to 2022 (-7.4, 95% confidence intervals [CI]: -10.5, -4.2 AU; effect size [ES]: 0.72; $p<0.001$) as seen in Table 1. Both right (-7.8, 95% CI: -11.7, -3.9 AU; ES: 0.63; $p<0.001$) and left (-8.2, 95% CI: -12.1, -4.2 AU; ES: 0.64; $p<0.001$) sided symmetry index improved from 2022 to 2023. For specific movement assessments, the left-sided lower body symmetry index improved the most (-12.8, 95% CI: -17.4, -8.3 AU; ES = 0.88; $p<0.001$). No significant changes in total or single-sided peak force were observed for the IMTP from 2022 to 2023 ($p>0.05$) as seen in Table 1.
**Conclusions:** Overall, firefighters exhibited a significantly higher movement efficiency score following completion of a 12-month training program. No significant changes in total or single-sided lower body peak force were observed. These results suggest that there can be an improvement in movement efficiency when it is targeted during training. While isometric peak force did not improve, it is unknown how muscular performance during more dynamic tasks may have changed.

**Table 1: Changes in Movement Efficiency and Lower Body Force**

| Variable | Mean | SD |
|---|---|---|
| ***Movement Screen*** | | |
| **Weight (kg) 22** | 88.5 | 12.3 |
| **Weight (kg) 23** | 89.4 | 12.4 |
| **Movement Efficiency 22** | 72.4 | 10.8 |
| **Movement Efficiency 23** | 79.8 | 6.9 |
| **RUBSI 22** | 78.6 | 18.2 |
| **RUBSI 23** | 82.7 | 14.8 |
| **LUBSI 22** | 75.4 | 18.1 |
| **LUBSI 23** | 79.4 | 14.2 |
| **RLBSI 22** | 67.7 | 12.5 |
| **RLBSI 23** | 258.0 | 1159.1 |
| **LLBSI 22** | 69.7 | 16.0 |
| **LLBSI 23** | 82.5 | 8.9 |
| ***IMTP*** | | |
| **Peak Force (N) 22** | 2921.1 | 450.0 |
| **Peak Force (N) 23** | 2998.5 | 528.9 |
| **Left Peak Force (N) 22** | 1457.6 | 320.8 |
| **LPeak Force (N) 23** | 1484.6 | 313.9 |
| **RPeak Force (N) 22** | 1463.4 | 257.7 |
| **RPeak Force (N) 23** | 1549.4 | 317.4 |
| **RBSI 22** | 72.8 | 12.1 |
| **RBSI 23** | 80.6 | 7.6 |
| **LBSI 22** | 72.8 | 12.6 |
| **LBSI 23** | 80.9 | 8.2 |

kg = kilogram; RU = Right upper body; LUB = Left upper body; RLB = Right lower body; LLB = Left lower body; SI = symmetry index; RB = Right; LB = Left; IMTP = Isometric mid-thigh pull; LPeak = Left sided peak force; RPeak = Right sided peak force.

**Cutaneous Reflex Modulation of the Peroneus Longus During Rhythmic Sidestepping in Subjects With and Without Chronic Ankle Instability**

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**Context:** Cutaneous reflex modulation of the peroneus longus (PL) during sidestepping has been shown to be facilitatory throughout the gait cycle in healthy individuals, but no research has been completed on individuals with chronic ankle instability (CAI) performing sidestepping motions. The purpose of this study was to expand upon previous research studying sidestepping in healthy subjects to include those with CAI.

**Methods:** Twenty-eight participants (16 Control:13 Female, 3 Male, 21.1±1.7yrs, 151.5±20.7lbs, 12 CAI: 9 Female, 3 Male, 19.6±1.5yrs, 170.0±24.6lbs) were separated into groups based on IDFAI scores (CAI≥11;Control=0). Surface electrodes measured EMG for the PL of the test limb (most affected limb in those with CAI and matched for limb dominance in controls) as subjects sidestepped on a treadmill. While sidestepping, the subject's test limb was always the lead limb and the speed of the treadmill was set so that their step cadence matched their 4 km/hr walking gait rhythm. Non-noxious stimulations to the sural nerve were administered randomly during three phases of swing. The ensemble averages for both stimulated trials and unstimulated trials were compiled to calculate the net reflex at each phase. Average reflex amplitudes were calculated 80-120ms after the stimulation and were normalized as a percentage of maximum EMG amplitude during unstimulated trials.

**Results:** Two-way mixed factor ANOVAs revealed a statistically significant interaction between the group and phase on background PL activity, $F(1.4,36.6)=6.24$, $p=.01$, partial $\eta 2=.194$. Specifically, PL activity during unstimulated trials was similar between groups at swing phase 1, but significantly greater in the control group during phases 2 (Control=28.9%, CAI=19.6%, $p=.041$) and 3 (Control=57.8%, CAI=44.8%, $p=.02$). There was also a statistically significant interaction between the group and phase on PL reflex amplitude, $F(1.2,31.2)=8.3$, $p=.005$, partial $\eta 2=.24$. The main effect of phase found the groups had similar average PL reflex amplitudes regardless of phase (Control=18.4%, CAI=21.6%), but the groups presented with different reflex modulation patterns. The CAI group had statistically significantly more PL facilitation at phase 1 (mean difference=20.6%, $p=.006$), while the control group, although not statistically significant, had higher average facilitation at phase 3 (mean difference=17.8%, $p=.156$).

**Conclusions:** Cutaneous reflex modulation patterns varied between groups throughout the swing phase in the PL. In healthy controls, greatest PL facilitation occurs in later stages of swing just prior to ground contact, while the CAI group demonstrated greatest facilitation during early swing which diminished into the later phases. These findings demonstrate evidence that there are abnormal neural control mechanisms in the swing phase of sidestepping as participants are preparing to transition back into stance. This could potentially lead to an increased risk of injury as the limb is transitioning back to stance and the neuromuscular control of the ankle muscles will not provide sufficient stability to the ankle joint.

**Deficits in Time-to-Boundary Measures During Dynamic Task With Chronic Ankle Instability**

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**Context:** Previous research has used time-to-boundary (TTB) to assess balance during static postural control. However, static single-leg stance may not be challenging enough to mimic dynamic tasks and differentiate between Chronic Ankle Instability (CAI) and controls, as indicated by small effect sizes. TTB analysis during dynamic balance tasks, such as single-leg hopping, may yield a more robust outcome than traditional dynamic postural control analysis. Therefore, our study aimed to compare TTB measurements between CAI patients and healthy controls during single-leg stance and single-leg hopping.

**Methods:** In this cross-sectional study, 20 patients with CAI (10 men, 10 women; 24±3 years; 168±7 cm; 68±13 kg; IdFAI = 21.45±4.31) and 20 controls (8 men, 12 women; 23±3 years; 165±6 cm; 60±11 kg; IdFAI = 0) participated in a controlled research environment. In this study, two tasks were performed three times each: (1) traditional static balance with eyes closed for 10 seconds and (2) a dynamic task of hopping on a force plate for 5 seconds, with a reach distance set at 50% of leg length. An origin of all foot markers including 1st, 2nd, 5th metatarsal heads and COP were converted to the calcaneus marker. In addition, width and truncated foot length were measured with these markers using Visual 3D software. Using aforementioned data, mean of TTB minima (TTB mean), and standard deviation of TTB minima (TTB SD) in the anteroposterior (AP) and mediolateral (ML) directions, were obtained for both tasks. T-tests compared TTB variables between groups in SPSS, with effect sizes (Hedges' g). An alpha level was set at $\leq 0.05$ for all statistical analyses.

**Results:** The CAI group had significantly lower TTB mean in both the AP and ML directions during the dynamic task (AP = 4.87 ± 1.74s; ML = 0.74 ± 0.26s) compared to healthy controls (AP = 6.85 ± 1.95s; ML = 0.93 ± 1.74s). Effect sizes were large (g = -1.04, CI: -0.49, -1.69, $p < .05$; g = -0.75, CI: -0.12, -1.38, p = .02). However, there were no significant differences in TTB AP and ML mean and TTB AP and ML SD during the static task between the CAI and healthy groups; indicating small to medium effect sizes.

**Conclusions:** TTB measurements during dynamic single-leg hopping are sensitive to detect dynamic balance deficits associated with CAI. Dynamic balance assessment using spatiotemporal analysis is valuable for assessing individuals with CAI and should be incorporated in an impairment-based treatment approach.

**Functional Implications of Neurocognitive Profiles in Individuals With ACL Reconstruction**

Rush JL, Grooms DR, Burland JP, Bazett-Jones DM, Murray AM, Norte GE: Ohio University, Athens, OH; University of Connecticut, Storrs, CT; University of Toledo, Toledo, OH; University of Central Florida, Orlando, FL

**Context:** Worse neurocognitive function has recently been highlighted as a risk factor for primary lower extremity injury. However, the relationship between neurocognition and landing biomechanics associated with secondary anterior cruciate ligament (ACL) injury after ACL reconstruction (ACLR) is unclear. We aimed to determine the associations between neurocognitive profiles, defined by visual cognition, reaction time, and perceptions of uncontrollability, and single leg landing biomechanics in individuals with ACLR. We hypothesized that individuals with worse visual cognition and greater perceived uncontrollability would demonstrate landing mechanics associated with re-injury risk.

**Methods:** Eighteen individuals with primary, unilateral ACLR (10 male, 8 female; age: 20.6±3.7 years, time from surgery: 17.4±13.5 months, Tegner Activity Scale: 6.72±1.49) took the Immediate Post-concussion Assessment and Cognitive Testing (ImPACT) in a distraction reduced location to assess visual memory, visual motor speed, and reaction time. These neurocognitive constructs were extracted as composite scores from the reports derived by the ImPACT software. Lower visual memory and visual motor speed scores, as well as greater reaction times indicated worse performance. Participants completed the Learned Helplessness (LH) scale and the Anterior Cruciate Ligament-Helplessness Index (ACL-HI) to assess perceived uncontrollability. Greater scores on these scales indicated greater perceived uncontrollability. Participants performed a single leg landing task with 3D motion analysis. Participants were asked to stick the landing and to maintain their balance in a single leg stance with their hands on their hips for 10 seconds. Five successful landing trials were completed on each leg in a counterbalanced order. Sagittal and frontal plane knee joint angles and internal moments, and ground reaction forces were assessed at initial contact (IC) and peak vertical ground reaction force (vGRF). Peak knee joint angles, internal moments, and vGRF were also extracted during the initial 100 milliseconds of landing. Pearson's r and Spearman's ρ rank-order correlation coefficients were used to determine the associations between individual neurocognitive constructs and biomechanical outcomes.

**Results:** At IC, greater ACL-HI scores associated with greater internal knee extension moment (ρ=.472; p=.048) and slower reaction times associated with greater vGRF (ρ=.484; p=.042) in the involved limb. Slower visual motor speed associated with greater vGRF at IC in the uninvolved limb (r=-.479; p=.044). At peak vGRF, lesser visual memory scores associated with lesser knee flexion angles in the involved limb (r=-.477, p=.045). Lesser visual memory scores associated with greater peak knee abduction angles at peak vGRF in the uninvolved limb (r=.492, p=.038).

**Conclusions:** Individuals with ACLR presenting with worse visual cognition and greater perceived uncontrollability landed with biomechanical patterns associated with ACL injury risk. Identifying interventions that address poor visual-cognition and perceived helplessness associated with poor landing biomechanics may aid in reducing secondary injury risk following ACLR.

This work was funded by the National Athletic Trainers' Association Doctoral Student Research Grant.

**Inter-limb Symmetry in Hip and Knee Neuromuscular Function in Females With Unilateral and Bilateral Patellofemoral Pain**

Kim S, Glaviano NR: University of Connecticut, Storrs, CT

**Context:** Patellofemoral pain (PFP) is a frequent musculoskeletal condition, with females being twice as likely to develop PFP compared to males. PFP is commonly associated with hip and knee neuromuscular dysfunction, and inter-limb symmetry in neuromuscular function has been related to pain severity in PFP cohorts. Researchers have identified that unilateral PFP often results in bilateral deficits in neuromuscular function; however, it remains unclear how the extent of inter-limb symmetry differs between females with unilateral and bilateral PFP. The purpose of this study was to compare inter-limb symmetry in hip and knee neuromuscular function between females with unilateral and bilateral PFP.

**Methods:** Twenty females with PFP (10 unilateral and 10 bilateral) completed this cross-sectional laboratory study. Participant demographics, symptom duration, pain severity (worst pain level in the previous week on a visual analog scale), and self-reported function (Knee injury and Osteoarthritis Outcome Score-Patellofemoral subscale) were obtained. We assessed bilateral hip (extension and abduction) and knee (extension and flexion) neuromuscular function (isometric and isokinetic strength [60° / s and 180° / s] and rate of torque development [0-100 ms and 100-200 ms]) using a multimodal dynamometer (Biodex System 4 Pro; Biodex Medical Systems Inc., Shirley, NY). The limb symmetry index (LSI) was used to express the inter-limb symmetry: painful / non-painful limb (for unilateral PFP) or more painful / less painful limb (for bilateral PFP). Inter-limb symmetry was classified as normal (LSI ≥ 0.90) or abnormal (LSI < 0.90). Independent t tests or Mann-Whitney U tests evaluated between-group differences in participant characteristics and inter-limb symmetry. All statistical analyses were performed using SPSS (version 28.0; IBM Corp., Armonk, NY) with an alpha level set a priori at $P < .05$. To determine clinical significance, we also calculated Cohen d effect sizes with 95% confidence intervals (CI) using Microsoft Excel 2018 (Microsoft Corp., Redmond, WA).

**Results:** Participant characteristics are detailed in Table 1. Females with unilateral PFP displayed greater inter-limb asymmetry in isometric knee flexion strength (LSI for unilateral PFP: 0.91 vs. LSI for bilateral PFP: 0.97; $P = .027$; $d = 0.31$, 95% CI = –1.19, 0.57) compared to females with bilateral PFP, but remained within the normal LSI range (≥ 0.90). No other statistically significant differences were noted for inter-limb symmetries in hip and knee neuromuscular function between females with unilateral (LSI range: 0.91-1.08) and bilateral (LSI range: 0.95-1.04) PFP ($P < .05$).

**Conclusions:** Our findings suggest that females with unilateral and bilateral PFP may experience a comparable amount of inter-limb symmetry (LSI range: 0.91-1.08) in hip and knee neuromuscular function. Clinicians and researchers should not use a non-painful or less painful limb as a criterion for ‘’normal’’ hip and knee neuromuscular function and consider addressing bilateral neuromuscular changes when treating females with PFP.

**Table 1. Participant Characteristics**

| Variable | Group (Mean ± SD) | | *P* Value |
|---|---|---|---|
| | Unilateral PFP (n=10) | Bilateral PFP (n=10) | |
| **Demographics** | | | |
| Age, y | 21.2 ± 4.9 | 25.8 ± 3.1 | .002 |
| Height, cm | 163.3 ± 7.4 | 166.6 ± 8.4 | .37 |
| Mass, kg | 63.9 ± 16.1 | 60.7 ± 7.5 | .97 |
| Painful or more painful limb, no. (right / left) | 7 / 3 | 4 / 6 | – |
| Dominant limb, no. (right / left) | 10 / 0 | 8 / 2 | – |
| **Self-reported measures** | | | |
| Symptom duration, mo | 27.6 ± 31.5 | 44.3 ± 64.7 | .80 |
| Pain severity (VAS), cm | 6.2 ± 1.5 | 5.7 ± 1.6 | .51 |
| Self-reported function (KOOS-PF), score | 58.4 ± 17.8 | 60.0 ± 20.1 | .85 |

Abbreviations: cm, centimeter; kg, kilogram; KOOS-PF, Knee injury and Osteoarthritis Outcome Score-Patellofemoral subscale; mo, month; no., number; PFP, patellofemoral pain; SD, standard deviation; VAS, visual analog scale; y, year.

**Quadriceps Endurance in Individuals With and Without Patellofemoral Pain**

Xu K, Batista NP, Garcia MC, Norte GE, Murray AM, Bazett-Jones DM: University of Toledo, Toledo, OH, and University of Central Florida, Orlando, FL

**Context:** Patellofemoral pain (PFP) is a common musculoskeletal disorder associated with poor knee- and health-related quality of life. Although the etiology of PFP is unclear, several quadriceps neuromuscular impairments have been reported in this population, such as weakness, reduced muscle power, poor force steadiness and altered muscle activation. Muscle endurance is defined as the ability to repetitively produce force without fatiguing and has been studied in other knee disorders. While quadriceps strength is very well studied in PFP, just a few studies had investigated quadriceps endurance, reporting conflicting findings. Therefore, the objective of this study was to compare isometric and isokinetic quadriceps endurance of individuals with and without PFP.

**Methods:** We enrolled 15 individuals with PFP (11 F, 21.8±3.8 years, 170.5±9.5 cm, 73.3±22.4 kg) and 20 pain-free controls (9 F, 23.2±4.3 years, 175.4±9.1 cm, 79.0±20.0 kg) in this cross-sectional study. We assessed worst knee pain in last week and physical activity level using a 100-point visual analog scale and Tegner scale, respectively. Participants completed a standard warmup, followed by an isokinetic and isometric quadriceps endurance test using an isokinetic dynamometer (System 3, Biodex Medical Systems, Inc., Shirley, NY) in a randomized order. For isometric endurance, participants performed a 35-second maximum knee extension contraction with the knee fixed in 60° of flexion. For isokinetic endurance, participants performed 35 maximal knee extension and flexion contractions at 240°/s within 20-90° of knee flexion. We identified the peak torque in the first five seconds or repetitions. We then established perfect muscle endurance by tracing a horizontal line for 30 seconds/repetitions after that peak and calculated the area under the curve (AUC). We then calculated the actual AUC based on participant's force curve during testing. The fatigue index (FI) was defined as the difference between the horizontal line AUC (perfect endurance) and the tested AUC, in which a lower FI indicates better endurance. We performed independent t-tests to compare pain level, peak torque, and FI during isometric and isokinetic tests between groups ($p < .05$).

**Results:** No significant differences between groups were observed for Tegner (PFP=6.0±2.0, CON=6.2±2.0, p=0.82), but the PFP group showed significantly greater knee pain (PFP=4.2±1.6, CON=0.0±0.0, $p < .001$). We observed no significant differences in isometric and isokinetic quadriceps FI (p=.180, p=.124, respectively) or peak torque (p=.36, p=.41, respectively) between groups (Table 1).

**Conclusions:** Individuals with PFP did not demonstrate deficits in quadriceps endurance compared to pain-free controls. The PFP group had a larger proportion of females to males so that may have influenced these results. Muscular endurance does not seem to be important in all people with PFP. Clinicians should prioritize other aspects of quadriceps muscle function when treating PFP patients.

**Table 1.** Quadriceps endurance, peak torque, and pain of patellofemoral pain (PFP) and pain-free controls (CON) groups.

| | PFP | CON | p-value |
|---|---|---|---|
| *Isometric test* | | | |
| Endurance (FI) | 15.2 ± 7.7 | 18.2 ± 11.8 | .180 |
| Peak torque (Nm) | 175.7 ± 59.1 | 182.8 ± 56.2 | .362 |
| Pain level (VAS) | 2.93 ± 2.18 | 0.09 ± 0.38 | <.001 |
| *Isokinetic test* | | | |
| Endurance (FI) | 31.3 ± 12.3 | 26.1 ± 13.6 | .124 |
| Peak torque (Nm) | 100.0 ± 44.1 | 103.0 ± 34.8 | .411 |
| Pain level (VAS) | 2.43 ± 2.36 | 0.30 ± 0.66 | <.001 |

Abbreviations: VAS, visual analogue scale; FI, fatigue index.

**Quadriceps Strength Outcomes in Individuals Several Years Post-ACL Reconstruction**

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**Context:** Quadriceps strength is one of many indicators to determine overall knee joint health following ACL reconstruction (ACLR). Deficits in quadriceps strength have been well documented through return to play following ACLR; however, there is little evidence to demonstrate if these deficits persist several years post ACLR and how it impacts the risk for the development of knee osteoarthritis. The purpose of this study was to examine quadriceps strength in physically active individuals several years post ACLR compared to healthy controls. We hypothesized that ACLR individuals would demonstrate strength deficits in their involved limbs compared to their uninvolved limbs and healthy controls.

**Methods:** Twenty ACLR participants (11 females, 9 males; Age = 21.9±2.1; Years since ACLR = 5.2±2.5) were compared to 20 age, sex, limb, and activity-matched healthy controls (11 females, 9 males; Age = 22.2±1.9). Bilateral quadriceps and hamstring strength was tested at 60°/s during five consecutive concentric/concentric contractions on the Biodex Multi-Joint Testing and Rehabilitation System (Biodex Medical Systems, Shirley, NY). The distributions of each dependent variable (peak knee extension torque, total work on max repetition) were examined for normality. We used SAS GLIMMIX to fit a 2 x 2 linear mixed effects model with one between-subjects factor group (ACLR, Healthy) and one within-subjects factor limb (Involved/dominant, Uninvolved/non-dominant) with random intercepts for subject for each dependent variable. Tukey post hoc procedure was used to follow-up significant effects.

**Results:** There was a significant interaction between group (Healthy, ACLR) and limb (Involved/dominant, Uninvolved/non-dominant) for peak knee extension torque, $p < 0.001$. In the ACLR group the involved limb was −21.86 Nm weaker than the uninvolved limb, $p < 0.001$. In the Healthy group the non-dominant limb was 2.32 Nm stronger than the dominant limb, $p = 0.523$. There was a significant interaction between group (Healthy, ACLR) and limb (Involved/dominant, Uninvolved/non-dominant) for total work done in maximum repetition, $p < 0.014$. In the ACLR group the involved limb did −19.07 J less work than the uninvolved limb, $p < 0.001$. In the Healthy group the non-dominant limb did 4.21 J more than the dominant limb, $p = 0.384$.

**Conclusions:** ACLR participants several years post-reconstruction exhibited decreased peak knee extension torque and total work in their involved limbs. Strength deficits persisting several years after ACLR can contribute to worse outcomes in long-term knee joint health. Rehabilitation strategies should be utilized in this population to restore quadriceps muscle function and provide secondary prevention for knee osteoarthritis.

This study was partially funded through a Doctoral Grant from the Southwest Athletic Trainers' Association (SWATA).

**Quadriceps Strength Symmetry Influences Movement Generation During Single Leg Hop Performance Among Individuals With ACL Reconstruction**

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**Context:** Functional performance following ACL reconstruction (ACLR) is routinely assessed using a single leg hop (SLH) for distance. While informative, traditional methods of assessment fail to consider the movement profile generating hop distance. Satisfactory hop performance is achieved early and in the presence of profound quadriceps weakness, suggesting that individuals adopt compensatory movement patterns to accomplish this task. Since a detailed kinematic analysis of the take-off phase of the SLH has not been described, we aimed to do so as a function of quadriceps strength symmetry. We hypothesized that individuals with lesser quadriceps strength symmetry would utilize greater trunk and hip flexion, but lesser knee flexion to accomplish the task.

**Methods:** We cross-sectionally investigated quadriceps strength and SLH kinematics in a convenience sample of 15 individuals with primary, unilateral ACLR (8 female, age=20.3±2.1 years, time from surgery=34.8±28.0 months). Procedures were conducted during one session in a research laboratory. Peak isokinetic knee extension torque was assessed in each limb at 60°/ second (concentric-concentric). We used a 12-camera motion capture system to assess SLH kinematics from an embedded force plate. Sagittal trunk, hip, knee, and ankle angles were quantified throughout the take-off phase (0-100%) from onset of movement (0%=vertical ground reaction force [vGRF] < 1N/kg) to toe-off (100%=vGRF < 10N). Take-off was subdivided into loading (onset-to-peak knee flexion) and propulsion (peak knee flexion-to-toe-off) for descriptive purposes. Ensemble curves of each kinematic variable were calculated separately for individuals with knee extension torque symmetry ≥ 90% (SYM) and < 90% (ASYM). Outcomes were compared between groups using 90% confidence intervals (CIs). Regions where CIs did not overlap were considered different and Cohen's d effect sizes were calculated. Independent t-tests were used to compare peak torque symmetry, peak angle, and time to peak angle (% take-off).

**Results:** Torque symmetry was greater in the SYM (n=6) group compared to ASYM (n=9) (96.8±4.3% vs. 74.1±15.0%, P=.003). Ensemble curves are shown in Figure 1. The ASYM group utilized more trunk (mean difference=14.8° 95%CI [7.3-22.2°], d=2.25) and hip (mean difference=20.0° 95%CI [9.4-30.7°], d=2.15) flexion during loading, with more knee flexion (mean difference=8.2° 95%CI [6.9-9.6°], d=6.93) and less dorsiflexion (mean difference=7.1° 95%CI [-5.1-19.3°], d=0.66) during propulsion compared to SYM. The ASYM group reached peak trunk (P=.029) and hip (P=.029) flexion earlier than SYM. Peak angles did not differ between groups.

**Conclusions:** Individuals with lesser quadriceps strength symmetry may adopt a compensatory movement strategy during SLH loading by flexing the trunk and hips earlier. During propulsion, asymmetric individuals utilize lesser dorsiflexion, yet remain in greater knee flexion at toe-off. This movement profile may reflect an offloading of the knee and quadriceps effort during SLH performance and highlights a need to target global movement dysfunction during rehabilitation to minimize the likelihood of adopting compensatory movement patterns.

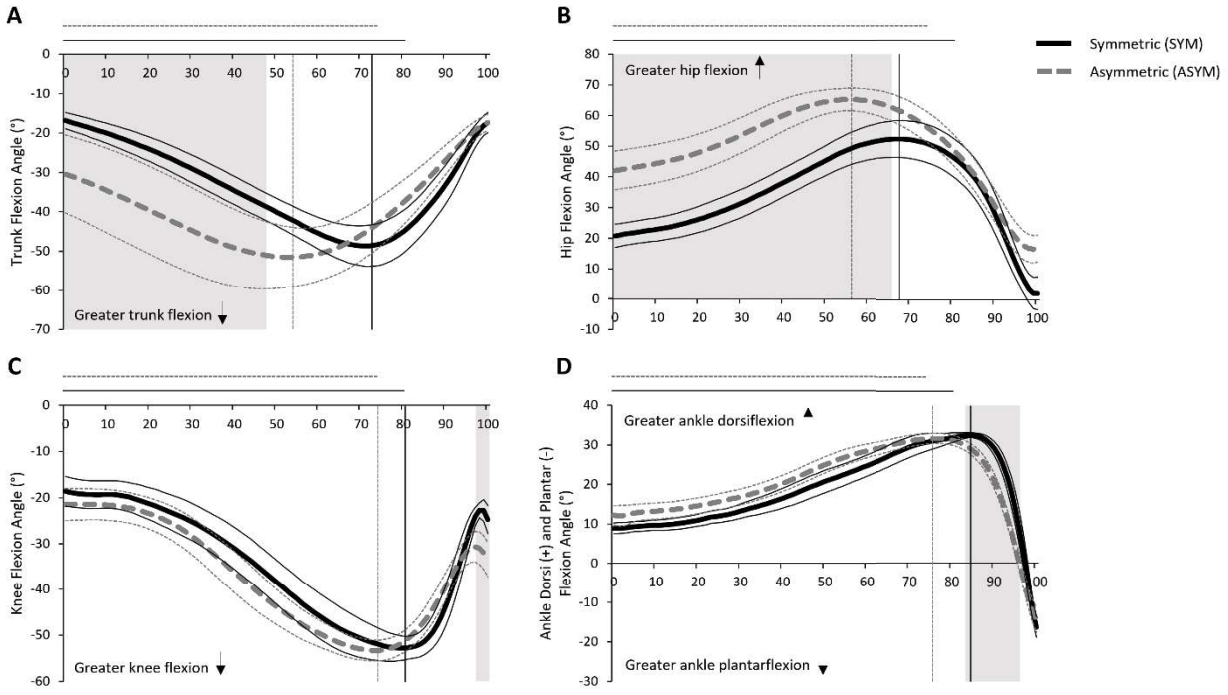


**Figure 1.** Ensemble curves depicting (A) trunk, (B) hip, (C) knee, and (D) ankle flexion angles during take-off of a single leg hop for distance. Thin vertical lines represent average peak values and horizontal lines above each graph represent the average length of loading before transitioning to propulsion.

**Quadriceps Torque Output of the Uninjured Limb Similar to the Injured Limb at 3-Months Post-ACLR and Outpaced by Injured Limb through First 12 Months**

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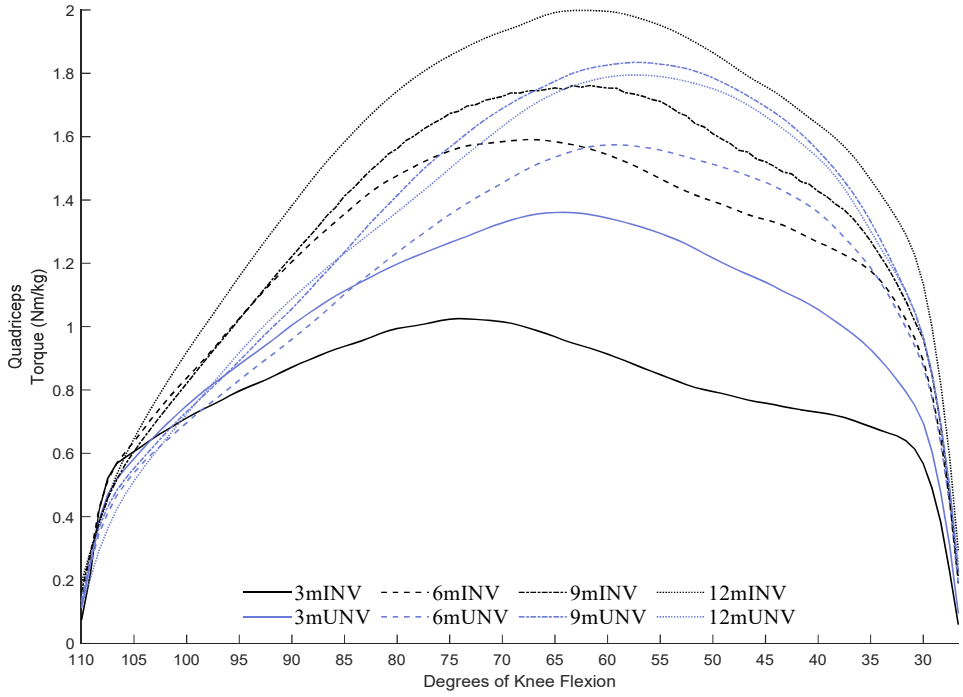
**Context:** Quadriceps strength deficits following anterior cruciate ligament reconstruction (ACLR) elevate risk for secondary ACL injury. Isokinetic testing of the quadriceps, using the uninjured limb as a comparator, is often included as a return-to-sport criterion. However, longitudinal progression of bilateral torque-angle spatiotemporal time series data after a unilateral ACLR using a quadriceps tendon (QT) graft remain limited. Characterization of angle-specific progression in both limbs may provide finer details of strength restoration to inform rehabilitation targets in patients with compromised knee extensor mechanisms.

**Methods:** Ten female patients (16.7±1.9yrs; 168.9±8.8cm; 59.7±9.3kg) who underwent primary ACLR using ipsilateral QT grafts completed bilateral isokinetic testing at 3, 6, 9, and 12 months post-ACLR. Each participant was seated in a Biodex isokinetic dynamometer with the machine's axis positioned in line with the lateral femoral condyle. The uninjured limb was tested first. The test consisted of 5 repetitions of knee extension / flexion (concentric / concentric) at 60° / s. Torque-angle curves were exported and five knee extension arcs were aligned by angle, averaged within each participant-session, normalized by participant mass and standardized to 101 data points. A 4 (time) x 2 (limb) repeated-measures statistical parametric mapping (SPM) ANOVA was conducted to determine angle-specific differences in quadriceps torque (Nm / kg). Post hoc testing was completed, as appropriate, to deconstruct significant time-by-limb interactions.

**Results:** Participant knee extension arcs ranged from 110.08±5.79° - 24.38±7.66° knee flexion (Figure 1). A main effect for time (SPM-F3,27=42.46, $p < .001$) indicated bilateral longitudinal strength improvements for 24-92° knee flexion. A main effect for limb (SPM-F1,9=27.04, p=.001) indicated the uninjured limb generated more torque than the injured limb from 91-107° knee flexion. However, the time and group main effects were superseded by a time-by-limb interaction (SPM-F3,27=12.82, $p < .001$) from 27-100° knee flexion. Post-hoc SPM paired t-tests revealed between-limb differences at 3 months at 49-50° knee flexion (uninjured limb greater; p=.048), 6 months at 86-95° knee flexion (injured limb greater; $p < .001$) and at 12 months at 70-105° and 27-30° knee flexion (injured limb greater; $p < .001$ and p=.02, respectively). The injured limb strengthened from 3 to 6 months at 27-91° knee flexion ($p < .001$). The uninjured limb strengthened from 6 to 9 months at 67-35° knee flexion ($p < .001$).

**Conclusions:** In patients with QT ACLR grafts, quadriceps torque output is similar between limbs at 3 months post-surgery. The injured limb then outpaces the uninjured limb through the first post-surgical year and is stronger at 12-months. These data indicate that the uninjured limb lags the injured limb, particularly in higher degrees of knee flexion, providing targetable weaknesses for rehabilitation approaches that restore force generation throughout the knee extension arc in both limbs to reduce secondary injury risk.



## Assessment and Training of Perceptual-Motor Function in College Wrestlers With and Without a History of Concussion


Acocello SN, Fleming LR, Adams VP, Carlson LM, Hogg JA, Wilkerson GB: The University of Tennessee at Chattanooga, Chattanooga, TN



**Context:** Concussion history has been shown to reduce performance capabilities related to visual perception of environmental stimuli, decision making, and generation of effective movement responses. Immersive virtual reality (VR) offers a means to quantify, and potentially enhance, the speed, accuracy, and consistency of responses generated by integrated neural processes. The use of VR, however, has had limited examination as a training tool among individuals with a concussion history.

**Methods:** A cohort of 24 NCAA Division I male wrestlers (age: 20.5 ±1.7 years, height: 1.76 ±0.07 m, mass: 79.5 ±11.8 kg) completed VR assessments before and after a 3-week VR training program designed to improve perceptual-motor performance. Testing consisted of 40 successive trials involving reaching and lunging responses in the right or left directions according to presentation of a visual stimulus, which was either a filled circle or an unfilled circle that moved in a right or left direction. Participants were instructed to lunge and reach for the target in the same direction (filled circles) or in the opposite direction (unfilled circles) that the circle was moving. Primary outcomes of interest included perceptual latency (PL; time between stimulus presentation and initiation of movement) and response time (RT; time between stimulus presentation and completion of the response) as well as intra-individual variability (IIV) for each. Average PL, RT, PL-IIV, and RT-IIV were collected for neck, arm, and step movements, respectively. Intraclass correlation coefficients demonstrating acceptable test-retest reliability of VR measures assessed have previously been documented, with values ranging from .724 to .836. The VR training program consisted of 2 sets of 20 trials each session, which were performed 2 times per week for 3 weeks. The training program was similar to the VR test except that participants executed a single-step lunging movement in the left or right direction according to the same congruent and incongruent circle presentations and they received visual and auditory confirmation of correct versus incorrect responses.

**Results:** Ten wrestlers self-reported a history of concussion (HxCx) while 14 wrestlers denied such history (NoCx). Average PL, RT, PL-IIV, and RT-IIV values were non-normally distributed so a natural log transformation was used to improve distribution normality. Repeated measures ANOVA results demonstrated statistically significant differences ($p < .05$) between groups for neck, arm, and step movements for both PL-IIV and RT-IIV outcomes. Loge means, standard deviations, and effect sizes are provided in Table 1. Five of the 6 IIV metrics demonstrated a statistically significant magnitude of pre- to post-training change, along with large effect sizes for both groups.

**Conclusions:** VR assessment and training may provide a valuable addition to the traditional methods used to enhance performance capabilities in college wrestlers. Further research is needed to elucidate the role of this training approach in injury risk mitigation.


Table 1. Training Changes among Athletes Reporting No Concussion (NoC) versus History of Concussion (HxC) for Perceptual Latency & Response Time Intraindividual Variability

| | | Geometric Mean ($Log_e$ Mean) | | Group x Session Interaction | | Group Difference | | Session Difference | |
|---|---|---|---|---|---|---|---|---|---|
| Metric | Group | Pre-Training | Post-Training | p | $\eta p^2$ | p | $\eta p^2$ | p | $\eta p^2$ |
| Neck PL-IIV* | NoCx | 0.193 (-1.646) | 0.133 (-2.015) | .231 | .065 | .005 | .303 | .060 | .152 |
| | HxCx | 0.301 (-1.200) | 0.276 (-1.286) | | | | | | |
| Arm PL-IIV* | NoCx | 0.199 (-1.615) | 0.133 (-2.018) | .339 | .042 | .005 | .301 | <.001 | .414 |
| | HxCx | 0.294 (-1.225) | 0.231 (-1.468) | | | | | | |
| Step PL-IIV* | NoCx | 0.207 (-1.576) | 0.153 (-1.876) | .668 | .009 | .008 | .282 | .005 | .303 |
| | HxCx | 0.317 (-1.148) | 0.253 (-1.374) | | | | | | |
| Neck RT-IIV* | NoCx | 0.222 (-1.505) | 0.154 (-1.872) | .221 | .067 | .007 | .285 | .022 | .216 |
| | HxCx | 0.296 (-1.216) | 0.263 (-1.335) | | | | | | |
| Arm RT-IIV* | NoCx | 0.214 (-1.543) | 0.136 (-1.995) | .073 | .139 | .003 | .336 | <.001 | .410 |
| | HxCx | 0.285 (-1.256) | 0.243 (-1.415) | | | | | | |
| Step RT-IIV* | NoCx | 0.220 (-1.513) | 0.155 (-1.863) | .272 | .055 | .009 | .269 | <.001 | .448 |
| | HxCx | 0.302 (-1.199) | 0.246 (-1.401) | | | | | | |

**Association Between Kinesiophobia and Concussion Assessment Battery Scores at Return-to-Play After Concussion**

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**Context:** Athletes are at an increased risk of musculoskeletal injury following a concussion and those who sustain an injury report higher kinesiophobia (fear of movement) compared to uninjured athletes at return-to-play. The multifactorial concussion assessment, evaluating an array of domains, is recommended, however, it is unknown if kinesiophobia associates with performance on these assessments at return-to-play. It is important to understand if an association exists because targeted treatment and recovery of kinesiophobia-related symptoms may also aid in the improvement of post-concussion symptoms and identified deficits. We aimed to determine if Tampa Scale of Kinesiophobia (TSK-17) scores are associated with concussion assessment outcomes at return-to-play. We hypothesized that an increase in TSK-17 scores would be associated with a decrease in performance on a concussion assessment battery.

**Methods:** Forty-two Division I athletes (20.3±1.3 years old, 54.8% female) consented to participate. Athletes completed a concussion assessment battery (CNS Vital Signs, Balance Error Scoring System [BESS], single- and dual-task tandem gait, Standard Assessment of Concussion [SAC], and self-reported symptom checklist) and TSK-17 at the physician-directed return-to-play timepoint post-concussion. Thirty-nine athletes completed BESS, and 26 completed single- and dual-task tandem gait. All other assessments had no missing data. Outcomes of interest included BESS total score, single- and dual-task tandem gait time, SAC total score, and symptom severity. Since the TSK-17 addresses the fear of movement, we were only interested in the motor-related CNSVS domains (motor speed, psychomotor speed, processing speed, and reaction time). We used separate Pearson's correlations to identify associations between TSK-17 scores and the concussion assessment battery outcomes (alpha=0.05). Values between 0.00-0.30 were considered negligible, 0.30-0.50 low, 0.50-0.70 moderate, 0.70-0.90 high, and 0.90-1.00 very high.

**Results:** Results are presented in Table 1. There was a negligible, but significant, positive association between TSK-17 scores and SAC total score (r=.287, p=.033), and a low positive association with the CNS Vital Signs processing speed domain (r=.304, p=.025). No other significant associations were observed between TSK-17 scores and all other concussion assessment battery outcomes (p>0.05).

**Conclusions:** TSK-17 scores had a negligible and low positive correlation with SAC total scores and the processing speed domain within CNS Vital Signs, respectively. The minimal association with two outcomes and lack of association with all others suggests that the TSK-17 captures information that is not reflected by the concussion assessment battery at the return-to-play timepoint following concussion. Higher kinesiophobia is related to an increased risk of further injury following a concussion, and without the administration of the TSK-17 this information may go unrecognized by clinicians as an athlete returns to play. The unique information provided by the TSK-17 can allow clinicians to monitor which athletes may be at an increased risk of further injury and work towards creating strategies to limit this risk.

**Table 1.** TSK-17 association with concussion assessment outcomes

| Outcome | r | Sig. |
|---|---|---|
| BESS Total Score | .113 | .247 |
| Total Symptom Severity | .147 | .177 |
| SAC Total Score | .287 | .033* |
| Single-task Tandem Gait Time | -.102 | .310 |
| Dual-Task Tandem Gait Time | -.236 | .123 |
| *CNS Vital Signs:* | | |
| Motor Speed | -.103 | .259 |
| Processing Speed | .304 | .025* |
| Reaction Time | -.077 | .315 |
| Psychomotor Speed | .061 | .351 |

Abbreviations: TSK-17, Tampa Scale of Kinesiophobia-17; SAC, Standard Assessment of Concussion; BESS, Balance Error Scoring System. *Denotes significant value (p≤.05).

**Association Between Sociodemographic Factors and Vestibular Ocular Motor Screening Baseline Performance in Young Adults**

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**Context:** Vestibular-ocular motor screening (VOMS) is gaining popularity amongst clinicians as a component of the standardized assessment of sport-related concussion. However, there is a paucity of literature investigating sociodemographic differences in vestibular and visual performance at baseline, which may affect interpretation of baseline and post-injury scores. Therefore, the purpose of this study is to explore if racial or subjective social status (SSS) differences exist on VOMS performance at baseline in young adults.

**Methods:** This cross-sectional study included 55 young adults (47 female 8 male; mean age 22.3+3.53) who completed comprehensive demographic information and concussion baseline testing administered in a laboratory setting by a trained researcher. These analyses utilized demographic information, specifically items derived from the MacArthur Scale of SSS, and the VOMS assessment. The independent variables were SSS [high (n=45) vs. low (n=10)] and race (White [n=42] vs. Non-White[n=13]). Scores on the SSS range from 1-10. Therefore, high SSS was classified as a score of ≥ 6 while low SSS was classified as a score of ≤5. Due to the low sample size of individuals whose self-reported race was non-white, race was categorized as a binary variable. The outcome variables were VOMS symptom provocation, calculated as the change score from baseline on each VOMS item: smooth pursuits, horizontal saccades, vertical saccades, near point convergence, horizontal vestibular ocular reflex, vertical vestibular ocular reflex, and visual motion sensitivity (VMS) tests. Before data analysis, each dependent variable was screened for normality (Shapiro-Wilk <0.005). Shapiro-Wilk tests indicated each outcome to be non-normally distributed. Individual Mann-Whitney U tests were used to assess group differences between race and SSS for each VOMS item.

**Results:** Mann-Whitney U tests indicated differences between high and low SSS on horizontal saccade (U= 352.000; z= 2.877; p=0.002) and VMS (U= 352.000; z= 1.856; p=0.032) VOMS symptom provocation. Participants with a high SSS had lower symptom increases for horizontal saccades (median: 0; Q1=0, Q3=1 vs. median:1; Q1=0, Q3=1) and VMS (median: 0; Q1=0, Q3=1 vs. median:1; Q1=0, Q3=1). There were no differences based on SSS between other VOMS items. Regarding race, Mann Whitney U tests indicated differences in vertical saccade symptom provocation (U= 352.000; z= 1.856; p=0.032) with white participants having lower symptom increases (median: 0; Q1=0, Q3=1) that non-white participants (median:1; Q1=0, Q3=1). There were no differences based on race for other VOMS items.

**Conclusions:** SSS differences were present for horizontal saccade and VMS symptom provocation. Racial differences were observed for vertical saccade symptom provocation. However, the possible explanation of these differences may be rooted in social determinants of health that contribute to disparities between levels of SSS and race. Using a larger sample size, future research should further investigate the impact of social determinants of health on VOMS baseline performance in young adults.

**Collegiate Athletes Social Determinants of Health and Concussion Seeking Care: A Preliminary Analysis**

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**Context:** Social determinants of health (SDH), including economic stability, education, health and health care, neighborhood and built environment, and social and community context influence health and well-being of individuals and populations. SDH affect how people understand, interpret, and access care; which too influences the athletic population. Concussions in collegiate athletes are of great concern and often go undisclosed, yet concussion care seeking and its relationship with SDH has not been robustly reported. The purpose of this study was to determine which SDH domain(s) are associated with concussion care seeking intentions and behavior among collegiate athletes.

**Methods:** As part of a larger project, this cross-sectional study design recruited a convenience sample of collegiate athletes to complete a 39-item survey. Content and face validity were assessed by content experts. All five SDH domains were incorporated and participants completed four sections on concussion care seeking intentions (indirect and direct) and behavior (indirect and direct). Items included multi-select, binary, multiple choice, and Likert-scale. The SDH domain items were summed and concussion care seeking intention items were averaged (indirect and direct). Responses to concussion care seeking behavior (indirect and direct) were used to categorize participants as "reporters" or "non-reporters." Two linear and two logistic regressions were completed to better understand associations between SDH domains and concussion care seeking intentions and behavior.

**Results:** Overall, 239 participants completed at least one item of the survey with 211 respondents completing it entirely (completion rate=211/239, 88.3%; age=19.7 ± 1.6 years; male=95/239, 39.7%, females=111/239, 46.4%, intersex=1/239, 0.4%, androgynous=2/230, 0.8%, other=1/239, 0.4%, prefer not to answer=2/239, 0.8%; missing=2/239, 11.3%). A one-point increase in health and health care ($\beta$=0.16, $p$=0.020) and social and community context ($\beta$=0.22, $p$=0.038) increased direct care seeking intentions by 0.16 and 0.22, respectively ($R^2$=0.07). A one-point increase in social and community context decreased the odds of being a "non-care seeker" by 49% ($\beta$=-0.68, odds ratio=0.51, $p$=0.01, Nagelkerke's $R^2$=0.10). SDH domains did not predict indirect intentions (p=0.27), nor indirect care seeking behavior ($p$=0.44).

**Conclusion:** Identification of social factors that promote athletes to seek care for a suspected concussion is important for improving concussion education and care. This preliminary analysis indicates that access to health care and social support systems increase a collegiate athletes' intentions to seek concussion care when needed. Athletic trainers providing care to this population need to understand the influence of SDH on concussion care seeking intentions and behaviors when making efforts to educate athletes when and how to seek care. Athletic trainers should consider each population and patient's life experiences related to health care access, insurance, health literacy, and social networks to inform person-centered approaches to concussion reporting and management.

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**Depression After Sport-Related Concussion in Adolescent and Collegiate Athletes, A Partly Cloudy Forecast – A Critically Appraised Topic**

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**Context:** Sport-related concussion (SRC) is a health condition that increases both short- and long-term physical and psychosocial burdens on those who sustain them. There have been several recent systematic reviews that have concluded depression resolves relatively quickly after SRC, but it is unclear whether there are other factors at play influencing that forecast. In adolescent and collegiate athletes (P), does sustaining a SRC (I) increase depression reporting at 6-months post-SRC (O) compared to baseline values (C)? Secondarily, we examined attrition rates from the included studies to uncover a potential reporting bias in the literature.

**Methods:** We searched PubMed, MEDLINE, CINAHL, and SportDiscus (Limits: English Language) from January 2018 to September 2023 using the following search terms: sport-related concussion, baseline, and depression. Study Inclusion criteria: 1) original research using a prospective cohort design, 2) included adolescent or collegiate athletes with SRC, 3) investigated pre-injury baseline score and post-concussive depression scores, 4) used a validated instrument to quantify/qualify depression, and 5) reported response rates across all time points out to least 6-months. The search strategy resulted in 22 potential articles. Three met the inclusion criteria. From each of the articles included, relevant data regarding the outcome measures used to capture depression at baseline and after SRC were extracted. We used the Joanna Briggs Institute (JBI) Cohort Study checklist to assess the methodological quality and potential validity threats.

**Results:** In all 3 studies, depression scores increased when compared to baseline in the first 24-72 hours after SRC, but returned to normal or below baseline (improved scores compared to baseline) at time of return to play, at 3-months post-SRC and at 6-months post-SRC. From the evidence presented in all 3 studies, depression symptoms resolve within 3 days after SRC and remain at or below baseline values up to 6-months post-SRC. The JBI scores for the included articles ranged from 9-10/11, indicating high quality evidence. However, when examining the attrition rates across time points, we found that the 6-month time-point attrition for the depression scales were 50%, 19%, and 17% respectively across included studies.

**Conclusions:** Based on the evidence from these 3 studies, it appears that depression increases acutely after SRC, but resolves by return to play and remains similar to baseline at the 6-month time point. However, the high attrition rates in the studies included cloud this answer as 17-50% of those athletes remain unaccounted for at the 6-month time-point. Considering that a history of concussion has been linked to elevated depression at baseline screening, these findings should be interpreted with caution. We therefore conclude that there is grade B evidence to suggest that SRC does not increase depression at 6-months post-injury based on 3 well-designed prospective cohort studies with high attrition rates.

**Differences in Jump-Landing Mechanics Between Individuals With and Without a History of Concussion on a Clinical Assessment**

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**Context:** Emerging evidence indicates that individuals with a concussion history display altered jump-landing biomechanics that are associated with ACL injury risk. Traditional biomechanical techniques involving jump-landing require advanced equipment, specialized training, and time-consuming data analysis, making it impractical for "just-in-time" clinical use. Our research objective was to investigate the quality of jump-landing using a clinically feasible tool, the Landing Error Scoring System (LESS), in individuals with and without a concussion history.
**Methods:** We conducted a cross-sectional study involving 18 recreational college students, including 10 individuals in the concussion history group (age= 19.6 ± 1 yr., height= 1.69 ± .1 m, mass= 74.1 ± 10 kg, time since concussion= 3.8 ± 2.2 mo.) and 8 participants in the healthy reference group (age= 19.8 ± 1.4 yr., height= 1.71 ± 1.1 m, mass= 73.7 ± 10.5 kg). Participants completed an online survey (Qualtrics Inc, Provo, UT) reporting their demographic information (age, sex), activity level (Tegner Activity Scale), dominant leg, and medical history (concussion history). Consented participants completed double-leg jump-landing tasks, recorded by 3 video cameras (AKASO, Brave 6) positioned anterior and laterally to the landing zone. The LESS scores were calculated as the average of three trials for both dominant and non-dominant legs. The symmetry in LESS scores was determined by calculating the absolute differences between the legs. We performed a 2 X 2 mixed model ANOVA to compare the LESS scores between legs and groups. An independent t-test was completed to compare the symmetry of LESS scores between the groups. The level of significance was set at $p < .05$.
**Results:** The mixed design ANOVA revealed that the concussion history group (5.6±1.7) had greater LESS scores than the healthy reference group (3.1±2.9) (p= .042, η2=.235) (Figure 1); however, both groups demonstrated similar LESS scores for their dominant (4.6±2.8) and non-dominant (4.3±2.5) legs (p= .22, η2=.091). Furthermore, there was no interaction effect (p= .42, η2=.041) between the group and legs. Additionally, the asymmetrical LESS scores between concussion history (0.73±0.6) and healthy reference (0.42±0.5) group did not differ (p= .26, t=1.17).
**Conclusions:** Our findings suggest that clinical measures, such as LESS, can effectively detect altered jump-landing mechanics in individuals with previous concussions. This finding underscores the clinical utility of the LESS in identifying individuals who may be susceptible to secondary injuries post-concussion. Additionally, it is noteworthy that the effect of concussion history on jump-landing mechanics appears to be consistent in both dominant and non-dominant legs. Understanding the symmetry of jump-landing mechanics would be helpful for clinicians as they develop injury prevention strategies. Future study should investigate potential factors that might influence the effectiveness and applicability of LESS.

This abstract received an internal grant from the University of Delaware.

**Evaluation of Kinesiophobia Following Sport Related Concussion in Collegiate Athletes Until Symptom Resolution at Rest**

Di Francesco OG, Rosenblum DJ, Furey CE, Band H, Resch JE: University of Virginia, Charlottesville, VA

**Context:** An emerging mood state associated with sport related concussion (SRC) is kinesiophobia. Kinesiophobia has been demonstrated to associate with an increased risk of lower extremity injury following return-to-sport after SRC in collegiate athletes. Despite these findings, kinesiophobia has yet to be evaluated in collegiate athletes throughout recovery from SRC which may yield therapeutic targets for intervention. The purpose of this study was to evaluate kinesiophobia in collegiate athletes with SRC from the time of their diagnosis until symptom resolution at rest (SRA) and to determine the relationship between individual Tampa Scale of Kinesiophobia (TSK) items and typical (<14 days) or atypical (>14 days) recovery.

**Methods:** Division I collegiate athletes (N=45 [48.9% female, ], 20.3+1.54 years of age) who were diagnosed with a SRC by an athletic trainer or physician participated in this descriptive laboratory study. All participants completed the TSK up to 48 hours after their SRC. Following the completion of their first TSK, participants were administered the inventory every other day until SRA was achieved as measured using the Revised Head Injury Scale (HIS-r). Participants were then classified as having typical (n=35 [77.7%]) or atypical (n=10 [22.2%]) recovery according to their HIS-r data. A Mann-Whitney U Test was used to compare days until SRA between groups. Due to our relatively low sample size and the number of TSK responses, only descriptive statistics were used to compare group TSK item responses data throughout recovery from SRC. All analyses were performed with $\alpha$=0.05.

**Results:** Participants in the typical group took significantly fewer days, on median (interquartile range) to achieve SRA 5.0 (4.0) days as compared to participants in the atypical group 18.0 (6.0) days ($z$=4.80, $p$ <0.001). In the typical recovery group, participants were observed to have the lowest composite score 32.66[0.59] at 13.5 days following diagnosis. In the atypical recovery group, participants were observed to have their lowest composite TSK score (30.25[2.95]) at approximately 15.5 days following diagnosis. The most notable differences in individual TSK item scores were for Item 1 (Typical [1.58(0.18)] and Atypical [2.14(0.55)]), Item 2 (Typical [1.81(0.31)] and Atypical [2.66(0.38)]), and Item 11 (Typical [2.11(0.25)] and Atypical [1.75(0.45)]). Items may be found in Table 1.

**Conclusions:** Our findings suggest collegiate athletes who experience an atypical recovery from SRC may have an elevated fear of worsening symptom levels if physical activity occurs as compared to athletes with typical recoveries. Future research should address the influence of injury education in collegiate athletes about what will or will not be detrimental to their recovery from concussion.

| TSK Item | Typical | Atypical |
|---|---|---|
| 1. I'm afraid that I might injure myself if I exercise | 1.58 (0.18) | 2.14 (0.55) |
| 2. If I were to overcome it, my pain would increase | 1.81 (0.31) | 2.66 (0.38) |
| 11. I wouldn't have this much pain if there wasn't something potentially dangerous going on in my body | 2.11 (0.25) | 1.75 (0.45) |

**Perceived Barriers and Support When Athletic Trainers Respond to Social Determinants of Health During Concussion Management**

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**Context:** Social determinants of health (SDOH) include economic stability, educational access and quality, access to healthcare, the quality of healthcare services, the environmental characteristics of neighborhoods and built environments, as well as the broader social and community context. Prior consensus guidelines have called for clinicians to incorporate domains of SDOH into concussion management. However, it remains unclear whether athletic trainers (ATs), who play a pivotal role in the management of patients with concussions, incorporate considerations of SDOH, and navigate perceived barriers to doing so into their clinical practice. This study aimed to present preliminary findings regarding ATs' observations of the effect of SDOH on concussion management, and to describe the perceived barriers to responding to SDOH in concussion care among ATs.

**Methods:** As a component of a larger mixed-methods study, we extracted data for the current study from a cross-sectional survey. We developed the survey based on prior research and validated it via expert review. The survey was disseminated via the National Athletic Trainers' Association Research Survey Service, social media, and alumni email listservs. In total, 162 athletic trainers (men: n=59, women: n=100, non-binary: n=3; age=37.35±11.66) completed the survey (68.9% completion rate). Outcome variables were assessed via Likert-type scales. Items related to ATs' observations of the effect of SDOH on concussion management were anchored as: 1=Strongly Disagree to 5=Strongly Agree. Items related to barriers were anchored as: 1=No impact to 5=Very impactful. Exploratory descriptive analyses of frequencies, percentages, and mean-ranks were reported per item.

**Results:** Descriptive statistics per scale items can be found in Table 1. Overall, a majority of the participants "agreed" that concussion management had been affected by SDOH variables, and endorsed several barriers to be at least "somewhat impactful" when responding to SDOH in concussion care. By mean-ranks, ATs endorsed healthcare access and quality (3.5±1.2), social and community context (3.5±1.1), and education access and quality (3.4±1.2) as the top three observed SDOH that have affected concussion management. The most endorsed barriers participants endorsed included: insufficient workforce (3.8±1.3), followed by lack of training (3.7±1.2), and lack of standardized screening tools (3.6±1.2). Notably, the barrier of lack of reimbursement for addressing SDOH into care was listed last by mean ranks (2.9±1.4).

**Conclusions:** The preliminary findings shed light on the challenges ATs navigate when responding to SDOH in the context of concussion management, while concurrently navigating important barriers to doing so. Among the various barriers identified, the greatest was insufficient workforce. This finding, in conjunction with the other barriers described, underscores the importance of access to ATs and sufficient AT staff to address the need in concussion care. Addressing such barriers can better facilitate management of concussion that is inclusive of SDOH, to promote more equitable care.

This study was funded by the University of New Hampshire Collaborative Research Excellence (CoRE) Grant (PI: PM Kelshaw).

| In my practice, I have observed that concussion management has been affected by: | Strongly Disagree n (%) | Disagree n (%) | Neutral n (%) | Agree n (%) | Strongly Agree n (%) | M±SD |
|---|---|---|---|---|---|---|
| Healthcare Access and Quality | 15 (9.1) | 25 (15.1) | 24 (14.5) | 66 (39.8) | 36 (21.7) | 3.5±1.2 |
| Social and Community Context | 11 (6.6) | 20 (12.0) | 43 (25.6) | 68 (40.7) | 25 (15.0) | 3.5±1.1 |
| Education Access and Quality | 16 (9.58) | 29 (17.4) | 26 (15.6) | 70 (41.9) | 26 (15.6) | 3.4±1.2 |
| Neighborhood and Built Environment | 10 (6.0) | 32 (19.2) | 49 (29.3) | 56 (33.5) | 20 (12.0) | 3.3±1.1 |
| Economic Stability | 15 (8.9) | 36 (21.6) | 46 (27.5) | 53 (31.7) | 17 (10.2) | 3.1±1.1 |
| **Barriers to responding to SDOH in concussion care:** | No Impact n (%) | Low Impact n (%) | Neutral n (%) | Somewhat Impactful n (%) | Very Impactful n (%) | M±SD |
| Insufficient workforce to navigate patients to community resources to address SDOH. | 16 (8.5) | 15 (7.9) | 14 (7.4) | 50 (26.5) | 60 (33.3) | 3.8±1.3 |
| Lack of training on how to discuss SDOH with patients. | 13 (6.9) | 12 (6.3) | 23 (12.2) | 66 (34.9) | 42 (22.2) | 3.7±1.2 |
| Lack of standardized SDOH screening tools. | 12 (6.3) | 13 (6.9 | 31 (16.4) | 52 (27.5) | 39 (20.6) | 3.6±1.2 |
| Inadequate information about availability or how to access community resources. | 16 (8.5) | 20 (10.6) | 21 (11.1) | 49 (25.9) | 50 (26.5) | 3.6±1.3 |
| Limited time during patient visits to discuss SDOH | 14 (7.4) | 24 (12.7) | 19 (10.1) | 62 (32.8) | 34 (18.0) | 3.5±1.3 |
| Community resources are unavailable, inadequate, or difficult to access. | 20 (10.6) | 24 (12.7) | 22 (11.6) | 42 (22.2) | 45 (23.8) | 3.4±1.4 |
| Lack of supporting technology. | 20 (10.6) | 17 (9.0) | 30 (15.9) | 55 (29.1) | 31 (16.4) | 3.4±1.3 |
| Lack of reimbursement for screening for or addressing SDOH. | 39 (20.6) | 20 (10.6) | 37 (19.6) | 30 (15.9) | 26 (13.8) | 2.9±1.4 |

**Table 1.** Preliminary item endorsements and mean ranks per item of scales related to concussion management and perceived barriers to incorporating SDOH variables into concussion care. Note: Items are in rank order; Likert scale anchors were: 1=Strongly Disagree to 5=Strongly Agree; and 1=No impact to 5=Very impactful.

**Impact Mitigation Properties of Youth and Adult Ice Hockey Helmets**

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**Context:** Youth ice hockey helmets are similar in design and are tested under the same standard as adult ice hockey helmets. The objective of our study was to investigate the differences in impact performance between youth and adult ice hockey helmets across impact locations.
**Methods:** Our study used a cross sectional, repeated-measures design that took place in an engineering research laboratory. We tested a total of three new Bauer ReAKT 100 (Bauer, Exeter, NH) youth ice hockey helmets and three new Bauer ReAKT 95 adult ice hockey helmets. We employed a modified National Operating Committee on Standards for Athletic Equipment (NOCSAE) ND030 testing protocol using a twin-wire guided drop rig for this study. To assess youth helmets we substituted the recommended medium (blue, 57.6 cm, 4.90 kg) NOCSAE head form (SIRC, Rockford, TN) with the small (red, 53.4 cm, 4.12 kg) NOCSAE head form in order to obtain proper fit according to manufacturer instruction. An Endevco triaxial accelerometer recorded measurements on the Southern Impact Research Center drop tower rig. For each helmet shell, we completed three trials of impacts at four locations (front, right front boss, side, rear) at 4.5 m/s, for a total of 72 impact tests. The dependent variables for our study were peak linear acceleration (PLA), Head Injury Criterion (HIC)-15, and Gadd Severity Index (GSI). Helmet type (youth and adult; between factor) and impact location (front, right front boss, side, and rear; within factor) served as the independent variables. We ran 2x4 mixed model ANOVAs for each of the dependent variables to explore interactions and set the alpha value to $P<0.05$ a priori.
**Results:** The interaction between helmet type and impact location was significant for PLA ($F3, 45=10.22$, $P<.001$, $p\eta2=.41$) and GSI ($F1.60, 23.97=9.52$, $P=.002$, $p\eta2=.39$), but was not significant for HIC-15 ($F2.16, 45=.74$, $P=.49$, $p\eta2=.05$). Means, standard deviations, post hoc results, and effect sizes can be found in the Table.
**Conclusions:** We observed statistically significant differences in helmet impact performance between representative youth specific helmets and adult specific hockey helmets. The relationship between the better performing design varied by impact location. The variation could be the result of head form mass and shape differences or specific helmet designs and employed materials. Performance variations would not likely lead to clinical differences across designs, but future work to better understand the causes driving our results is warranted.

The study was funded in part by a grant from the National Athletic Trainers' Association Research and Education Foundation.

**Winner of the Pre-Professional/Professional Student Category**

**Table:** Descriptive statistics for dependent variables across levels of independent variables and post hoc.

| | | | | Post hoc | |
|---|---|---|---|---|---|
| | Location | Helmet Type | Mean±SD | P | Cohen's D |
| PLA (g) | Front | Youth | 149.87±18.71 | .15 | 9.39 |
| | | Adult | 135.66±19.98 | .15 | 9.39 |
| | Front Boss | Youth | 140.82±13.21 | .00 | 13.84 |
| | | Adult | 188.31±39.23 | .00 | 13.84 |
| | Side | Youth | 136.08±10.22 | .00 | 6.71 |
| | | Adult | 161.86±17.01 | .00 | 6.71 |
| | Rear | Youth | 118.08±5.71 | .52 | 8.78 |
| | | Adult | 123.84±25.74 | .52 | 8.78 |
| GSI (AU) | Front | Youth | 821.85±154.55 | .74 | 73.56 |
| | | Adult | 796.50±147.69 | .74 | 73.56 |
| | Front Boss | Youth | 677.54±102.92 | .01 | 143.06 |
| | | Adult | 1140.34±416.69 | .01 | 143.06 |
| | Side | Youth | 572.22±90.87 | <.00 | 53.86 |
| | | Adult | 803.82±129.95 | <.00 | 53.86 |
| | Rear | Youth | 499.15±20.17 | .22 | 22.94 |
| | | Adult | 469.92±65.67 | .22 | 22.94 |
| HIC-15 (AU) | Front | Youth | 388.92±43.27 | .01 | 25.59 |
| | | Adult | 468.89±61.68 | .01 | 25.59 |
| | Front Boss | Youth | 310.82±45.96 | .05 | 35.03 |
| | | Adult | 384.71±93.38 | .05 | 35.03 |
| | Side | Youth | 244.56±24.19 | .04 | 17.05 |
| | | Adult | 282.43±44.37 | .04 | 17.05 |
| | Rear | Youth | 163.16±16.19 | <.00 | 11.37 |
| | | Adult | 225.84±29.57 | <.00 | 11.37 |

**Reaction Time Assessment Using the SWAY Balance Application in Military Service Academy Cadets Recovering From Mild Traumatic Brain Injury: A Prospective Case-Control Study**

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**Context:** Mild traumatic brain injuries (mTBIs) are a great concern to our military. Due to added physical requirements, the prevalence of mTBI is greater among military Service Members than collegiate and general populations.1,2 Individuals experiencing acute mTBI commonly display deficits in performance and function, including inhibited reaction time.2,3 The Sway Balance Application ((SWAY) Sway Medical, Tulsa, OK) assesses reaction time using a triaxial accelerometer built into iOS mobile devices and may assist in diagnosing and managing mTBI. This prospective case-control study aimed to determine the ability of the SWAY Reaction Time test to discriminate between participants within 72 hours of mTBI and matched healthy controls to assess the test's known-groups validity.

**Methods:** The data presented in this abstract are part of a larger prospective case-control study evaluating novel tools for measuring and assessing neurocognitive function after mTBI. The Regional Health Command Atlantic Institutional Review Board approved the study. Twenty individuals within 72 hours of mTBI diagnosis (age, 20 ± 1 years; height, 70 ± 4 inches; 16 males / 4 females) were age, sex, and height matched with 20 healthy controls (age, 20 ± 2 years; height, 70 ± 4 inches; 16 males / 4 females) through convenience sampling within a military physical therapy clinic. The mTBI group completed the SWAY Reaction Time assessment that measured reaction time in milliseconds (ms) at their initial visit (within 72 hours of mTBI event), at one-week post-mTBI (one week), and at the time of full return to activity (RTA). The healthy controls completed the SWAY Reaction Time test at the same time intervals as their matched mTBI counterparts. Independent samples t-tests were performed to evaluate whether there was a difference between the reaction times of individuals with mTBI and healthy controls.

**Results:** Reaction time measured by SWAY was not different between participants within 72 hours of an mTBI event and healthy controls (mTBI, mean = 271 ± standard deviation 64 ms; control, 251 ± 60 ms; t = -1.04; p = .307). Consistent with previous reports4, reaction time was similar between groups at one week (mTBI = 255 ± 45 ms; control = 248 ± 39 ms; t = -.501; p = .619), and at RTA (mTBI = 239 ± 39 ms; control= 249 ± 56 ms; t = .664; p = .510).

**Conclusions:** Current evidence supports that reaction time is sensitive to the acute effects of concussion.5 In our analysis, however, the SWAY Reaction Time test did not detect significant differences in reaction time between military academy Cadets after acute mTBI and a healthy matched control group. The results of our analysis do not support the known groups' validity of the SWAY Reaction Time test in this patient population.

The authors report no relevant financial disclosures. The views, opinions, and findings contained in this research are those of the authors and do not necessarily reflect the views of the Department of Defense and should not be construed as an official DoD/Army position, policy, or decision unless designated by other documentation. No official endorsement should be made. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government.

**Same Goal, Different Challenges: Differences in Secondary School and Collegiate Athletic Trainers' Barriers to Improving Concussion Symptom Disclosure**

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**Context:** Recommendations for improving concussion symptom disclosure were developed by an NCAA-DoD Mind Matters Challenge expert panel. Athletic trainers (ATs) are central to their implementation; understanding ATs' perceived barriers to following these recommendations in different practice settings is therefore critical for determining necessary implementation supports. Therefore, we aimed to compare secondary school (SS) and college/university (collegiate) ATs' reported barriers to identify potential setting-specific implementation needs.

**Methods:** This cross-sectional online survey study presented the recommendations grouped by substantive domain: 1) education content, 2) dissemination and implementation of athlete education, 3) stakeholder education, 4) team-level processes, 5) organizational processes. Guided by the capability, opportunity, motivation (COM-B) behavioral framework, our novel survey asked respondents their professional setting and to select the barriers (i.e., capability, opportunity, motivation) they experienced for each domain (five questions with select-multiple response options). The NATA sent survey links to 9,997 member ATs they identified as practicing in SS or collegiate settings. We received 357 complete responses from 224 SS ATs and 133 collegiate ATs (completion rate=3.5%; mean age=40.4±12.4 years, gender identity=56.0% female). We calculated odds ratios (OR) and 95% confidence intervals to express the odds of collegiate-setting ATs experiencing a barrier for each domain relative to SS ATs. OR > 1 indicate that collegiate setting ATs had greater odds of reporting a barrier relative to SS ATs, and < 1 indicate the opposite relationship.

**Results:** Collegiate ATs had 40% lower odds of reporting opportunistic barriers regarding delivering recommended educational content than SS ATs (Domain 1; OR=0.603; 95%CI=0.391-0.931; p=.022; Figure 1B). Collegiate ATs had 38% lower odds of reporting an opportunistic barrier to improving team-level processes (Domain 4; OR=0.624; 95%CI=0.405-0.961; p=.032; Figure 1B) than SS ATs. Collegiate ATs had 4.7 times greater odds of reporting limited capability to improve team-level processes (Domain 4; OR=4.715; 95%CI=1.228-18.094; p=.013; Figure 1A) compared to SS ATs. Collegiate ATs have 2.6 times greater odds of reporting limited capability to review and enhance organizational processes than SS ATs. (Domain 5; OR=2.588; 95%CI=1.075-6.232; p=.029; Figure 1A). We identified no differences in motivation type barriers (Figure 1C).

**Conclusions:** Overall, ATs in SS and collegiate settings face different barriers to achieving the same goal: following best practice recommendations and increasing concussion symptom disclosure. Collegiate ATs less often experience barriers in their opportunity to deliver the recommended content and engage with the stakeholders to improve team processes encouraging symptom disclosure. Collegiate ATs more often feel they are not capable of reviewing and modifying organizational or team processes to support concussion symptom disclosure compared to SS ATs. SS ATs may benefit from increased time to deliver robust education to address team processes. Identifying strategies to help collegiate ATs address these processes may be an important direction for improving concussion symptom disclosure in collegiate athletes.

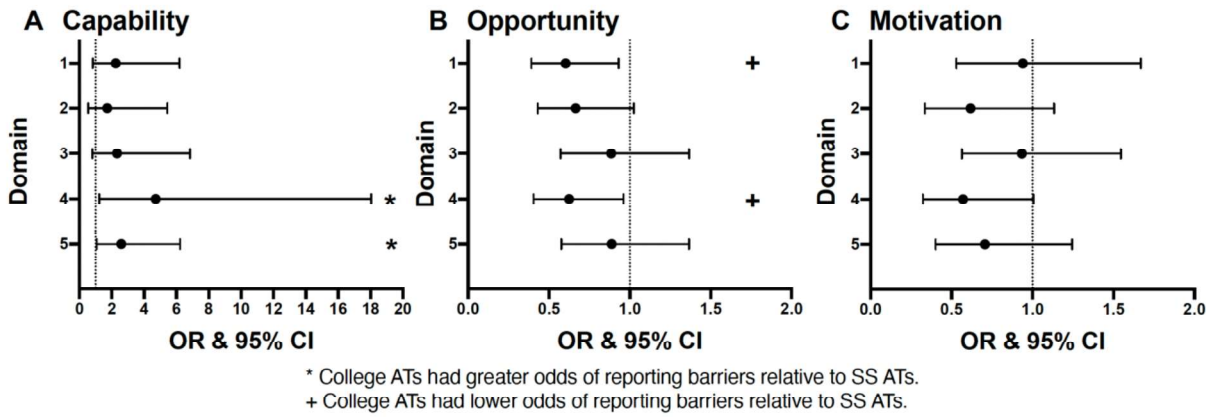


Figure 1: Plots of odds ratio (OR) and 95% confidence intervals (CI) of college athletic trainers (ATs) experiencing a barrier type for each domain relative to secondary school (SS) athletic trainers. Recommendation domains were related to 1) content, 2) dissemination and implementation, 3) stakeholders, 4) team-level processes, 5) organizational processes.

**The Association Between Sleep Duration and Computerized Neurocognitive Assessment Composite Scores at Baseline and Post-Concussion in United States Service Academy Cadets**

Aderman MJ, Roach MH, Malvasi SR, Ross JD, Svoboda SJ, Robb J, McGinty G, Jackson J, Campbell D, Estevez CA, Brodeur RM, Broglio SP, McCrea MA, McAllister T, Pasquina PF, Cameron KL: Keller Army Hospital, West Point, NY; Extremity Trauma and Amputation Center of Excellence, Defense Health Agency, Falls Church, VA, and Womack Army Medical Center, Department of Clinical Investigation, Fort Liberty, NC; United States Air Force Academy, USAFA, CO; United States Coast Guard Academy, New London, CT; University of Michigan Concussion Center, Ann Arbor, MI; Medical College of Wisconsin, Milwaukee, WI; Indiana University School of Medicine, Indianapolis, IN; Walter Reed National Military Medical Center, Bethesda, MD

**Context:** Sleep deprivation is common in college students and military service members. Insufficient sleep has been associated with acute neurocognitive impairment and may impact results during concussion baseline and post-injury assessments. The purpose of this study was to examine the relationship between sleep duration and computerized neurocognitive testing at baseline and initial post-injury assessments in service academy cadets.
**Methods:** A prospective cohort study was conducted with cadets enrolled at three US military service academies. Participants were enrolled in the Concussion Assessment, Research and Education Consortium from 2014-2020. Participants underwent baseline concussion testing and reported demographic information during their first year at their respective academy. Participants who sustained a concussion underwent a standardized initial assessment <48 hours post-concussion. The Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) was administered at both timepoints. Self-reported hours slept the night before each evaluation was recorded on the Sport Concussion Assessment Tool (SCAT) at each timepoint. Univariate and multivariable linear regression models were used to examine the relationship between sleep duration and ImPACT composite scores while controlling for significant covariates (varsity status, sex, concussion symptom burden, psychological status). Two-way ANOVA models were used to examine mean differences in ImPACT scores by hours slept and timepoint. Subjects were grouped based on sleep into quartiles (<5 hours, ≥5 to <6 hours, ≥6 to <7 hours, ≥7 hours) and by assessment timepoint (baseline, initial post-concussion) for each model. Post-hoc testing was conducted on statistically significant models ($p<0.05$).
**Results:** During the study period, 15,932 participants (25% female;19.02±1.42y) completed an ImPACT baseline assessment and 1,143 (39% female;20.04±1.49y) sustained a concussion and completed an initial post-concussion ImPACT assessment. Univariate linear regression models displayed a significant association between hours slept and verbal memory (Coefficient=0.396;95%CI=0.24-0.55;$p<0.001$), visual motor speed (Coefficient=-0.253;95%CI=0.18-0.33;$p<0.001$), reaction time (Coefficient=-0.004;95%CI=-0.01,-0.00;$p<0.001$), and cognitive efficiency (Coefficient=0.006;95%CI=0.00-0.01;$p<0.001$) at baseline testing. An association between sleep and verbal (Coefficient=0.957;95%CI=0.51-1.40;$p<0.001$) and visual (Coefficient=1.217;95%CI=0.70-1.73;$p<0.001$) memory, visual motor speed (Coefficient=0.387;95%CI=0.11-0.67;$p=0.007$), reaction time (Coefficient=-0.010;95%CI=-0.01,-0.00;$p<0.001$), and cognitive efficiency (Coefficient=0.006;95%CI=0.00-0.01;$p=0.027$) was observed at the initial post-concussion assessment. After controlling for significant covariates, multivariable linear regression models yielded similar results. Table 1 displays descriptive statistics for ImPACT scores by sleep group and timepoint, results from two-way ANOVA testing, and post-hoc results for the main effects and interaction among variables of interest.
**Conclusions:** A one-hour sleep increase was associated with improved verbal memory and cognitive efficiency and faster reaction time and visual motor speed at baseline testing and improved verbal and visual memory, faster reaction time and visual motor speed and improved cognitive efficiency at the initial post-injury assessment. A dose-dependent relationship was observed within each timepoint where increased sleep was associated with improved ImPACT composite scores. Sleep duration the night before a baseline or initial post-concussion assessment should be considered when examining results from the ImPACT neurocognitive assessment.

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**Table 1. ImPACT composite scores by hours slept and evaluation timepoint.**

| | *Baseline (1)* | | *Initial Post-Injury (2)* | | *Two-Way ANOVA Results* | | | | *Post-Hoc Results* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **n** | **Mean±SD** | **n** | **Mean±SD** | **Effect** | **F** | **p-value** | **Group** | **Effect** | **Contrast** | **p-value** |
| **Sleep Group** | | | | | *Verbal Memory Composite Score* | | | | | | |
| <5 (1) | 1941 | 89.80±9.47 | 95 | 81.87±14.44 | Sleep | 10.42 | <0.001 | 1 vs 2 | Sleep | 0.502 | 0.220 |
| ≥5 to <6 (2) | 4534 | 90.10±9.25 | 135 | 85.68±12.43 | Timepoint | 186.54 | <0.001 | 1 vs 3 | Sleep | 0.795 | 0.007 |
| ≥6 to <7 (3) | 5624 | 90.37±9.04 | 288 | 85.11±12.59 | 2-Way | 11.44 | <0.001 | 1 vs 4 | Sleep | 0.936 | 0.001 |
| ≥7 (4) | 3833 | 89.95±9.33 | 625 | 87.46±11.83 | | | | 1 vs 2 | Timepoint | -3.929 | <0.001 |
| | | | | | *Visual Memory Composite Score* | | | | | | |
| <5 (1) | 1941 | 80.63±12.07 | 95 | 71.07±16.00 | Sleep | 14.27 | <0.001 | 1 vs 2 | Sleep | 0.815 | 0.070 |
| ≥5 to <6 (2) | 4536 | 81.27±11.95 | 135 | 75.36±13.54 | Timepoint | 229.29 | <0.001 | 1 vs 3 | Sleep | 1.089 | 0.003 |
| ≥6 to <7 (3) | 5624 | 81.87±11.79 | 289 | 73.63±14.51 | 2-Way | 8.20 | <0.001 | 1 vs 4 | Sleep | 1.365 | <0.001 |
| ≥7 (4) | 3835 | 82.01±11.70 | 625 | 77.41±14.05 | | | | 1 vs 2 | Timepoint | -5.831 | <0.001 |
| | | | | | *Visual Motor Speed* | | | | | | |
| <5 (1) | 1940 | 42.10±6.09 | 95 | 38.50±9.37 | Sleep | 9.33 | <0.001 | 1 vs 2 | Sleep | 0.103 | 0.936 |
| ≥5 to <6 (2) | 4535 | 42.20±6.07 | 135 | 39.35±7.54 | Timepoint | 138.85 | <0.001 | 1 vs 3 | Sleep | 0.668 | <0.001 |
| ≥6 to <7 (3) | 5624 | 42.65±6.07 | 289 | 39.85±7.75 | 2-Way | 2.28 | 0.078 | 1 vs 4 | Sleep | 1.080 | <0.001 |
| ≥7 (4) | 3834 | 42.85±5.93 | 625 | 40.81±7.61 | | | | 1 vs 2 | Timepoint | -2.277 | <0.001 |
| | | | | | *Impulse Control* | | | | | | |
| <5 (1) | 1941 | 5.74±4.29 | 95 | 7.12±9.66 | Sleep | 3.72 | 0.011 | 1 vs 2 | Sleep | -0.373 | 0.007 |
| ≥5 to <6 (2) | 4536 | 5.42±3.94 | 135 | 5.56±5.76 | Timepoint | 23.75 | <0.001 | 1 vs 3 | Sleep | -0.312 | 0.027 |
| ≥6 to <7 (3) | 5624 | 5.39±3.93 | 289 | 6.33±5.06 | 2-Way | 1.83 | 0.139 | 1 vs 4 | Sleep | -0.084 | 0.887 |
| ≥7 (4) | 3835 | 5.59±4.10 | 625 | 6.29±5.51 | | | | 1 vs 2 | Timepoint | 0.773 | <0.001 |
| | | | | | *Reaction Time* | | | | | | |
| <5 (1) | 1940 | 0.60±0.10 | 95 | 0.70±0.19 | Sleep | 17.82 | <0.001 | 1 vs 2 | Sleep | -0.007 | 0.970 |
| ≥5 to <6 (2) | 4535 | 0.60±0.10 | 135 | 0.66±0.15 | Timepoint | 299.85 | <0.001 | 1 vs 3 | Sleep | -0.012 | 0.828 |
| ≥6 to <7 (3) | 5624 | 0.59±0.10 | 288 | 0.66±0.13 | 2-Way | 6.89 | <0.001 | 1 vs 4 | Sleep | -0.004 | 0.992 |
| ≥7 (4) | 3832 | 0.59±0.10 | 625 | 0.64±0.13 | | | | 1 vs 2 | Timepoint | 0.056 | 0.005 |
| | | | | | *Cognitive Efficiency* | | | | | | |
| <5 (1) | 1827 | 0.34±0.15 | 95 | 0.33±0.15 | Sleep | 3.74 | 0.011 | 1 vs 2 | Sleep | 0.009 | 0.140 |
| ≥5 to <6 (2) | 4377 | 0.35±0.15 | 135 | 0.35±0.15 | Timepoint | 3.16 | 0.076 | 1 vs 3 | Sleep | 0.022 | <0.001 |
| ≥6 to <7 (3) | 5382 | 0.36±0.15 | 288 | 0.35±0.14 | 2-Way | 0.61 | 0.612 | 1 vs 4 | Sleep | 0.031 | <0.001 |
| ≥7 (4) | 3550 | 0.36±0.15 | 625 | 0.36±0.14 | | | | 1 vs 2 | Timepoint | -0.004 | 0.820 |

**The Influence of Fatigue on the Magnitude and Limb-asymmetry in Ground Impact During Double-leg Jump Landings in Individuals With and Without Concussion History**

Chen YL, Chou TY, Huang YL: National Taiwan Normal University, Taipei, Taiwan, and University of Delaware, Newark, DE

**Context:** Concussion history and fatigue have been linked to higher ACL injury risk, as do factors like excessive and asymmetrical ground impact, including vertical ground reaction force (vGRF) and loading rate. However, no previous study has investigated the effect of fatigue and concussion on ground impact. Therefore, the aim of this study was to determine the influence of fatigue on the magnitude and limb-asymmetry of vGRF and loading rate in individuals with and without concussion history.

**Methods:** Thirteen participants had experienced a concussion in the past two years (Age:21.08±2.72 years, Height:170.54 ± 7.31 cm, Mass:69.48±11.09 kg, Time since concussion:10.00±7.2 months) and 11 matched controls (Age:22.09±2.84 years, Height:169.73±7.81 cm, Mass:60.99±9.73 kg) were included. Landing mechanics during three double-leg jump-landing trials before and after a fatigue protocol were recorded using an optical motion capture system interfaced with two force plates. Peak vGRF between initial contact and 100ms after initial contact-the critical timeframe of ACL injury-was identified and normalized by body mass. Loading rate was calculated by dividing the normalized peak vGRF by the time to the peak vGRF. Limb-asymmetry (dominant minus nondominant) of peak vGRF and loading rate were calculated and averaged across three trials for statistical analysis. Separate 2×2 (group*time) mixed-model ANOVA models were used to evaluate the influence of fatigue, concussion and their interaction on the magnitude and limb-asymmetry of vGRF and loading rate (α=.05).

**Results:** A significant main group effect on loading rate in the dominant limb indicated the concussion group consistently landed with a higher loading rate compared to controls, irrespective of fatigue status (p=.031). Main time effects were found, with increased peak vGRF in both legs (dominant: p=.013; non-dominant: p=.006), and an elevated loading rate in the dominant leg only (p=.001) post-fatigue, regardless of concussion history. Furthermore, a significant interaction effect on loading rate (p=.033) in the non-dominant limb was found. The post-hoc test showed that the concussion group exhibited a higher loading rate than controls pre-fatigue, but no difference was observed post-fatigue. This resulted from a significant increase in loading rate after fatigue in controls, while no change between pre- and post-fatigue was observed in the concussion group. Moreover, a significant interaction effect on peak vGRF limb-asymmetry was noted (p=.038). Based on the post-hoc test, post-fatigue, the concussion group displayed greater peak vGRF limb-asymmetry compared to the control group (Table 1).

**Conclusions:** During double-leg landings, individuals with a concussion history consistently displayed higher loading rate on their dominant leg, regardless of fatigue. The impact of fatigue on loading rate in the non-dominant leg and peak vGRF limb-asymmetry differed between groups. These findings highlight the complex interaction of fatigue and concussion history on ground impact mechanics, underscoring the importance of considering fatigue when assessing ACL injury risk following concussion.

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**Table 1.** Ground impact magnitude and limb-asymmetry during double-leg jump landing

| | Concussion | Control | Group*Time | | Group | | Time | |
|---|---|---|---|---|---|---|---|---|
| | (n=13) | (n=11) | *p* | $\eta_p^2$ | *p* | $\eta_p^2$ | *p* | $\eta_p^2$ |
| **Dominant limb** | | | | | | | | |
| PvGRF, N × N$^{-1}$ | | | | | | | | |
| Pre | 2.01±0.38 | 1.79±0.37 | .675 | .008 | .085 | .129 | .013* | .252† |
| Post | 2.13±0.29 | 1.88±0.27 | | | | | | |
| Loading rate, N×[kg×s]$^{-1}$ | | | | | | | | |
| Pre | 42.76±17.33 | 28.15±13.56 | .463 | .025 | .031* | .195† | .001* | .381† |
| Post | 47.10±13.36 | 34.71±13.91 | | | | | | |
| **Non-dominant limb** | | | | | | | | |
| PvGRF, N × N$^{-1}$ | | | | | | | | |
| Pre | 1.77±0.38 | 1.70±0.39 | .105 | .115 | .974 | <.001 | .006* | .296† |
| Post | 1.82±0.30 | 1.88±0.31 | | | | | | |
| Loading rate, N×[kg×s]$^{-1}$ | | | | | | | | |
| Pre | 38.42±12.74 | 25.55±9.98 | .033* | .191† | .071 | .141 | .002* | .352† |
| Post | 40.50±11.20 | 35.70±14.31 | | | | | | |
| **Limb symmetry** | | | | | | | | |
| PvGRF, N × N$^{-1}$ | | | | | | | | |
| Pre | 0.23±0.23 | 0.08±0.33 | .038* | .181† | .039* | .179† | .851 | .002 |
| Post | 0.31±0.30 | 0.00±0.23 | | | | | | |
| Loading rate, N×[kg×s]$^{-1}$ | | | | | | | | |
| Pre | 4.34±10.25 | 2.60±9.24 | .142 | .096 | .274 | .054 | .734 | .005 |
| Post | 6.60±13.81 | -0.98±10.41 | | | | | | |

PvGRF, peak vertical ground reaction force. The effect size ($\eta_p^2$) was small=.01, medium=.06, and large=.14.

* Significant difference † Large effect size

**The Role of Pre- and Post-Injury Anxiety on Exercise Tolerance and Autonomic Dysregulation Following Concussion**

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**Context:** One in three athletes experience post-concussion anxiety, and 10-20% report pre-injury anxiety, which can result in dysregulation of the autonomic nervous system (ANS). Concussion is also associated with ANS dysregulation, which is often evaluated via exercise tolerance testing. Surprisingly, researchers have yet to examine the effects of pre- and post-injury anxiety on ANS dysregulation in adults following concussion. This study aimed to compare ANS response using the Buffalo Concussion Bike Test (BCBT) between adults with and without pre-injury and post-injury anxiety.

**Methods:** Ninety-six patients 18-49 years within 8 days to 6 months of a diagnosed concussion were included. Participants completed demographic and medical history data, the Concussion Clinical Profile Screen (CP Screen), Brief Symptom Inventory-18 (BSI-18), and BCBT at an initial clinic visit. Participants were adjudicated with post-injury anxiety based on the preceding information. ANS function was evaluated using symptoms, heart rate (HR), blood pressure (BP), and ratings of perceived exertion (RPE) pre- and post-BCBT. Two-way mixed-effects ANOVAs were used to evaluate the interaction between group (pre-injury anxiety [yes / no]; post-injury anxiety [yes / no]) and time (pre- to post-BCBT) on ANS metrics. Independent-sample t-tests were used to compare BCBT stages completed between groups.

**Results:** The sample was 28.1±8.0 years and 61.5% (n=59) female, with 45.8% (n=44) having a concussion history. Thirty-nine (40.6%) participants reported pre-injury anxiety, and 30 (31.2%) were adjudicated with post-injury anxiety. Results supported a significant group x time interaction in participants with pre-injury anxiety for increased diastolic BP ($F[1,92]=4.36$, $p=0.04$) and RPE ($F[1,94]=5.43$, $p=0.02$). Diastolic BP for participants with pre-injury anxiety was 81.7 mmHg (95%CI, 77.9-85.4) pre-BCBT and 85.6 mmHg (95%CI, 81.5-89.7) post-BCBT, while diastolic BP for those without was 82.9 mmHg (95%CI, 79.9-85.9) pre-BCBT and 82.3 mmHg (95%CI, 78.9-85.5) post-BCBT. RPE for participants with pre-injury anxiety was 1.7 (95%CI, 1.3-2.2) pre-BCBT and 3.5 (95%CI, 2.9-4.1) post-BCBT, while RPE for those without was 1.9 (95%CI, 1.5-2.3) pre-BCBT and 2.9 (95%CI, 2.4-3.5) post-BCBT. Results also supported a significant group x time interaction in participants with post-injury anxiety for HR ($F[1,92]=6.13$, $p=0.02$). HR for participants with post-injury anxiety was 71.1 bpm (95%CI, 66.5-75.8) pre-BCBT and 90.6 bpm (95%CI, 82.3-98.9) post-BCBT, while HR for those without was 74.1 bpm (95%CI, 70.9-77.2) pre-BCBT and 104.7 bpm (95%CI, 99.2-110.3) post-BCBT. Participants with pre- ($M=8.3±3.3$) and post-injury anxiety ($M=8.2±3.7$, $p=0.02$) completed fewer BCBT stages than those without pre- ($M=10.2±3.9$) and post-injury anxiety ($M=10±3.7$, $p=0.03$), respectively.

**Conclusions:** Participants with pre- and post-injury anxiety experience altered physiological responses to exercise, including increases in diastolic BP and RPE, and complete fewer stages of the BCBT. The findings suggest that both pre- and post-injury anxiety affect ANS function following concussion and should be considered by clinicians when interpreting findings from exercise tolerance tests such as the BCBT.

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**Time to Return to Sports Participation After Sports-Related Concussion in Middle School Athletes**

Hacherl SL, Kelshaw PM, Avramovic S, Martin JR, Caswell AM, Herman DC, Caswell SV: George Mason University, Fairfax VA; University of New Hampshire, Durham, NH; University of California at Davis, Davis, CA

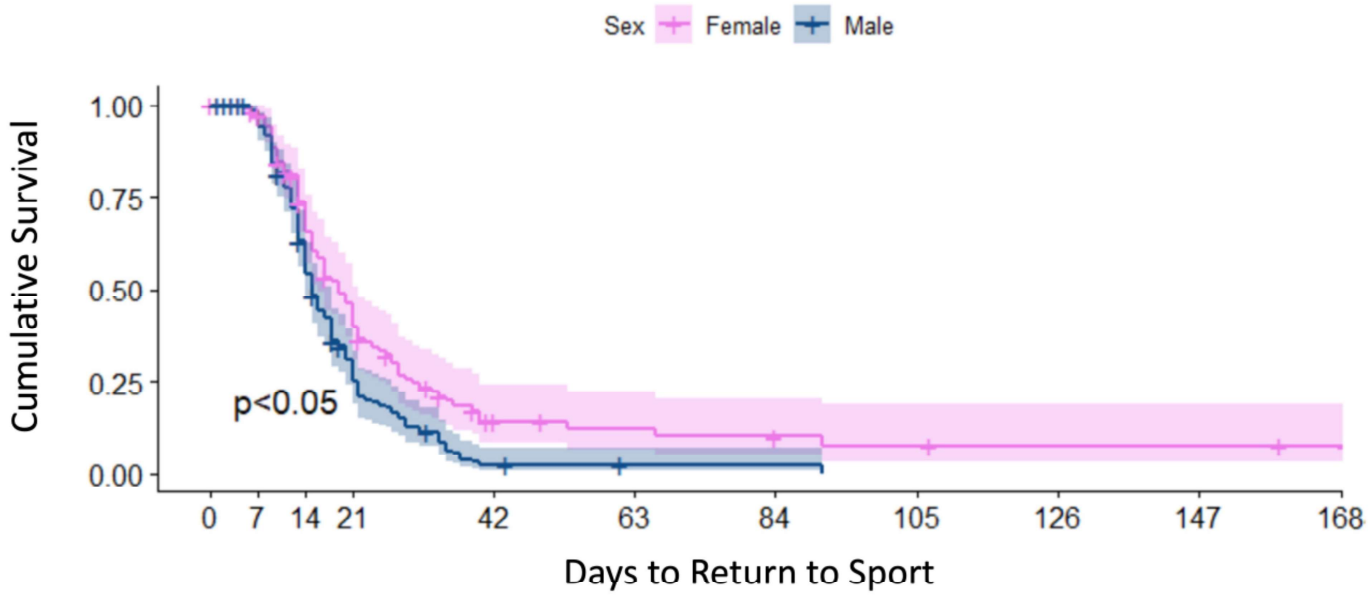
**Context:** Prior studies have characterized sex-related disparities in sport-related concussion (SRC) rates and recovery timelines among athletes suggesting that female athletes may take longer to recover from SRC than their male counterparts. However, the literature disproportionally represents collegiate and high school athletes, leaving pediatric athletes under-represented. A deeper understanding of any potential effects of sex on SRC recovery in pediatric athletes may inform the development of targeted risk reduction and clinical management strategies for this population. Therefore, the purpose of this study was to explore the association between sex and the time required for middle school (MS) athletes to resume sports participation following a SRC.

**Methods:** Certified athletic trainers collected concussion data for all MS sponsored events in a large public-school division between 2015-2022 school years. Time to sports participation was defined as the number of days between the date of injury and return to sport. Descriptive statistics were used to present demographics by sex. Concussions were censored if the case was lost to follow-up (i.e., the athlete did not return to sport, did not follow-up, or quit the team). A Kaplan-Meier survival curve examined SRC clinical recovery stratified by sex. A log-rank test examined differences between Kaplan-Meier survival curves. Alpha was set a priori at $p < 0.05$.

**Results:** A total of 230 concussions were included in the analysis (45 censored; girls=25, boys=20). Boys accounted for a larger proportion of concussions (n=162, 58.9%, age:12.6±1.0) compared to girls (n=113, 41.1%, age:12.4±1.0). The mean participation time-loss for MS athletes was 18.5±11.4 days. Girls took on average 3 days longer to return to sport than boys (girls=20.0±13.2 days; boys=17.7±10.1 days). Girls were more likely to take longer to return to sport than their male counterparts (log-rank $p < 0.05$; Figure 1). Nearly 65% of female athletes took longer than 14 days and 39% took longer than 21 days to return to sport after SRC. Approximately, 58% of male athletes took longer than 14 days, and 27% took longer than 21 days to return to sport participation after SRC.

**Conclusions:** Previous studies conducted at the high school level have reported that nearly 87% of athletes with an SRC returned to full participation within 21 days. However, in our cohort, only 68% of participants were cleared to return to sports within that timeline. Previous research also highlights that women may experience symptoms longer and have a protracted return to sports participation as compared to men. While our findings similarly suggest that MS girls may take longer to return to sports participation, further investigation of SRC recovery among MS-age athletes is needed. Future research must examine time to symptom resolution and other measures to describe SRC clinical recovery in pediatric populations more fully.

The ACHIEVES project is supported by non-restrictive grant funding from a public school division in Virginia.



### A Qualitative Analysis of Career Longevity in Athletic Training


Roeckl-Navazio CL, Sage BW: Indiana University, Bloomington, IN



**Context:** When examining retention within the profession of athletic training current literature focuses on reasons individuals choose to leave the profession. There is little research focused on the factors that contribute to career longevity within the profession. The objective of this study was to identify the factors that contribute to individuals remaining in the athletic training profession.

**Methods:** Participants were Board of Certification (BOC) certified athletic trainers with a minimum of 20 years of clinical experience. We began with a convenient sample of 2-4 individuals and then branched out to athletic trainers within the Power 5 athletic conferences. Additional recruitment was done through non-discriminative snowball sampling. A total of 11 semi-structured interviews were conducted. Interviews took place in a private Zoom room. The current literature identifies three main categories of influence concerning retention: personality characteristics, organizational (extrinsic) factors, and personal (intrinsic) factors, therefore, the 12 interview questions of this study were divided into these categories. All interview questions were modeled from previous studies and have been validated. Each interview was recorded and transcribed using Sonix. Member checks were used to establish trustworthiness. Participants were asked to verify the validity and accuracy of their interviews through transcript verification. Following interview verification, an inductive content analysis strategy was used to derive results from this study. Transcripts were individually coded; codes were then grouped into themes; from emerging themes, conclusions were drawn.

**Results:** The findings of this study show personality characteristics along with organizational and personal factors are all influential in an individual's decision to remain in the profession of athletic training. Related to personality, themes emerged related to the reasons individuals pursue a career in athletic training, qualities needed for success in the profession, and skills used for conflict resolution. Reasons individuals chose to pursue the profession were being a former athlete, enjoyment of the athletic environment, wanting to be involved in a healthcare profession, and having early exposure to the profession. The themes that emerged related to qualities needed for success were altruism, communication skills, soft skills, and competency in skillset. The themes identified allowing for conflict resolution were communication skills, interpersonal skills, and the ability to compromise. Organizational themes that positively influence retention were decreased role conflict, organizational support for work-life balance, and support of professional development, in addition to having a trusted professional support network. Lastly, the personal themes that emerged from this study that contribute to individuals remaining in the profession are the ability to maintain work-life balance, being intrinsically motivated, and having a strong personal support network.

**Conclusions:** The current literature relating to retention in the athletic training profession focuses on why individuals choose to leave the profession. In contrast, this study explored the factors contributing to individuals staying in the profession. The findings of this study highlight the importance of specific personality qualities in combination with organizational and personal factors that strongly influence individuals to remain in the profession. Future research should continue to explore other factors that contribute to career longevity. Additionally, further research can examine the influence of race, gender, and ethnicity on the career longevity of clinically practicing trainers. Furthermore, this study identified a variety of skills viewed as essential for retention, therefore, athletic training education programs should implement strategies aimed at fostering these skills within the curriculum. Career longevity for clinically practicing athletic trainers is attainable through the combination of personality characteristics, and organizational and personal factors.

**Addressing Barriers to Black Men Entering the Athletic Training Profession**

Glover SL, Mensch J, Siple BJ, Smith BJ: University of South Carolina, Columbia, SC

**Context:** There is an underrepresentation of certified black male athletic trainers in the athletic training profession. Current literature highlights the barriers of minorities in other healthcare professions, but none specifically researched black men in athletic training.

**Methods:** Our participants were eight, self-identifying, black male certified athletic trainers working in the state of South Carolina. Using a semi-structured interview guide, 30–60-minute virtual interviews were conducted via Zoom to gain insight about the experiences of black men in regards to the perceived barriers and keys to success in entering the athletic training profession.

**Results:** The research team deliberated and decided on four, overarching areas that all of the data points could fall under. The final consensus yielded these themes: (1) knowledge of the profession, (2) academic preparedness, (3) support system and (4) representation. Three of the categories were broken down further into sub-themes.

**Conclusions:** This study resulted in identifying major barriers for black men entering the athletic training profession; 1) lack of knowledge of the profession, 2) academic unpreparedness, and 3) lack of existing representation in the field. Initially, there is the issue of students who are not familiar with athletic training as a career option. Even with those who are aware, they may not meet the academic pre-requisites to be accepted into programs, causing them to change paths. In addition, lack of representation of black men in the profession already make it difficult to push the initiative further to reach areas with large minority populations that may not have an athletic trainer. A number of strategies were proposed by our participants. The National Athletic Trainers' Association (NATA), district and state associations, and athletic training programs need to raise awareness of the profession as a whole, starting at the high school level. In addition, support from instructors and preceptors, especially those who come from similar backgrounds improve the persistence of black men in athletic training. The athletic training profession should take note of these barriers as well as keys to success to develop strategies in approaching their initiative set in place by Commission on Accreditation of Athletic Training Education to increase diversity within the field. These considerations should be evaluated further and used to push for change with the ultimate goal of cultural competence and patient-centered care in mind.

**Athletic Trainers' Beliefs Regarding Professionalism**

Moffit DM, Neil ER, Burns S, Miller S, Mansell JL: Idaho State University, Pocatello, ID, and Temple University, Philadelphia, PA

**Context:** The term professionalism has been defined and adopted in different forms by various professions. Limited research exists regarding the self-determined perceptions of professionalism regarding athletic trainers. The purpose of this study was to explore the lived experiences of athletic trainers on their perceptions of professionalism.

**Methods:** Within a larger survey study, athletic training participants through criterion sampling were recruited through listservs and social media self-identified their interest to participate in a follow-up interview. We used a grounded theory with consensual qualitative research (CQR) analysis to explore athletic trainers' perceptions of professionalism. The 10 question semi-structured interview with follow-up prompts was created by three research team members and was validated by three external reviewers. Audio-only recorded interviews (Zoom, San Jose, CA; average 24±7 minutes, range 16-42 minutes) occurred until saturation was met and included diverse participants. All transcripts were audio recorded, transcribed verbatim, and were coded using a 3-person coding team following the CQR protocol to determine domains and categories. Member checking, auditing, and triangulation established trustworthiness and credibility in the data analysis process. A total of 17 certified athletic trainers (age 33±8y; 9 women, 8 men) with an average of 10±8y experience from diverse settings participated in the interview. Data saturation occurred with 12 participants; however, 5 additional interviews were conducted to increase diversity of participants.

**Results:** A total of four domains with supporting categories were identified within the interviews. Of the 10 supporting categories, six were general (appearing in 16-17 transcripts) and 4 were typical (appearing in 9-15 transcripts). Athletic trainers spoke to the specifics of the employee environment that affected their perceptions of what was determined to be professional. Participants noted differences in various settings or situations such as distinguishing differences between days with a competition versus a practice day. Participants also shared their personal determination of outward appearance and expression when differentiating what was deemed professional, including references to cleanliness, judgment of self-expression, and implicit bias. Specific examples of a clean healthcare facility and following OSHA standards were important to participants. Additionally, participants shared judgements such as the location and types of self-expressions in tattoos or piercings. Finally, whether intentional or unintentional, participants made comments that demonstrated a bias towards sexes or race and ethnicity when determining outward appearance appropriateness. Additionally, participants noted various cultural awareness situations including progression of perceptions over time, external pressure, and internal dialogue. Despite the fact that many participants noted shifts in their personal beliefs regarding their determination of professionalism, some shared how their stance has not changed. Some participants shared that their definition of professionalism was shaped in their professional athletic training program or through societal external pressures. Participants also shared discourse of an internal struggle of what is right and wrong within their responses. Finally, participants discussed professionalism based on provider's conduct, mainly in terms of communication and patient care. Participants shared that communication occurring through both verbal and non-verbal means is vital to the perceptions of professionalism for athletic trainers. Participants described their perceptions of professionalism as the quality of patient care that is provided.

**Conclusions:** Current views of professionalism within athletic training are shaped from various personal experiences. Participants skewed toward outward appearance in their responses. With the emphasis in athletic training recognizing diversity, equitable care, and inclusivity, antiquated professionalism ideals need to shift for a better work environment. Administrators should review current policies and procedures regarding professionalism, including but not limited to dress code, outward appearance, and conduct policies. These policies should be examined through a diversity lens accepting of all individuals.

**Athletic Trainers' Confidence and Preparedness Recognizing and Responding to Social Determinants of Health Needs Among Patients**

Fletcher AA, Kelshaw PM, Smith ET, Valovich McLeod TC, Hunt T, Picha K, Newman T, Bay C, Bowman TG: University of Lynchburg, Lynchburg, VA; University of New Hampshire, Durham, NH; A.T. Still University, Meza, AZ; Georgia Southern University, Statesboro, GA; University of Kentucky, Lexington, KY

**Context:** Social determinants of health (SDOH) are recognized as environmental and socioeconomic circumstances that influence people's daily living conditions and long-term health outcomes. Athletic Trainers' (ATs) confidence and preparedness in their ability to recognize and respond to the impact of SDOH on patient health and well-being are crucial factors for promoting whole-person health. However, didactic domains of SDOH have recently been incorporated in CAATE standards and therefore may vary by type of professional training among ATs. Therefore, the purpose of this study was to describe ATs' confidence and preparedness in recognizing and responding to indices of SDOH among patients by type of professional AT education (e.g., Bachelor, Master, and Internship) and years of experience.

**Methods:** Following expert review for content validity, we distributed an online survey, as part of a larger mixed-methods study, to 10,000 ATs across the United States using the National Athletic Trainers' Association Research Survey Service. A total of 235 ATs opened the survey, and 162 ATs (men: n=59, women: n=100, non-binary: n=3; age=37.35±11.66 years; experience=13.61±10.96 years; AT education: Bachelors: n=94, Internship: n=13, Masters: n=55) completed the survey (68.9% completion rate). We deployed two Likert-type scales for Preparedness (15 items total) and Confidence (7 items total) that incorporated responses of 1="Strongly Disagree" to 5="Strongly Agree" per item). Both scales were internally consistent (Preparedness: Cronbach α=.81; Confidence α=.92). Following assumption testing, we conducted two one-way ANOVAs examining professional AT education and years of AT experience, as well as a Pearson correlation to quantify the association between continuous variables.

**Results:** Descriptive statistics for Confidence and Preparedness can be found in Table 1. AT preparedness and confidence did not vary by professional AT education type [F(2,18)=1.35, p=.285 and F=0.37(2,19), P=.695], respectively, or AT years of experience (r = -.006, P=.943 and r=.063, P=.432, respectively).

**Conclusions:** The lack of significant findings across groups and years of experience suggests a level of consistency among graduates of different AT professional education programs in preparedness and confidence of recognizing and responding to SDOH. However, most participants endorsed most items with interpretively "neutral" responses per preparedness and confidence items, suggesting that ATs only feel moderately prepared and moderately confident to recognize and respond to SDOH in their clinical practice. In light of these findings, there is a preliminary rationale for prioritizing professional development initiatives aimed at enhancing the efficacy of ATs in recognizing and responding to SDOH-related needs among patients.

This study was funded by the University of New Hampshire Collaborative Research Excellence (CoRE) Grant (PI: PM Kelshaw).

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | n (%) |
| **Preparedness** | | | | | |
| I am **prepared to identify** patients needing assistance due to: | | | | | |
| Economic Stability | 3 (1.7%) | 20 (11.5%) | 37 (21.3%) | 101 (58.1%) | 13 (7.5%) |
| Education Access and Quality | 3 (1.7%) | 16 (9.2%) | 33 (19.0%) | 108 (62.1%) | 14 (8.1%) |
| Healthcare Access and Quality | 3 (1.7%) | 13 (7.5%) | 25 (14.4%) | 114 (65.6%) | 19 (10.9%) |
| Neighborhood and Built Environment | 3 (1.7%) | 30 (17.2%) | 57 (32.8%) | 74 (42.5%) | 10 (5.8%) |
| Social and Community Context | 4 (2.3%) | 19 (11.0%) | 52 (30.1%) | 89 (51.5%) | 9 (5.2%) |
| I am **prepared to make appropriate referrals** for patients needing assistance due to: | | | | | |
| Economic Stability | 12 (6.9%) | 39 (22.4%) | 42 (24.1%) | 68 (39.1%) | 13 (7.5%) |
| Education Access and Quality | 7 (4.0%) | 26 (14.9%) | 31 (17.8%) | 90 (51.7%) | 20 (11.5%) |
| Healthcare Access and Quality | 4 (2.3%) | 16. (9.2%) | 16 (9.2%) | 106 (60.9%) | 32 (18.4%) |
| Neighborhood and Built Environment | 10 (5.8%) | 38 (21.8%) | 55 (31.6%) | 61 (35.1%) | 10 (5.8%) |
| Social and Community Context | 7 (4.0%) | 23 (13.3%) | 43 (24.9%) | 85 (49.1%) | 15 (8.7%) |
| **Confidence** | | | | | |
| I am confident in **my ability to recognize patients** who are experiencing barriers due to: | | | | | |
| Economic Stability | 2 (1.1%) | 19 (10.4%) | 40 (21.9%) | 102 (55.7%) | 20 (10.9%) |
| Education Access and Quality | 2 (1.1%) | 17 (9.3%) | 40 (21.9%) | 104 (56.8%) | 20 (10.9%) |
| Healthcare Access and Quality | 2 (1.1%) | 8 (4.4%) | 25 (13.7%) | 116 (63.4%) | 32 (17.5%) |
| Neighborhood and Built Environment | 3 (1.7%) | 45 (24.9%) | 51 (28.2%) | 70 (38.7%) | 12 (6.6%) |
| Social and Community Context | 5 (2.8%) | 22 (12.2%) | 45 (24.9%) | 96 (53.0%) | 13 (7.2%) |
| I am confident in **my ability to communicate** with a patient who is experiencing barriers related to a SDOH | 2 (1.1%) | 8 (4.4%) | 30 (17.2%) | 110 (60.8%) | 31 (17.1%) |
| I am confident in **my ability to find resources** related to mitigating the influence of the SDOH for my patients | 4 (2.2%) | 26 (14.2%) | 40 (21.9%) | 89 (48.6%) | 24 (13.1%) |

Table 1. Participant responses per item of Confidence and Preparedness scales to recognize and respond to SDOH needs among patients.

**Athletic Trainers' Delivery of Patient-Centered Care in the Physician Practice Setting**

Mitchell AM, Eberman LE, Greffly TJP, Neil ER, Armstrong TA, Winkelmann ZK: University of South Carolina, Columbia, SC; Indiana State University, Terre Haute, IN; Illinois Bone and Joint Institute, Morton Grove, IL; Temple University, Philadelphia, PA; Drake University, Des Moines, IA

**Context:** Health literacy describes how individuals can obtain, process, and understand basic health information to make appropriate medical decisions. The 8th edition of the BOC Practice Analysis states that athletic trainers (ATs) are responsible for promoting health literacy by educating patients and stakeholders. The role of patient education is to guide individuals to comprehend their diagnosis and treatment options to achieve their goals. Assessing health literacy allows ATs to deliver patient education in a patient-centered environment. In the physician practice setting, ATs often have a variety of scheduled patients following a structured plan. The uniqueness of this job setting may change the roles and responsibilities of health literacy and patient education. Therefore, this study aimed to explore the lived experiences of ATs from the physician practice setting on how they explore health literacy and deliver patient education to create a patient-centered environment.

**Methods:** We followed a ground theory study design to interview 10 ATs in the physician practice setting (age=36±9 y; women=6, men=4; clinical experience=11±10 y). Recruitment occurred from 333 ATs that opted into the NATA research database. We completed one-on-one virtual interviews, as part of a larger study, following a semi-structured protocol until data saturation was achieved. The protocol was comprised of 15 questions and an application-based patient case scenario on patient-centered care, health literacy, and patient education. Each interview was audio recorded and transcribed using real-time software. A 3 person coding team used a three-phase consensual qualitative analysis to create a codebook that identified domains and categories. Each participant's patient case scenario response was coded using a 34-item behavior checklist (described / not described) and is presented in averages. Trustworthiness and credibility were established through triangulation, member checking, and internal auditing.

**Results:** Four domains emerged (Table 1) from the interviews: 1) work environment, 2) essential traits and skills, 3) health literacy assessment strategies, and 4) patient education materials and delivery. Participants expressed that they often saw many patients, which impacted the delivery of patient education. The characteristics of the patients, specifically comorbidities and social determinants of health, often create complex patient education needs. Participants noted the work environment provided opportunities to work collaboratively and receive feedback on patient satisfaction. The ATs in physician practice described their essential traits and skills to deliver patient-centered care through shared decision-making, transparency, and providing options. Interpersonal communication through verbal mechanisms and non-verbal recognition were also discussed. The ATs reported using patient input and perceived expertise to determine patient health literacy. However, they expressed struggles in assessing patient health literacy due to language barriers and not knowing the definition of health literacy, which leads to not measuring patient health literacy. The participants discussed patient education as an ongoing, personalized process complemented by digital resources and supplemental teaching. When delivering patient education, the identified struggles were knowing how to modify for a specific patient and limited time. In the patient case scenario, the participants, on average, discussed 34.7% of the criteria for making a patient-centered environment, 24.0% of the requirements for health literacy, and 34.4% of the standards for patient education. Participants did well establishing a personal connection with the patient, using plain language, and providing visual materials. Participants did not do well using preferred pronouns, assessing literacy using validated tools, and assessing language preferences.

**Conclusions:** ATs working in the physician practice setting attempt to create a patient-centered environment, but findings suggest areas of concern specific to health literacy and patient education. Improvements that need to be made by physician practice ATs include utilizing a validated health literacy assessment tool, confirming patient understanding, and providing written materials at a sixth-grade level in their preferred language.

**Table 1. Domains and Category Analysis**

| Domain | Category | Count | Label |
|---|---|---|---|
| Work Environment | Feedback | 4 | Variant |
| | Patient Load | 3 | Variant |
| | Interprofessional Approach | 9 | General |
| | Characteristics of the Patients | 10 | General |
| Essential Traits and Skills | Patient-Centered Abilities | 10 | General |
| | Interpersonal Communication- Verbal | 9 | General |
| | Interpersonal Communication- Non-Verbal Recognition | 4 | Variant |
| Health Literacy Assessment Strategies | Patient Input | 10 | General |
| | Perceived Expertise of Clinician | 7 | Typical |
| | Struggles (Patient) | 10 | General |
| Patient Education Materials and Delivery | Ongoing and Personalized | 10 | General |
| | Digital Modes | 10 | General |
| | Supplemental Teaching | 10 | General |
| | Struggles (Clinician) | 7 | Typical |

**Athletic Trainers' Experience, Knowledge, and Confidence Treating Patients Who are Deaf or Hard of Hearing**

Quintana CP, Johnson S, Hunt T: University of Kansas Medical Center, Kansas City, KS; California State University, Fresno, Fresno, CA; Georgia Southern University, Statesboro, GA

**Context:** Fifteen percent of American adults report some trouble hearing and athletic training educational programs provide limited exposure to working with and managing this population. With the growing number of individuals from unique backgrounds participating in sports and recreational activities, it is important that the athletic trainer be competent and confident in providing culturally competent and inclusive care. One important and often under-recognized group in athletic training practice is the Deaf and Hard of Hearing (DHH) community. Thus, this research seeks to understand the attitudes, beliefs, and preparedness of athletic trainers working with DHH practicing in traditional settings.

**Methods:** A cross-sectional survey was created from the literature and previous surveys in similar studies to explore the knowledge and experience of athletic trainers working with athletes who are deaf or hard of hearing. Cohort piloting and expert review ensured content accuracy and validity during survey development. Anonymous surveys were sent via the National Athletic Trainer's Association Research Survey Service. Respondents were asked to answer questions regarding their knowledge and experience working with DHH patients. Questions were ranked from strongly disagree to strongly agree. Demographic data was also collected and used for analysis. Descriptive statistics were calculated.

**Results:** 124 certified athletic trainers began the survey, with 107 completing the survey entirely (86% completion rate: 68 women, 37 men, 2 prefer not to answer/gender not listed). Respondents' years as a certified athletic trainer ranged from 1-5 years (n=21) to 25+ years (n=14), represented bachelor's (n=22), master's degree (n=72), clinical (n=4) and academic doctorate (n=9) degree holders. Among the respondents only 16% were currently working with patients who are DHH and 66% had less than one year of experience working with patients who are DHH with most respondents practicing at the secondary school (36.4%) or college/university (34.6%) level. 69% of respondents believed that individuals with hearing loss would benefit from the services of an athletic trainer; however only 12% strongly agree they have access to an interpreter and 18% strongly knew how to access one, if necessary. Additionally, only 3% strongly agreed that they felt their athletic training education prepared them to work with individuals with disabilities including individuals who are DHH and 2% strongly agreed that athletic trainers have sufficient training to work with this population. Finally, 18.7% of respondents did not feel confident treating patients who are DHH and 21.5% felt confident treating this patient population.

**Conclusions:** The majority of Athletic Trainers do not typically work with or feel prepared to work with athletes who are DHH. Identifying the experience, knowledge, and confidence of athletic trainers can help support future education and demonstrate areas to strengthen efforts to create inclusivity and better health equity practices.

**Athletic Training Student Debt: A Look at Payment and Cost Containment Strategies**

Hatzel BM, Del Rossi G: Grand Valley State University, Allendale Charter Township, MI, and Creighton University, Omaha, NE

**Context:** With the rising cost of education, students who do not have the financial resources to pay for their studies are increasingly relying on educational loans. The purpose of this investigation was to examine athletic training student debt accrual and strategies used to pay, manage, or contain costs, and secondarily, to examine if there are differences between graduate and undergraduate students.

**Methods:** A 76-question survey was developed, in part, with constructs previously used in other fields such as medicine and physical therapy to examine demographic information, student debt levels and questions related to payment and cost containment strategies. An external panel of 10 individuals validated the survey (scale content validity index = 0.95). The NATA distributed the Qualtrics (Provo, UT) survey by email to 18,689 certified athletic trainers. A total of 2271 recipients completed the online survey which resulted in an overall response rate of 12.2%. Of all respondents, 268 reported that they did not have student debt, with 2003 (31.9 ± 5.4 years) saying they did. Data collection occurred over 9 weeks with 4 reminders encouraging participation. Data were analyzed with descriptive statistics and comparisons between graduate and undergraduate students were made using a generalized linear model with significance set a priori at $p < 0.05$.

**Results:** Undergraduates (UG) acquired $52,000 in debt while those from graduate (G) programs reported $86,000. Respondents selected all options that applied when sharing how they paid for college: federal student loan (89% UG, 92%G), scholarships (64%UG, 21%G), grants (32%UG, 9%G), parent or relative gift (30%UG, 13%G), private loan (37%UG, 28%G), parent loan (23%UG, 7%G). When exploring options to manage or contain costs for both groups, 68.9% worked, 26% lived with family/friends and 72% lived with roommates. Interestingly, significant relationships were noted between G and UG's while exploring cost containment strategies (graduate early = $F(1,1817) = 17.73$, $p < 0.0001$, lived with family = $F(1, 1816) = 28.78$, $p < 0.001$, commuter school = $F(1, 1817) = 34.41$, $p < 0.0001$) while UG tended to attend a less expensive school $F(1, 1816) = 6.23$, $p = 0.013$. Further highlighting student debt realities, 57% actively tried to limit school loans at the time, 27% received loan counseling, 30% considered themselves financially literate and 46% reported they would have paid for college differently.

**Conclusions:** Regardless of the route to professional preparation students do often acquire debt. The mechanisms by which graduates paid for their degrees varied by UG or G while strategies taken to contain costs also differed by degree level. These data suggest that students may benefit from financial literacy programming and loan counseling that provides insights into educational costs and cost management and containment strategies.

**Barriers and Facilitators of Physical Activity: Experiences of Racially Marginalized Girls Living in a Low-Socioeconomic Community**

Zuk EF, Evanovich JM, McGarry JE, Burland JP, Glaviano NR, Srinivasan S, DiStefano LJ: University of North Carolina Charlotte, Charlotte, NC, and University of Connecticut, Storrs, CT

**Context:** Interventions have attempted to increase safe physical activity engagement and reduce injury risk in low socioeconomic status, racially marginalized children, who display the lowest levels of physical activity engagement, however, interventions often are unsuccessful in the long-term. These interventions fail to account for systemic inequities that some populations, specifically low socioeconomic and racially marginalized girls, encounter. Therefore, the purpose of the study was to understand the lived experiences surrounding physical activity engagement of racially marginalized girls living in a low-socioeconomic status community in order to design more informed interventions to promote physical activity and reduce injury risk.

**Methods:** A qualitative study was used to explore physical activity experiences of 12 fourth and fifth grade girls who participated in the Nutrition Sport Academy, a campus-community partnership that uses sport and activity to engage youth and college students in nutrition education, physical activity, and life-skill development during the 2022-2023 school year. The racial/ethnic breakdown of the girls was representative of the school's population as a whole (>98% of the students were considered a racially marginalized person, such as, Black, Latina, Puerto Rican). Data collection consisted of 5 semi-structed focus groups with 3 children in each focus group with conversations guided off of the initial question, "share how you feel about physical activity". Focus group interviews were digitally recorded using WebEx software and transcribed verbatim by the software and then checked by the researcher. Field notes were used to gather information surrounding body language and other mannerisms not gathered in the transcripts. To ensure rigor and trustworthiness of the data, we utilized peer debriefs with experts in the area of sport-based youth development and youth physical activity engagement. We utilized multiple data sources, including various individuals, settings, and methods to understand the lived experiences from multiple viewpoints instead of a singular valid truth. After discussions with the peer reviewers and consulting the field notes, results and themes were finalized.

**Results:** Four major themes were revealed: 1) relationships, 2) stereotypes, 3) activity selection, and 4) self-awareness. The girls discussed family and peers as a large influence to engage or disengage in physical activity. Cultural traditions, such as dance, was discussed as a way to connect with family. Common stereotypes, such as girls having to be 'girly' or girls not receiving parental support to play contact sports was common. Girls that wanted to rebel against this norm displayed higher levels of sport-confidence. Activity selection was often linked to available opportunities to get engaged in physical activity. The focus groups discussed lack of equipment as a barrier for physical activity engagement, but also described the lack of equipment as a facilitator for creative play. These 4th and 5th graders were self-aware that being physically active generally brought them a sense of joy and calmness, but they also grappled with the pressure of letting peers down. Quotes were used to support all themes (Table 1).

**Conclusions:** While racially marginalized girls in low-socioeconomic status communities complete the least amount of physical activity engagement, this study discusses the structures in place for the girls in this community to succeed in being physically active. Researchers and clinicians should appreciate these barriers and facilitators when designing future interventions to improve safe physical activity across the lifespan.

| Theme | Facilitator Quote | Barrier Quote |
|---|---|---|
| **Relationships** | "I like to dance and probably move my body a little bit because that's what I got from my mom" | "I'm good at the game [soccer], but they [peers] say, I'm not, and when they say that, I just get concentrated on that, and it makes me not score." |
| **Stereotypes** | I like them [girl sports] because boys, boys sometimes say that girls are weak… but actually girls run the world". | "I play with the boys because most of the girls are not running around. And I don't really want to sit down… Cause most of the girls here are like girly...they just like to gossip." |
| **Activity-Selection** | I like when you [Nutrition Sport Academy] make us do a new activity… I like when its volleyball, running, hockey" | "I wish I played tennis, but I don't have tennis ball... well I do have a tennis ball, but I don't have a racket." |
| **Self-Awareness** | I have ADHD, so sitting like, just sitting and not doing that thing, it makes me feel weird. So, when I'm running around, doing stuff like, it makes me calm." | *"People say that you are going to lose and that kinda makes me want it to go away…"* |

**Conflict Management in Athletic Training: The Role of Social Capital and Swift Trust in Stable and Transient Contexts**

Emerson CC: Kansas State University, Manhattan, KS

**Context:** Athletic trainers (ATs) regularly encounter conflict due to tension between their role to advocate for health and safety and organizational goals to maximize performance. When poorly managed, conflict can lead to decreased job satisfaction and increased stress, burnout, and intentions to leave the profession. Alternatively, effective conflict management can improve professional relationships and job satisfaction. Trust plays an important role in conflict management by promoting cooperative behaviors and preventing conflict from deteriorating relationships. Social capital is shared norms and values-including trust and reciprocity-as a result of networking and relationship-building. Swift trust is an assumed form of trust between individuals who are unknown to each other but are compelled to trust each other. Swift trust is based on limited contextual information and norms (social category, role, third party information) or one's disposition to trust.

**Methods:** This qualitative study based in a phenomenological framework explored experiences of conflict management through the perspectives of AT managers. AT managers hold positions which allow them to observe and facilitate conflict management in a variety of settings and with a wide range of people and personalities. An interview guide was developed based on conflict management and leadership literature and reviewed by an expert in organizational leadership. Eleven AT managers (7 males, 4 females; years certified=17.9±8.2; years as manager=7±4.9) participated in two 1-hour videoconference interviews, which were recorded then transcribed via an online transcription platform. Member checks were performed to confirm accuracy, ensure clarity and intention, and offer the opportunity to provide additional information. Transcripts were analyzed through an inductive process, including descriptive, values, and versus coding strategies. Codes were clustered and thematized through a phenomenologically informed process. Operational models were developed to illustrate a network of interconnected ideas.

**Results:** Managers described two distinct contexts in which trust influenced conflict management: stable (ie, coaches, administrators, co-workers, full-time settings) and transient (ie, parents unfamiliar with the AT, per diem settings). In stable contexts, conflict emerged between the AT and another individual with whom the ATs were compelled to build or maintain positive relationships. In these cases, working relationships were valuable to the AT performing their duties and upholding standard of care. Participants emphasized the importance of building and maintaining relationships and social capital prior to conflict emerging. Different forms of social capital are useful in mitigating conflicts between co-working ATs, promoting knowledge sharing and social support, establishing trust and mutual understanding with key stakeholders, providing a sense of embeddedness and enculturation into the broader community, lending credibility and administrative support to ATs' perspectives, and mitigating unfavorable power dynamics. Social capital opens lines of communication, improves conflict management processes, leads to favorable outcomes, and establishes a sense of mutual purpose. In transient contexts, an encounter occurred with an individual unknown to the AT when conflict emerged, and in which an ongoing relationship was either impractical or unnecessary. In these cases, trust had not been previously established. Managers described strategies used by ATs to quickly generate trust and credibility. These experiences are consistent with swift trust theory. The AT's ability to gain trust from strangers was determined by contextual information and norms. Finally, ATs' first impressions were seen as critical in establishing buy-in from stakeholders and preventing conflict when delivering confusing or controversial medical information.

**Conclusions:** Establishing trust is a critical part of managing conflict. The context in which conflict occurs influences the approach to establishing trust. In stable contexts, social capital was an asset to ATs, while in transient contexts, ATs' ability to gain swift trust influences the ability of stakeholders to approach potential conflicts with vulnerability and openness, improving the conflict management process and outcomes.

**Does Student Loan Debt Impact the Achievement of Life Milestones Among Athletic Trainers?**

Del Rossi G, Hatzel BM: Creighton University, Omaha, NE, and Grand Valley State University, Allendale Charter Township, MI

**Context:** Research that examines how student loan debt affects the personal lives of certified athletic trainers following graduation is lacking. The main objective of this study was to determine the extent that education-related debt impacted the attainment of important life milestones among athletic trainers, and secondarily, to examine if the achievement of life milestones differed between females and males.

**Methods:** An online Qualtrics survey developed using constructs addressed in other fields such as medicine and physical therapy was used for data collection. The survey instrument consisted of questions designed to gather demographic information, details related to post-secondary education and student debt levels, and questions to determine if student debt incurred while completing the athletic training degree impacted the ability to attain significant life milestones following graduation. Specifically, respondents were asked if milestones such as pursuing further education, getting married, buying a home, purchasing a car, starting a family, saving for retirement, and building wealth through investments had been delayed because of their student debt load. An external panel of 10 individuals familiar with the student loan process in higher education validated the survey (scale content validity index (S-CVI) = 0.95). The National Athletic Trainers' Association helped distribute the survey to athletic trainers certified over the past 20 years. Data collection occurred over a period of 9 weeks with several reminders sent to encourage participation. The survey was sent to a sample of 18,689 athletic trainers. A total of 2271 recipients completed the survey for a response rate of 12.2%. Of the participants who provided responses to questions related to life milestones, 610 were male and 1378 were female. All other respondents either indicated they had not accrued student debt or did not specify their sex. Data were analyzed with descriptive statistics and comparisons between females and males were made using chi-square analyses with the level of significance set a priori at $P < .05$.

**Results:** Participants reported that life milestones most frequently delayed because of student-debt load included pursuing additional education (35.2% of respondents), starting a family (35.7% of respondents), building wealth through investments (50.0% of respondents), and buying a home (52.6% of respondents). Additionally, a significantly greater percentage of females reported delaying the pursuit of further education compared to males ($\chi 2 = 5.86$, $P = .015$), whereas a greater percentage of males delayed starting a family ($\chi 2 = 6.16$, $P = .013$) and building wealth through investments ($\chi 2 = 12.11$, $P < .001$) as compared to females.

**Conclusions:** The burden of student loan debt results in delays to the achievement of several important life milestones among athletic trainers, but the milestones that are chosen to be delayed differ between females and males.

**Educational Strategies Athletic Trainers Use for Health Literacy Assessment and Patient Education**

Toubman SR, Young JP, Eberman LE, Rivera MJ: Indiana State University, Terre Haute, IN

**Context:** Health literacy plays a vital role in patients' health and dictates their ability to locate, process and understand basic health information to make informed decisions. Athletic trainers in the secondary school (SSATs) setting work with patients with varying health literacy levels. The purpose of this study was to explore SSATs' knowledge of health literacy and integration of best practice behaviors for patient education.

**Methods:** We used a cross-sectional design with a web-based survey that included 10 demographic, 12 patient education practice behaviors, and 10 health literacy knowledge assessment questions. Practice behavior questions identified techniques, strategies, and educational materials used during patient education. Health literacy knowledge assessment questions were developed from best evidence for assessing health literacy including patient education materials reading level, consequences and financial burden of low health literacy, and ways to enhance communication with patients with low health literacy. A Context Validity Index (CVI) was used to assess the demographic questions and practice behaviors questions (S-CVI/Ave = 0.94). A modified Delphi approach, included 3 athletic trainers with related expertise, was used to build consensus across 3 rounds of review on the knowledge assessment questions. Of the 13 original knowledge assessment questions proposed, only 10 had consensus for inclusion in the final instrument. A random sample of 3124 SSATs were recruited using the NATA Research Survey Service. A total of 158 participants started the survey 5% (access rate) while 149 (94.3% completion rate)) completed the survey (age=48±13 years, experience=18±13 years; women=76, men=73). Descriptive statistics were calculated using the measures of central tendency for demographic, practice behaviors, and the health literacy knowledge assessment.

**Results:** The most common patient education strategies participants used were verbal communication (n=108, 72.5%), demonstration, (n=83, 55.7%), and pictures (n=75, 50.3%). The least common patient education strategies participants used were music (n=1, 0.7%) and patient reported outcome measures (n=26, 17.4%). Just over half of participants assess grade level of their own written patient education materials (n=83, 55.7%). Participants mostly learned about health literacy through continuing education (n= 55, 36.9%) or clinical/lived experience (n= 43, 30.1%). The overall score for health literacy knowledge assessment was 1.5±1.1 out of 10 with a high score 4/10, indicating low knowledge on the assessment and impact of health literacy on patient care. The items correctly answered included understanding the average reading level of the U.S. population (n=38, 44.2%) and best practices for reading level of patient education materials (n=25, 29.1%). The health literacy knowledge assessment items and participant responses can be found in Table 1.

**Conclusions:** SSATs scored particularly low on a content validated health literacy knowledge assessment and reported few best practice patient education behaviors raising concerns for how well-prepared athletic trainers are for assessing health literacy and educating patients.

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**Table 1**. Health Literacy Knowledge Assessment

| Item | Frequency Correct | % |
|---|---|---|
| What are the best practices for assessing patient's health literacy? | 0 | 0 |
| What are the best practices when educating patients, for whom English is a foreign or second language? | 2 | 2.3 |
| Which of the following are related to a patient's health literacy levels? | 1 | 1.2 |
| What is the estimated cost and financial burden placed on U.S. healthcare system annually from patients with low health literacy? | 11 | 12.8 |
| What are the negative consequences of low health literacy? | 0 | 0 |
| What is U.S. adult average reading level? | 38 | 44.2 |
| What level should educational resources be written at? | 25 | 29.1 |
| What are the best practices for patient education of elder patients? | 0 | 0 |
| What are the best practices for patient education of minor patients? | 0 | 0 |
| To your knowledge, what ways enhance communication with patients with low health literacy? | 15 | 17.4 |

**Emergency Action Planning for NCAA Division I Rowing: An Examination of Current Practices**

Heller HM, Claiborne TL,Conway D, Scarneo-Miller S: Adrian College, Adrian, MI, and Ann Arbor, MI, and West Virginia University, Morgantown, WV

**Context:** An Emergency Action Plan (EAP) serves as a written document that defines the standard of care in the event of an emergency. The NATA states that members of the sports medicine team have a legal and professional obligation to uphold the standard of care and create emergency plans that protect the participating athletes, as well as the organization or institution involved. With uncontrolled open-water conditions and unique equipment, rowing introduces complex emergency planning challenges. Research suggests that athletic trainers do not consistently uphold recommendations for high quality, venue-specific written EAPs, however, emergency planning best-practices are not well studied for the sport of rowing. Therefore, the purpose of this study was to evaluate whether written EAPs specific to NCAA Division I rowing venues meet current NATA best-practice recommendations.
**Methods:** During this descriptive cross-sectional study, we invited NCAA DI rowing athletic trainers to submit a copy of their EAP, and received a response from 29.2% (26/89) of institutions. We then evaluated whether or not written EAPs included recommended criteria using a checklist derived from the 2002 NATA position statement on emergency planning (Table 1). The proportion of institutions adopting each criteria and overall compliance with the NATA recommendations were calculated. Of the 26 respondents, two institutions stated that they did not have a written EAP to submit; these institutions were included in our data and counted as non-compliant with all recommendations.
**Results:** None of institutions' written EAPs were 100% compliant with all 15 best-practice guidelines (Table 1). The highest proportion of respondents (92%, 24/26) complied with the first recommendation that athletics departments possess a written EAP. Notably, the majority (53.8%, 14/26) of EAPs only planned for on-land emergencies at the boathouse, without consideration for water emergencies. Compliance was also higher (76.9%-87.7%) for recommendations 7-9, which are related to personnel responsibilities, location of emergency equipment, and contact information for EMS. Conversely, only 1 institution developed and coordinated their EAP with internal stakeholders (recommendation #2), external stakeholders (recommendation #3), or specified where the EAP was posted at each venue (recommendation #13).
**Conclusions:** This study provides important insight regarding the current state of emergency planning procedures for NCAA DI rowing programs. Our results align with previous studies at the secondary school and university settings, showing a persistent lack of attention to the entire scope of EAP recommendations. To advocate for emergency planning in all sports and maximize health outcomes, athletic trainers must embrace their professional duty to be directly involved in emergency planning. As a result, future initiatives should work to identify and minimize barriers athletic trainers may face when planning for emergencies and implementing best-practices.

**Table 1:** The Proportion of Institutions that Include NATA Best Practice Recommendations (ref) in their Emergency Action Plan (EAP)

| | Recommended Components of Written EAP | Proportion of Institutions (N=26) |
|---|---|---|
| 1. | The athletics department has a written EAP | 92.3% (24) |
| 2. | Written EAP developed and coordinated with internal stakeholders | 3.9% (1) |
| 3. | Written EAP Developed and coordinated with external stakeholders | 3.9% (1) |
| 4. | Written EAP distributed and reviewed by all relevant athletics staff members annually | 7.7% (2) |
| 5. | Written EAP rehearsed annually | 7.7% (2) |
| 6. | Written EAP updated annually | 7.7% (2) |
| 7. | Written EAP identifies personnel and their responsibilities | 76.9% (20) |
| 8. | Written EAP identifies location of on-site emergency equipment | 80.8% (21) |
| 9. | Written EAP lists contact and location information for EMS | 80.8% (21) |
| 10. | Written EAP recommends plan for post-incident reporting/documentation | 7.7% (2) |
| 11. | Witten EAP includes information for healthcare professionals providing medical coverage included in review/rehearsal | 53.9% (14) |
| 12. | Written EAP includes venue specific emergency plan | 50.0% (23) |
| 13. | Written EAP delineates where the EAP is posted at every venue | 3.9% (1) |
| 14. | Written EAP identifies personnel responsible for ensuring maintenance of emergency equipment | 11.5% (3) |
| 15. | Written EAP includes personnel authorized to approve | 3.9% (1) |

**Emotional Resilience as a Mitigating Factor to Workaholism and Burnout Among Collegiate Setting Athletic Trainers**

Rohl BR, Wood TA, Pitney WA: Northern Illinois University, DeKalb, IL

**Context:** Emotional resilience (ER) is the ability to manage adversity, stress, or trauma and has been proposed as a mitigating factor to workaholism and burnout. Health professionals and secondary school athletic trainers (ATs) with higher ER adapt to stressful situations, more so than those who experience high levels of workaholism and burnout. However, limited knowledge exists regarding the level of ER among ATs in other practice settings, specifically the collegiate setting. Thus, the purpose of this study was to examine the relationship between ER, workaholism and burnout in collegiate ATs.

**Methods:** A cross-sectional online survey was sent to a random sample of 2,000 collegiate ATs by the NATA Research Survey Service. Participants completed the Connor Davidson Resilience Scale (CD-RISC) to measure ER, the Work and Well-being Survey (DUWAS-Short) to measure workaholism, a single item burnout scale, and demographic questions. The maximum score on the CD-RISC is 100. The DUWAS-short is subcategorized into working compulsively (WC) and working excessively (WE); an average of the scores is taken with a maximum of 4. The maximum burnout score is 5. A higher score indicates more ER, WE, WC and burnout, respectively. A Pearson correlation was used to examine the relationship between ER and age and years of certified experience. Another Pearson correlation was used to examine the relationships between ER, WE, WC and burnout. The $\alpha$ level was set a priori at $P < .05$.

**Results:** One hundred fifty-four participants responded to the survey (7.7% response rate) and 149 participants completed the survey (7.45% completion rate). Of these, 59 males (39.6%), 90 females (60.4%) aged 36.53 ± 10.05 years with 13.47 ± 9.75 years of certified experience. The mean ER score was 73.28 ±9.882, WC was 2.889 ± .5415, WE was 2.889 ± .5344 and burnout was 2.66 ± .934. Analysis revealed a significant weak positive correlation between ER and age ($r(147)= .203$, $p=.013$); and years of experience ($r(147)= .181$, $p=.027$). There was no significance between ER and WC ($r(147)= .086$, $p=.297$) or ER and WE ($r(147)= .052$, $p=.526$). There was a significant weak negative correlation between ER and burnout ($r(147)= -.245$, $p=.003$).

**Conclusions:** The positive correlation between ER and age, and ER and years of experience may indicate that ATs are better able to adapt to occupational stressors over time. The negative correlation between ER and burnout indicates that more ER can lead to lower rates of burnout. Regarding ER, neither age nor years of experience are modifiable. Future research should focus on modifiable factors and strategies to improve ER to ultimately reduce rates of burnout and increasing their ability to adapt to occupational stress to increase the longevity of ATs in the collegiate setting.

EC Lane and MN Zimmerman Doctoral Research Grant Program

**Factors Influencing Athletic Trainers Intention to Leave Their Employing Organization**

Young JP, Rivera MJ, Chew AR, Monohan MM, Drescher MJ, Games KE, Eberman LE: Indiana State University, Terre Haute, IN, and North Dakota State University, Fargo, ND

**Context:** The athletic training (AT) workforce has recently shifted, with increasing job vacancies and stagnant workforce matriculation for entry-level professionals. While factors related to athletic training professional retention have been explored, little is known about ATs intent to stay with their employing organization, which may better inform how to retain ATs in the profession. The purpose of this study was to investigate factors that influence ATs intention to leave their employing organizations.

**Methods:** We used a cross-sectional, web-based survey with demographic questions and the Turnover Intention Scale (TIS-6) to meet the aims of the study. The TIS-6 is a 6-item questionnaire, with responses ranked on a 5-point Likert scale, designed to investigate feelings and behaviors related to intent to leave employment. The demographic questions and TIS-6 were validated for AT by a panel of 4 content experts through a content validity index (CVI=1.00). Possible scores on the instrument range from 5-30. Scores greater than 18 indicate an intention to leave, while scores less than 18 indicate an intention to stay. In addition to the TIS-6, participants responded to demographic items and ranked their level of agreement on if they have a "work best friend" (0=Strongly Disagree, 100=Strongly Agree) consistent with the Harvard Study of Human Development. The survey was distributed through the NATA Research Survey Service to 6249 athletic trainers (completion rate = 5.7% (n=354). We analyzed the data using descriptive and inferential statistics to investigate factors that influence ATs intent to leave.

**Results:** : On average, participants were white (84.2%), women (56.8%), roughly 40 years old (SD=12), with 16 years of clinical practice experience (SD=11). Participants scores on the TIS-6 (M=16.54, SD=4.05) did not indicate an intention to leave their employing organization, though 31.6% (n=112) of participants scored greater than an 18, indicating an intention to leave their employer. There was a significant difference (t(347)=1.65, p=.003) in patient volume between those who intended to leave their employer (M=67.27 patient/week, SD=6.49) and those that intended to stay (M=57.03 patients/week, SD=2.97). There was also a significant difference in the level of agreement on the presence of a work best friend, between those who intended to leave their employer (M=55.92 (out of 100), SD=35.45) and those that intend to stay (M=69.50 (out of 100), SD=29.81). There were no significant differences between groups for gender identity, race and ethnicity, age, education, years of experience, clinical practice setting, income, or debt.

**Conclusions:** Our findings suggest one-third of ATs intend to leave their current employer. That intent was by patient load and the presence of a work best friend. Although additional predictive analysis about the degree of influence may be necessary, employers could apply these results by adjusting patient loads and embracing workplace social support through developing friendships.

I received funding from the Indiana State University Graduate Research Fund.

**Factors Influencing Athletic Trainers Intentions to Leave the Profession**

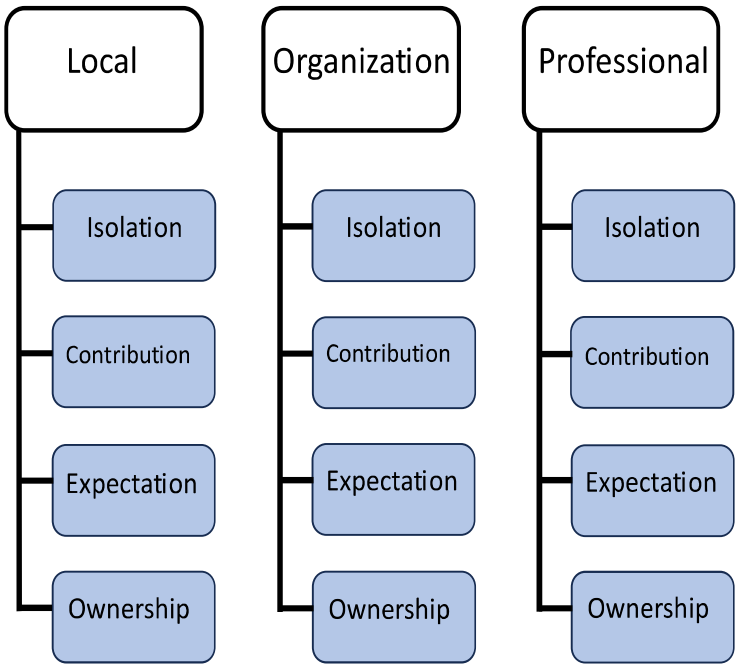
Monahan MP, Rivera MJ, Young JP, Drescher MJ, Chew AR, Eberman LE, Games KE: Indiana State University, Terre Haute, IN, and North Dakota State University, Fargo, ND

**Context:** Athletic trainer (AT) turnover has been a consistent challenge in the profession of athletic training. In healthcare professions the psychological state of burnout, work-life harmony, role ambiguity, and workload have been reported as factors that influence the intent to leave profession; however, limited data exist on the influencers of ATs decision to leave the profession of athletic training. The purpose of our study was to identify the lived experiences of ATs that may influence their intent to leave the athletic training profession.

**Methods:** We used a phenomenological approach to explore the experiences of 32 ATs (14 women, 17 men, 1 prefer not to say; age=40 ±11 years) and their intentions to leave the athletic training profession. We used criterion sampling, practicing ATs, to participate in a web-based survey (Qualtrics, Provo, UT) and a semi-structured interview (Zoom, San Jose, CA). The semi-structured interview protocol was designed using existing literature to capture data on AT lived experiences related to expectations, ownership, and investment in their employing organization and the profession. The script was reviewed internally and externally to establish content validity. Minor revisions were made to the script based on reviewer feedback. Recruitment and data collection continued until data saturation occurred. A 3-member coding team used a multi-phase, consensual qualitative research approach with deductive coding for analysis. The consensus codebook was applied across all 32 transcripts. Member-checking, multi-analyst review, and internal and external auditing were completed to ensure credibility and trustworthiness.

**Results:** We identified three domains regarding factors that may influence ATs intent to leave either their employing organization or the profession (Figure 1). The three domains were: 1) Local Factors, 2) Organizational Factors, and 3) Professional Factors. Local factors accounted for influencers within the community for which an AT worked, while organizational factors accounted for influences within the organization participants worked for. Professional factors were those that had influence at the athletic training profession level. Within each domain, we established four consistent categories: isolation, contribution, expectations, and ownership. Isolation referred to the perceived and real isolation ATs experienced in their workplace, creating distance from colleagues. Contribution described a sense of, or a lack of, doing work that was meaningful. We coded expectations any time a participant described the implicit expectations they had and how those may or may not influence their intent to leave, and ownership when a participant detailed feelings of self-efficacy, accountability, belongingness, or self-identity.

**Conclusions:** ATs reported feelings of isolation and decreased contribution to their local practice community, leading to an enhanced consideration to leave their employment. ATs also reported expectations and isolation at the organizational level prompting thoughts of leaving their current organization but remaining in the profession of athletic training. Based on the data, the expectations, contributions, and feelings of isolation feelings towards the athletic training profession were reportedly less impactful on a participant's intention to leave the profession than interactions at the local and organizational level. Future work should consider developing local and organizational interventions to increase individuals' sense of belonging and contribution. Profession-wide interventions may be less beneficial in altering an individual's intention to leave the athletic training profession.



**Factors That Impact Time to Athletic Trainer Evaluation Following Acute Injury Among High School Athletes: A Report from the Athletic Training Practice-Based Research Network**

Renner MN, Lam KC, Srygler EC, Adler SN, Bell DR: The University of Wisconsin-Madison, Madison, WI, and A.T. Still University, Mesa, AZ

**Context:** Delays in receiving medical care following an acute musculoskeletal injury may lead to worse long-term outcomes. High school athletic trainers (ATs) are in a unique position to provide youth athletes with direct access to care. However, it is unclear what factors are associated with delayed access to an AT evaluation. The purpose of this project was to identify factors that may impact access to care following acute sport-related injuries in the high school setting. We hypothesized that sex, setting where the injury occurred, and sport level will result in longer time from injury to AT evaluation.
**Methods:** This was a retrospective analysis of de-identified patient records within a web-based electronic medical record. ATs who were members of the Athletic Training Practice-Based Research Network created patient records. High school athletes were included if they were diagnosed with an acute sport-related injury by an AT from 2010-2023. Time to AT evaluation was measured as the number of days between injury onset, reported by the patient, to AT evaluation. Mann-Whitney U and Kruskal-Wallis tests were used to examine the effect of sex (male, female), setting (practice, game), and sport level (freshman, junior varsity [JV], varsity) on time to AT evaluation. Alpha was set a-priori at $p < 0.05$. If a significant Kruskal-Wallis was found, separate Mann-Whitney U-tests were conducted to determine where differences occurred with an adjusted p-value (SPSS, $p < 0.017$).
**Results:** A total of 17,354 patient cases representing 20 different sports were reviewed for this report. Descriptive statistics are in Table 1. Overall, 46.9% (n=8,138) of patients who sustained an acute injury during in-season play were evaluated by an AT within 1 day (range=0-14 days). Significant group differences were reported for sex (U=34193622, p <. 001), setting (U=31086141, p < .001), and sport level (H(2)=12.75, p < .01), with females and in-game injuries associated with longer times to AT evaluation. Furthermore, freshmen athletes were evaluated sooner than JV (U=4403938.5, p < .01) and varsity (U=10597839, p < .001) athletes. No difference was observed between JV and varsity athletes (U=23983277, p=0.34).
**Conclusions:** Almost half of patients received medical care within 1 day following an acute injury during in-season play. Factors associated with longer time from injury to AT evaluation included being female, playing at the varsity or JV level, and sustaining an injury during a game versus practice. These differences may be attributable to sex discrepancies in immediate medical coverage between sports and injury reporting patterns among athletes, but future research should evaluate reasons for potential delays in athletic health care in the high school population. Qualified health care is accessible for many student athletes through ATs, and our study highlights how quickly ATs can help enter youth athletes into the healthcare system following injury.

| Independent Variable | | n (%) | Mean ± SD | Median (IQR) | *P* |
|---|---|---|---|---|---|
| **Sex** | Male | 10708 (61.7%) | 1.62 ± 2.59 | 1.00 (2.00) | <.001* |
| | Female | 6646 (38.3%) | 1.81 ± 2.82 | 1.00 (2.00) | |
| **Setting** | Practice | 8930 (51.5%) | 1.51 ± 2.77 | 0.00 (1.00) | <.001* |
| | Game | 8424 (48.5%) | 1.89 ± 2.57 | 1.00 (3.00) | |
| **Sport Level** | Freshman[a,b] | 2051 (11.8%) | 1.56 ± 2.59 | 0.00 (2.00) | .002* |
| | Junior varsity[a] | 4468 (25.7%) | 1.63 ± 2.58 | 1.00 (2.00) | |
| | Varsity[b] | 17354 (62.4%) | 1.69 ± 2.68 | 1.00 (3.00) | |

IQR: Interquartile Range

*significant between groups using Mann-Whitney U or Kruskal-Wallis tests ($p < .05$)

[a,b] signifies significant between group differences ($p < 0.017$)

**How Do Athletic Trainers Learn Clinical Documentation? Athletic Trainer, Supervisor, and Educators' Perspectives**

Nottingham SL, Kasamatsu TM, Welch Bacon CE: University of New Mexico, Albuquerque, NM; California State University Fullerton, Fullerton, CA; A.T. Still University, Mesa, AZ

**Context:** Previous research has identified that athletic trainers (ATs) desire more educational guidance for documentation during both professional education and on-the-job training. Yet, little is known about the actual strategies used by educators and supervisors to help ATs document effectively. Therefore, the purpose of this study was to examine the educational preparation of ATs' documentation practices from multiple perspectives, including novice ATs, educators, and supervisors.

**Methods:** We used a Consensual Qualitative Research (CQR) approach within a multi-case study design to obtain ATs' perceptions of learning clinical documentation. Specifically, we interviewed connected triads of a novice AT (certified ≤1 year), their current supervising AT, and an educator from the professional program the novice AT graduated from to understand their experiences learning, teaching, and practicing clinical documentation. We recruited participants using a combination of purposeful and snowball sampling starting with educators of professional master's programs. Sixteen program directors who listed spring 2021 graduates on the CAATE outcomes website were contacted; 8 responded they were willing to participate, which triggered a progressive recruitment process to novice ATs followed by their supervisors. Four triads, including 12 ATs, participated in the study (9 women, 3 men, age=35.08±9.24 years). Participants averaged 11.66±9.44 years as an AT (educators=17.05±2.50, supervisors=13.75±8.06, ATs=1.00±0.00). Once the connected educator, AT, and supervisor agreed to participate, the principal investigator interviewed each participant via Zoom (audio only) using a semi-structured interview guide. The interview guides were developed and validated by 3 experts in qualitative research and piloted with 3 individuals before data collection. Data were collected until the interviewer perceived that saturation was obtained, and saturation was confirmed by the co-investigators during data analysis. Interviews were transcribed via Zoom and then de-identified and corrected for accuracy before analysis. Three researchers inductively analyzed interviews using the CQR approach through 3 rounds of coding and consensus meetings. We analyzed all data collectively followed by a within-case and between-case analysis of each triad's data, then an external auditor peer-reviewed the data. Trustworthiness was confirmed via an external auditor, multiple-analyst triangulation, and source triangulation.

**Results:** Analysis revealed 4 domains representative of all cases, including 1) learning, 2) electronic medical records (EMRs), 3) differences & accountability, and 4) point-of-care documentation. Related to learning, we found that learning over time through classroom and clinical experience facilitates the transferability of quality on-the-job documentation. Educators use a variety of resources to teach documentation and preceptors serve a critical role in helping students learn documentation. Additionally, EMRs are central to both learning and completing high-quality documentation during clinical practice. Yet, ATs face challenges in learning, navigating, and integrating EMRs into professional education and clinical practice. Participants described that it is common for ATs to use different approaches to documentation, but employer accountability improves consistency within workplaces and learning environments. Lastly, we found that point-of-care documentation is not a strongly implemented behavior, resulting in inefficient documentation practices. Within-case analysis identified consistencies between participant responses, such as ways of learning documentation. However, we also identified inconsistencies within cases, such as supervisors and ATs having different perceptions of employer expectations for documentation.

**Conclusions:** Similar to previous research, we found that employer onboarding and the use of EMRs facilitate effective clinical documentation. While these are important facilitators of documentation, they are implemented inconsistently, and ATs face challenges with EMR use. Standardization and point-of-care documentation continue to be poorly implemented behaviors within the athletic training profession. Additional educational strategies are needed to improve several aspects of clinical documentation, including point-of-care electronic documentation, standardizing quality clinical documentation, and consistently engaging students in patient care documentation during clinical education experiences. Employers and supervisors should provide guidelines and onboarding for documentation standards within their workplace

**How Do We Compare? Athletic Trainers' Perceptions of Occupational Prestige in Athletic Training, Physical Therapy, and Occupational Therapy**

Coleman KA, Strong AL: Southern Connecticut State University, New Haven, CT

**Context:** Athletic training is an allied health care profession recognized by the AMA, Health Resources Services Administration, and the Department of Health and Human Services. Despite this recognition, there is a dearth of information on how athletic trainers (ATs) perceive themselves as health care professionals (HCPs) in comparison to other HCPs. The social standing of a profession is referred to as occupational prestige (OP), and it is usually evaluated as the perception of that profession relative to other occupations. The consideration of OP is especially important as the profession of athletic training is often compared to other health care professions, such as occupational therapy and physical therapy, when deciding on a career path. The purpose of this project was to examine the perceptions ATs have in their OP in relation to other allied health care professions, specifically occupational therapists (OTs) and physical therapists (PTs).

**Methods:** A cross sectional survey design utilizing the Occupational Prestige Scale adapted from the works of Turner, Akinpelu, and Akodu was administered via Qualtrics®. The Occupational Prestige Scale is divided into six dimensions with participants ranking on a scale of 1 to 6 the level of physical stress, income, usefulness to society, responsibility, social status, and personal recognition of ATs, PTs, and OTs. Participants representing traditional and emerging practice settings were recruited (n=1100) using the NATA Research Survey Service. A one-way analysis of variance, with significance level of $\alpha$=0.05, was performed on all six dimensions of the OP scale and the overall OP score, with Tukey post-hoc correction if warranted. Effect size was calculated using eta squared ($\eta 2$) with 95% confidence intervals.

**Results:** A total of 111 respondents (age=41.4±12.1) completed the survey (10.1% response rate). Respondents were majority male (53.2%), of white race (85.6%), and have been practicing for 16 years or more (50.5%). Respondents' mean ratings of individual dimensions and overall OP and main effects statistical data are listed in Table 1. There were significant main effects of profession on OP in five dimensions and overall OP ($p<.001$). There was not a significant main effect on the dimension of usefulness to society. Post-hoc analysis revealed significant differences across professions for all significant main effects, ranging from $P<.001$ to $P=.041$. Effect sizes were all large, with values ranging from $\eta 2=.168$ to $\eta 2=.640$.

**Conclusions:** ATs perceive the profession of Athletic Training as more strenuous, with a lower income, higher responsibility, lower social status, and lower personal recognition than the professions of Physical Therapy and Occupational Therapy. Overall, ATs view the OP of athletic training as significantly lower than both physical therapy and occupational therapy. These findings can be impactful as we navigate the athletic training shortage and recruiting future ATs.

**Table 1. Mean Ratings and Main Effects of Individual Dimensions and Overall Occupational Prestige**

| Dimension of Occupational Prestige | ATs (mean ± SD) | OTs (mean ± SD) | PTs (mean ± SD) | F |
|---|---|---|---|---|
| Physical Stress | 4.75 ± 1.00[a] | 2.85 ± 1.12[b] | 3.59 ± 1.21[c] | $F(2,330)=81.913$, $P<.001$, $\eta^2=.332$ |
| Income | 2.35 ± .940[a] | 4.34 ± .815[b] | 4.70 ± .838[c] | $F(2,330)=237.383$, $P<.001$, $\eta^2=.590$ |
| Usefulness to Society | 5.01 ± 1.04 | 4.77 ± 1.08 | 4.95 ± 1.02 | $F(2,330)=1.619$, $P<.001$, $\eta^2=.010$ |
| Responsibility | 4.97 ± .847[a] | 4.14 ± 1.13[b] | 4.47 ± .989[c] | $F(2,330)=19.586$, $P<.001$, $\eta^2=.106$ |
| Social Status | 2.87 ± 1.22[a] | 4.15 ± .926[b] | 4.99 ± .745[c] | $F(2,330)=130.280$, $P<.001$, $\eta^2=.441$ |
| Personal Recognition | 3.13 ± 1.38[a] | 4.06 ± 1.09[b] | 4.97 ± .948[c] | $F(2,330)=71.040$, $P<.001$, $\eta^2=.301$ |
| Total Occupational Prestige | 3.85 ± .661[a] | 4.05 ± .642[b] | 4.61 ± .621[c] | $F(2,330)=42.333$, $P<.001$, $\eta^2=.204$ |

Abbreviations: ATs, athletic trainers; PTs, physical therapists; OTs, occupational therapists; SD, standard deviation

[a]Indicates a statistically significant difference between ATs and PTs

[b]Indicates a statistically significant difference between ATs and OTs

[c]Indicates a statistically significant difference between PTs and OTs

**How Secondary School Athletic Trainers Attempt to Overcome Barriers Associated With Social Determinants of Health**

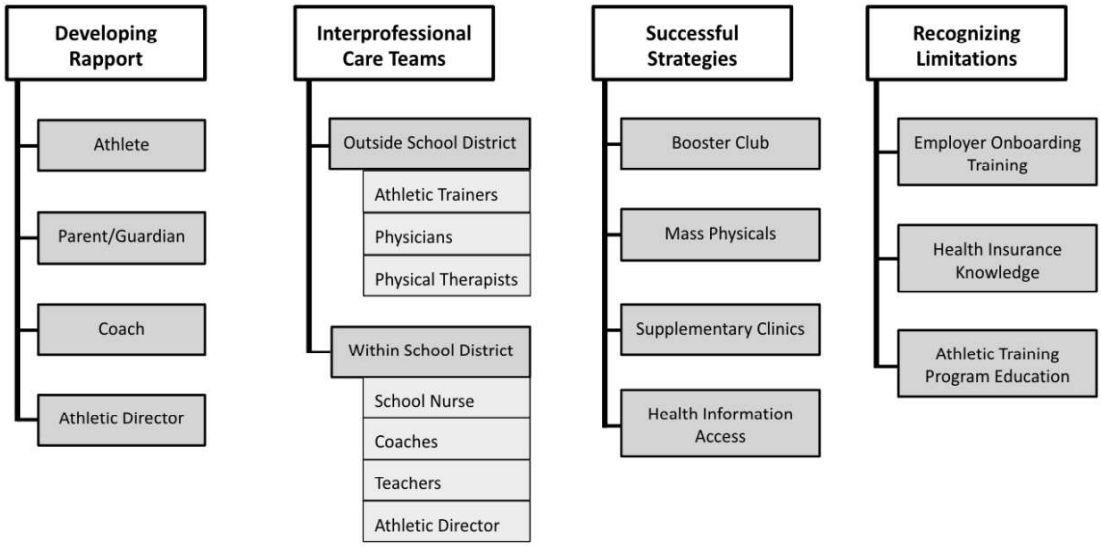
Adler SN, Chambers JS, Srygler EC, Sehmer MN, Bell DR: University of Wisconsin - Madison, Madison, WI

**Context:** Social determinants of health (SDOH) are the social, economic, and environmental factors that influence an individual's overall well-being and access to healthcare. Health disparities represent a critical concern when it comes to public health and the low socioeconomic status (SES) athlete. Common SDOH barriers include delay in health care, health insurance type, healthcare distrust, and geographic location. Athletic Trainers (AT) can help patients overcome these challenges by mitigating barriers in the secondary school setting. The purpose of the study is to explore how ATs recognize barriers associated with SDOH and how they address these barriers in low SES athletes in the secondary school setting.

**Methods:** Following a qualitative study design, semi-structured interviews were conducted with 10 ATs currently practicing in the secondary school setting. Recruitment was completed through social media. Researchers used criterion sampling to identify potential participants, who were screened for inclusion using a web-based survey (Qualtrics, Provo, UT). The research team used best-available literature to develop the semi-structured interview protocol. Lead investigator piloted the script and received feedback to maintain consistency before data collection occurred. The conducted virtual interviews were audio-recorded, transcribed verbatim, and saved to cloud storage (Zoom, San Jose, CA). Recruitment and data collection continued until data saturation was met. The socioecological model (SEM) was applied to explore how ATs recognize and address common SDOH barriers. The data analysis team completed a multi-phase inductive coding process, and recurrent codes were identified and organized into themes and sub-themes. To ensure credibility and trustworthiness of the data, researchers completed member checks, along with multi-analyst triangulation.

**Results:** Analysis of the qualitative data revealed four themes: 1) developing rapport, 2) interprofessional care teams, 3) successful strategies, and 4) recognizing limitations (Figure 1). ATs discussed developing rapport with athletes and parents/guardians as their most accurate way to recognize SDOH barriers. Additionally, ATs relied on coaches and athletic directors for background information on athletes when patient trust had not been established. Within the interprofessional care teams, two sub-themes emerged: outside the school district and within the school district. ATs often utilized local physical therapists, physicians, and other ATs in the care management plan for patient care advice, referrals, and health insurance limitations. ATs sought out individuals within the school district including school nurses, coaches, teachers, and athletic directors for patient care during school hours when the AT was not present. Participants also explained successful strategies for mitigating SDOH barriers, including mass physical nights at a free or reduced cost, booster club equipment and supply donations for their athletic training facility, access to patient health information, as well as supplementary clinics on the weekends to avoid parents'/guardians' need to request time off work for medical appointments. The final theme that emerged from the interviews was AT limitations in attempting to overcome barriers associated with SDOH. One out of ten ATs felt confident in providing health insurance education and navigation to their patient and family. As a result, most participants had limited involvement in this aspect of patient care. Furthermore, most ATs felt their athletic training program and employer onboarding training lacked sufficient education on SDOH and associated topics.

**Conclusions:** ATs should strive to develop quality relationships and trust with not only their athletes, but parents/guardians and coaches through an open line of communication. ATs should also utilize other healthcare professionals, along with staff at their school to assist in patient care. Majority of the participants in the study reported limited athletic training program education and employer onboarding training in addressing SDOH in student-athletes. Thus, successful strategies in patient care came from experience through patient rapport, interprofessional team collaboration, and supplementary healthcare opportunities.



**Initial Development and Validation of the Perception of Quality Patient Care (PQPC) Scale Among Collegiate Athletic Trainers**

Cairns AH, Lininger MR, Eason CM, Singe SM: University of Connecticut, Storrs, CT, and Northern Arizona University, Flagstaff, AZ

**Context:** The literature identifies many contributors to the athletic trainer's (ATs) well-being, including increased stress, work-family conflict, and burnout. Deficient from the literature is an understanding of the possible impact of these contributors on the quality of patient care thus the purpose of this study is to construct a scale that measures the ATs perception of quality patient care delivered and determine its level of validity.

**Methods:** This study followed instrument development best practices to develop a scale that measures the ATs perception of quality of patient care (PQPC) delivered to their student-athletes. The domain identified was clinicians' perception of quality of patient care, with deductive methodologies. This method allowed the current literature to guide the potential influences of quality patient care, which resulted in the developed scale items. A cross-sectional survey, through Qualtrics LLC, was utilized to collect the dependent variables; demographic information (14 items) as well as the newly developed independent variable; instrument items (33 items). Collegiate ATs were recruited through an email database created by the researchers, provided by public staff directories. 3,900 emails were sent in March 2023, 260 participants began the survey (7% response rate), and 248 were completed (95% completion rate). The data was downloaded into Excel, filtered for incomplete responses, and 201 responses remained and were analyzed with SPSS. The sample resulted in 63.7% females, 36.3% males, with a mean age of 33± 9.8 (range 22-72). An Exploratory Factor Analysis (EFA) was conducted to determine the underlying dimensionality and factor structure of the data as measures of construct validity. Reliability estimates were also determined for retained factors.

**Results:** Two hundred and one participants completed the questionnaire. After successful assumption testing, a principal axis factoring extraction was employed yielding a 6-factor model, with 29 items, explaining over 36% of the variance in ATs perception of quality of patient care. The 6 factors included: Personal and Professional Resources (7 items), Institutional Infrastructure (7 items), Workplace Dynamics (8 items), Support and Resiliency (3 items), Home Influence (2 items), and Team Physician Influence (2 items).

**Conclusions:** The EFA resulted in the PQPC scale not being unidimensional in nature, rather a 6-factor model best measured the construct of interest. The Personal and Professional Resources factor includes patient care satisfaction, self-care, time, compensation, professional development, benefits, and staffing. The Institutional Infrastructure factor includes workload, responsibilities, and organizational conflict. The Workplace Dynamics factor includes resources, support, culture, and access. Support and Resiliency includes family/spouse support, general support and resiliency. The Home Influence factor includes home responsibilities. The final factor names Team Physician Influence includes conflict, and access of the team physician. The PQPC scale (29 items) will undergo final validation in a future study utilizing Confirmatory Factor Analysis (CFA).

**Minority Students' Perception of Athletic Training Programs Recruitment and Retention Strategies**

DeBerry JL, Daniels MR, Armstrong KJ: The Ohio State University, Columbus, OH; Lincoln University, Oxford, PA; James Madison University, Harrisonburg, VA

**Context:** A lack of diversity within healthcare professionals has been identified as a necessary step in improving the health outcomes of diverse patients. Within athletic training (AT), the need exists to specifically increase the diversity of credential holders (including racial minorities and sexual and gender minorities). In order to increase the diversity of practicing clinicians, professional programs must attract, admit, and retain a diverse cohort of applicants. Therefore, the purpose of this investigation was to explore the recruitment and retention strategies used by the Commission on Accreditation of Athletic Training Education (CAATE) accredited professional athletic training programs that influenced minority students' decision to enroll and matriculate through a graduate program.

**Methods:** We used a cross-sectional survey design. CAATE accredited professional AT program directors (January 2023, n = 262) were emailed with a request to forward the email survey link to their current students. A total of 153 AT students accessed the survey, with 125 responding (81.7% completion rate). This survey included 8 demographic questions, 2 items pertaining to recruitment strategies, 2 items regarding retention strategies, and open-ended questions regarding additional strategies used for recruitment or retention. Cronbach's alpha determined internal consistency, $\alpha = 0.880$. Descriptive statistics were computed for all items. A Kruskal-Wallis or Mann-Whitney U test determined differences between demographic variables and recruitment and retention strategies.

**Results:** Overall, 59.6% (n=90) of respondents identified as Caucasian and 40.7% identified as racially diverse. The most important factors regarding recruitment included in-state tuition costs, scholarships offered, and the variety of clinical placements offered. Regarding retention, the learning environment, diversity of faculty and preceptors, diversity of college/university, and diversity of students within the program were most important. A Mann Whitney U revealed significant differences regarding recruitment strategies, where LGBTQIA+ respondents reported personal tours (Z=-2.18, p=.029), in-state tuition (Z=-2.13, p=.02), and housing costs (Z=-2.81, p=.005) important than heterosexual respondents. Additionally, a Kruskal-Wallis revealed that racially diverse respondents reported employment during enrollment (H=11.07, p=.004), availability of scholarships (H=7.12, p=.028), and distance of clinical placements (H=6.73, p=.035) as important more than Caucasian respondents. Regarding retention factors, A Kruskal-Wallis determined that racially diverse respondents reported significant differences were reported diversity of the students within the program (H=11.02, p=.004), faculty diversity (H=9.58, p=.008), and student diversity of the institution (H=5.99, p=.05) more than Caucasian respondents.

**Conclusions:** The first step to increasing diversity in AT credential holders is to increase the diversity of applicants within professional programs. Key considerations for recruitment include the availability of scholarships, tuition, and housing costs. Retention considerations include diversity of faculty and students both within the program and institution. It is imperative for AT educators to consider recruitment and retention strategies that allow minority students to foster a sense of belonging within the program.

Women in Athletic Training Research Endowment: $1,000 (Grant number: #2122MGP04)

**Organizational Culture and Job Satisfaction in Athletic Training Program Preceptors**

Schroeder LH, Bowman TG, Richardson E, Gordon J: University of North Carolina Wilmington, Wilmington, NC, and University of Lynchburg, Lynchburg, VA

**Context:** Role strain, organizational conflict, and workplace bullying may negatively affect athletic training preceptors, interfering with their ability to fully mentor, guide, and support students preparing to enter into the athletic training profession. To date, no investigation has sought to determine organizational culture experiences or job satisfaction specifically for preceptors. Therefore, we investigated how motivational factors related to healthcare professionals' precepting roles influence these outcomes.

**Methods:** We employed a cross-sectional online survey consisting of three sections: demographic information; a 36-item Likert scale job satisfaction survey (JSS; internal consistency reliability 0.91, test-retest reliability 0.71, discriminant and convergent validity correlations were conducted)1; and a 40-item ranking organizational culture survey (OCP; Spearman-Brown reliability range: .84 to .94, test-retest reliability .61, discriminant validity was utilized).2 For the JSS, participants indicated agreement on items using a 6-point Likert-type scale (1 = Disagree Very Much; 2 = Disagree Moderately; 3 = Disagree Slightly 4 = Agree Slightly 5 = Agree Moderately; 6 = Agree Very Much). The OCP contained 40 characteristics with which respondents described themselves. Items were hierarchically ranked from "most" characteristic on top to "least" characteristic on bottom. A names/email addresses database of university-based athletic trainers was created using an email extractor extension in Google Chrome. Recruitment emails were sent to 5,704 athletic trainers with a link to a self-administered Qualtrics survey through convenience sampling. Two subsequent reminders followed the initial contact. We collected partial study data from 841 participants (access rate = 14.7%), of whom 285 completed the survey (5.0% response rate; 33.9% completion rate; n=58 preceptors; men=107 (37.5%), women=178 (62.5%); age=34.8±9.9 years; employment setting = 99 NCAA DI (34.7%), 54 NCAA DII (18.9%), 84 NCAA DIII (29.5%), and other = 48 (16.9%). We used nonparametric Mann-Whitney U tests comparing overall job satisfaction, job satisfaction subsets (pay, promotion, supervision, fringe benefits, contingent rewards, operating conditions, coworkers, nature of work, and communication), and organizational culture (dependent variables) between those serving as preceptors vs. those who did not serve (independent variable).

**Results:** Descriptive statistics for the dependent variables across groups and statistical results for group comparisons are found in Table 1, with significant group differences in promotion (U=8742.00, z=-2.03, P=.04, r=-.12) and conditions (U=9975.00, z=-2.38, P=.02, r=-.14) with small effect sizes. All other comparisons were not significant (P > .05).

**Conclusions:** Job satisfaction and organizational culture scores were all in the ambivalent range or worse, regardless of group. Working conditions appear as a concern irrespective of preceptor status. Efforts to improve athletic training working conditions should continue, focusing on job satisfaction and organizational culture. Athletic training program directors should choose preceptors carefully, ensuring they are suitable professional role models for students.

**Table 1.** Descriptive statistics for the dependent variables across grou comparisons

| Dependent Variable | Group | Median | IQR | U | z | P | r |
|---|---|---|---|---|---|---|---|
| Job Satisfaction | P | 136 | 127, 146.25 | 9943 | -.29 | .77 | -.02 |
| | NP | 137 | 127, 147 | | | | |
| Salary | P | 14 | 13, 15 | 9165.5 | -1.44 | .15 | -.09 |
| | NP | 14 | 13, 14 | | | | |
| Promotion | P | 12 | 10, 14 | 8742 | -2.03 | .04 | -.12 |
| | NP | 13 | 10, 14 | | | | |
| Supervision | P | 14 | 13.75, 15 | 9978.5 | -.25 | .81 | -.01 |
| | NP | 14 | 14, 15 | | | | |
| Fringe Benefits | P | 14 | 13, 15 | 9565.5 | -.85 | .40 | -.05 |
| | NP | 14 | 13, 15 | | | | |
| Contingent Rewards | P | 14 | 12, 16 | 9926.5 | -.31 | .75 | -.02 |
| | NP | 15 | 12, 16 | | | | |
| Conditions | P | 15 | 14, 17 | 8502 | -2.38 | .02 | -.14 |
| | NP | 15 | 13, 17 | | | | |
| Coworkers | P | 19 | 16.75, 22 | 9975 | -.24 | .81 | -.01 |
| | NP | 19 | 16, 21 | | | | |
| Work Itself | P | 20 | 18, 22 | 9627 | -.75 | .46 | -.04 |
| | NP | 20 | 17, 22 | | | | |
| Communication | P | 15.5 | 12.75, 19 | 10079 | -.09 | .93 | -.01 |
| | NP | 16 | 13,19 | | | | |

Abbreviations: P = Preceptor, NP = Non-Preceptor
*P > .05

**Partly Cloudy: Forecasting Public Evidence of Mental Health Best Practices in the Sun Belt Conference**

Hellinger JR, Stonerook LG, Marshall AN, Howard JS: Appalachian State University, Boone, NC

**Context:** The NCAA "Interassociation Consensus Document: Mental Health Best Practices - Understanding and Supporting Student-Athlete Mental Wellness" was published in 2016 and revised in 2020. This checklist identified four key areas of best practice related to student-athlete mental wellness. However, it is unclear how transparently these best practices have been implemented across NCAA athletic departments and institutions. Therefore, the purpose of this study was to evaluate the frequency of publicly available evidence of fulfillment of these d best practices within the Sun Belt Athletic Conference.

**Methods:** This was a cross-sectional pilot study examining publicly available information for the 14 members of the Sun Belt Athletic Conference. From the Interassociation Consensus Document a 24 item checklist of best practice was used that addressed Area 1 - Clinical Licensure of Practitioners Providing Mental Health Care (5 items), Area 2 - Procedures for Identification and Referral of Student-Athletes to Qualified Practitioners (13 items), Area 3 - Pre-Participation Mental Health Screening (3 items), and Area 4 - Health-Promoting Environments that Support Mental Well-Being and Resilience (3 items). Two reviewers searched public websites to identify evidence of best practice implementation based on the checklist. Athletic department websites were reviewed first, and if the item could not be located, institutional websites were reviewed. When neither reviewer was able to locate evidence for an item, a third reviewer evaluated websites to confirm absence of evidence. Descriptive data regarding item fulfillment and location of information was recorded. Frequency counts for fulfillment were tabulated by item and area.

**Results:** Across institutions there was evidence of fulfillment for a mean of 8/24 items (33%) with a minimum of 1/24 (4%) and a maximum of 12/24 (50%). Results by checklist area are summarized in the table. Key findings included the following: all institutions reported access to "licensed practitioners who are qualified to provide mental health services"' with 11/14 (79%) institutions reporting access via athletics and 3/14 (21%) only reporting institutional access; only 7/14 (50%) had identifiable emergency action plans, and no athletic department presented a mental health emergency action management plan; although 6/14 (43%) showed evidence of screening for mental health disorders during the pre-participation exam, most of these were limited to disordered eating, and no processes related to referral of at-risk student-athletes identified through screening were identified.

**Conclusions:** Although a lack of publicly available evidence of fulfillment of best practices does not preclude these practices from still occurring, the lack of transparency in both practice and advocacy for mental well-being is counter to current recommendations. Additionally, the lack of clear policies and procedures on athletic websites, despite many housing student-athlete handbooks, calls into question whether employees and student-athletes themselves have access to information concerning available mental health resources and policies.

**Supervisor Authority and its Impacts on Equity, Diversity and Inclusion in Athletic Training**

Jean TO, Young JY, Edler Nye JR, Nye EA, Eberman LE: Indiana State University, Terre Haute, IN, and Grand View University, Des Moines, IA

**Context:** The demographic landscape of the United States is changing daily and the demand for representation in today's workforce is both a moral and practical imperative for creating workplaces diverse in thought, expression, and people. The imperative must be matched with inclusive workplace practices. The purpose of this study was to investigate workplace culture and the direct and indirect influence of supervisors on inclusion of minoritized communities, including those who have experienced marginalization for race, ethnicity, religion, national origin, age, marital status, ability, sexual orientation, sex, gender, gender identity and expression, socioeconomic status, spirituality, political affiliation, literacy, or the intersectionality of multiple identities.

**Methods:** We used a consensual qualitative research (CQR) design with semi-structured interviews to investigate workplace culture and the direct and indirect influence of supervisors on inclusion of minoritized communities. Eighteen participants were recruited through direct contact via their public domain email addresses that are located on college/university websites. Demographic data was collected through a web-based recruitment survey (Qualtrics Inc., Provo, UT), which was also used to schedule an interview on an audio Zoom conferencing software (Zoom Video Communications Inc, San Jose, CA). We used the multi-phased CQR tradition to identify domains and categories representative of the data, then characterized the commonality of responses by category. Trustworthiness of the data was established through the researchers' acknowledging biases throughout the research process, member-checking, as well as internal and external auditing.

**Results:** Three domains and their respective categories emerged regarding the direct and indirect impacts of supervisors on diversity, equity, inclusion, and accessibility (DEIA): 1) Environment, 2) Resources, and 3) Perceptions. The environment domain spoke to the culture each supervisor created through relationship building and intention; intention was further characterized as active or passive behaviors whereby almost all participants described both (Table 1). The environment was also supported through structural efforts, specifically the existence and implementation of DEIA policies and procedures, training, hiring and retention. Only one-third of participants referenced DEIA policies and procedures within their organization to support their efforts of workplace inclusion. The resources domain represented the existence and awareness of organizational DEIA resources, or lack thereof. The perceptions domain characterized the beliefs of the supervisors relative to DEIA, where about half of participants indicated equality as being sufficient to create an inclusive workplace. Two-thirds of participants described efforts to create inclusive patient care when asked about workplace inclusion, suggesting a perceived equivalency between efforts of both patient and employee inclusion. A little over half of participants responded to the interview questions limiting their responses to populations of differing race, ethnicity, and sexual orientation, and were not reflective of other minoritized communities even upon follow-up questioning.

**Conclusions:** Supervisors have a vital role in creating an inclusive workplace. Although many participants were able to communicate the intentional actions they take to create that environment, many also relied on passive means. Structural efforts must include the creation and implementation of policies and procedures for employee inclusion, not just patient inclusion. The awareness and use of organizational resources is an important component to support supervisor efforts and should be leveraged from within the unit. Most importantly, workplace inclusion should recognize all potentially marginalized communities, not just those that might be recognized by phenotype.

I received funding from the Indiana State University Graduate Research Fund.

**Table 1. CQR Results**

| Domains, Categories, & Subcategories | Frequency Count | Characterization |
|---|---|---|
| Environment | | |
| Culture | | |
| Relationship Building | 77.78% (n=14/18) | Typical |
| Intention | | |
| Active Behaviors | 94.44% (n=17/18) | General |
| Passive Behaviors | 88.89% (n=16/18) | Typical |
| Structure | | |
| Policies & Procedures (P&P) | | |
| Described P&P | 33.33% (n=6/18) | Variant |
| Described No P&P | 33.33% (n=6/18) | Variant |
| Training | | |
| Onboarding | 16.67% (n=3/18) | Rare |
| Professional Development | 72.22% (n=13/18) | Typical |
| Hiring & Retention | 61.11% (n=11/18) | Typical |
| Resources | | |
| Use | | |
| Used Resources | 66.67% (n=12/18) | Typical |
| Did Not Use Resources | 50.00% (n=9/18) | Variant |
| Awareness | | |
| Aware of Resources | 77.78% (n=14/18) | Typical |
| Unaware of Resources | 44.44% (n=8/18) | Variant |
| Perceptions | | |
| Equality is Enough | 50.00% (n=9/18) | Variant |
| Patient Inclusion is Provider Inclusion | 66.67% (n=12/18) | Typical |
| Limited Beliefs on Diversity | 61.11% (n=11/18) | Typical |

**The Relationship of Emotional Intelligence to Burnout and Related Factors in Healthcare Profession Students**

Taylor MJ, Andreatta R, Woltenberg L, Cormier M, Hoch JM: University of Kentucky, Lexington, KY

**Context:** Healthcare profession (HCP) students experience higher rates of stress and burnout than age-matched peers, resulting in detrimental effects on academic performance, mental health, and quality of life. Emotional intelligence (EI) is a trainable skillset demonstrated to protect against burnout in medical residents, improve psychological well-being in HCP students, and decrease anxiety and stress in healthcare professionals. To explore EI's utility as a tool for burnout mitigation in HCP students, the purpose of this study was to determine the relationship between EI and burnout in an interdisciplinary sample of HCP students and identify variables related to both constructs.

**Methods:** This cross sectional survey study included students from 8 HCP programs. Participants completed a demographics form (personal/school related variables), the Trait Emotional Intelligence Questionnaire-Short Form (TEIQue-SF), Oldenberg Burnout Inventory-Student (OLBI-S), and RU-SATED scale. The TEIQue-SF, OLBI-S, and RU-SATED are valid and reliable measures of EI, burnout, and sleep health (respectively). Descriptive statistics (Table 1) were determined for outcome measures and demographics. Separate independent t-tests were used to establish differences in TEIQue-SF and OLBI-S scores between stage in program (year 1-3/year 4-6), discipline (collapsed into rehabilitation/medicine), clinical status (yes/no), EI education history (yes/no), and mindfulness practice (yes/no). Pearson's correlations were performed to examine relationships between TEIQue-SF, RU-SATED and OLBI-S scores. A backward linear regression analysis was then performed with OLBI-S as the dependent variable (predictor variables with significant association to OLBI-S scores ($r > 0.20$) were included). Data were collected via REDCap and analyzed using SPSS software (v28.0, Chicago, IL., USA).

**Results:** There was a significant difference in TEIQue-SF between HCP students who reported previous EI education and those who did not ($t=-2.397$, $p=.018$) and a significant difference in both EI and burnout (OLBI-S) between those who reported mindfulness practices and those who did not ($t=-3.717$, $p<.001$; $t=3.387$, $p<.001$). A large negative correlation was identified between TEIQue-SF and OLBI-S scores ($r=-.591$, $p<.001$), a medium positive correlation between TEIQue-SF and RU-SATED scores ($r=.379$, $p<.001$) and a small negative correlation between OLBI-S and RU-SATED scores ($r=-.278$, $p<.001$). Regression analysis revealed that TEIQue-SF scores and age accounted for 36% of the variance in OLBI-S scores. On average, while controlling for mindfulness, gender and age, for every 1-point increase in burnout, EI decreased by .194 points ($p<.001$).

**Conclusions:** HCP students with higher EI demonstrated reduced burnout; our regression model indicated that EI and age were significant predictors of burnout. Previous EI learning and mindfulness practice demonstrated significant differences in EI, identifying both as noteworthy factors related to EI. Previous EI education contributes to elevated EI, demonstrating EI's trainability. Overall, these findings suggest that greater EI may have a positive impact on burnout and well-being in HCP students. Educational interventions aimed to improve EI should be explored.

**Table 1: Descriptive Statistics** (mean ± SD or count) **for Demographic Variables and Outcome Measures**

| | AT | PT | OT | SLP | RHB | MD | PA | RN | NP | MED |
|---|---|---|---|---|---|---|---|---|---|---|
| ***n*** | **11** | **25** | **6** | **4** | **46** | **38** | **16** | **35** | **12** | **101** |
| **Age** (yrs. ± SD) | 22.8 (3.53) | 24.0 (2.26) | 22.8 (0.41) | 21.5 (1.73) | 23.35 (1.99) | 24.6 (1.42) | 25.7 (5.07) | 21.7 (3.75) | 29.4 (2.84) | 24.36 (4.01) |
| **Male** (ct) | 5 | 9 | 0 | 0 | 9 | 4 | 1 | 2 | 14 | 16 |
| **Female** (ct) | 5 | 16 | 6 | 4 | 27 | 12 | 31 | 10 | 31 | 80 |
| **NB/GNC/IDW** (ct) | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 5 |
| **Clinically Active** (ct) | 9 | 11 | 3 | 2 | 17 | 0 | 22 | 8 | 25 | 47 |
| **Years 1-3** (ct) | 7 | 24 | 3 | 4 | 37 | 28 | 16 | 11 | 10 | 75 |
| **Years 4-6** (ct) | 4 | 1 | 3 | 0 | 9 | 10 | 0 | 14 | 2 | 26 |
| **Previous EI Ed** (ct) | 8 | 8 | 2 | 0 | 18 | 9 | 10 | 10 | 1 | 30 |
| **Mindfulness px** (ct) | 4 | 12 | 4 | 2 | 22 | 21 | 9 | 21 | 7 | 58 |
| **TEIQue-SF** Total score mean (SD) | 148.55 (19.64) | 151.64 (19.84) | 156.67 (17.47) | 163.00 (15.43) | 152.54 (19.02) | 158.34 (23.09) | 157.94 (11.57) | 151.37 (18.60) | 151.50 (20.61) | 155.05 (19.84) |
| **OLBI-S** Total score mean (SD) | 41.18 ( 8.90) | 39.80 (7.11) | 41.17 (3.82) | 37.25 (8.96) | 40.09 (7.27) | 38.29 (7.16) | 40.44 (5.19) | 39.89 (6.33) | 42.75 (6.38) | 39.71 (6.56) |
| **RU-SATED** Total score mean (SD) | 8.18 (2.48) | 9.04 (2.28) | 7.83 (3.25) | 9.00 (1.83) | 8.67 (2.40) | 9.55 (1.89) | 7.44 (3.05) | 8.29 (1.99) | 8.08 (3.03) | 8.60 (2.39) |

Abbreviations: Athletic training (AT), physical therapy (PT), occupational therapy (OT), speech language pathology (SLP), physician (MD), physician assistant (PA), nursing (RN), nurse practitioner (NP), rehabilitation (RHB: AT, PT, OT, SLP collapsed), medicine (MED: MD, PA, RN, NP collapsed), Previous emotional intelligence or emotions education/training (Previous EI Ed), engage in mindfulness practices (Mindfulness px)

**The Sociocultural Structures That Impact Women Athletic Trainers' Experiences in the Workplace**

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**Context:** While the majority of athletic trainers are female, the profession is historically a male-dominated industry. Research demonstrates that many women leave the profession between 28 and 35 years of age. Reasons for this phenomenon have been examined using traditional researcher-centered approaches; however, this prominent issue remains. In 2019, the Strategic Alliance Research Agenda Task force for athletic training identified vitality of the profession as a research priority and recommended increased research-clinician collaborations. This study used participatory inquiry to examine the sociocultural structures that impact women athletic trainers in the workplace.

**Methods:** Using a critical feminist framework, this study disengaged from traditional researcher-led projects to utilize a participatory inquiry approach to knowledge production. Participatory methodologies employ an inclusive approach to research, working collaboratively with community members through the entirety of the research process. This approach allows for in-depth insights, accurate interpretation of data, and can lead to actionable steps that can be implemented into practice. During this study, 8 clinically-practicing athletic trainers who identified as women examined the individual, organizational, and sociocultural factors that impacted their experiences in the workplace. For over 5 months, data were collected through a series of virtual meetings, journal entries, and a private WhatsApp text conversation. An in-depth critical structural analysis was conducted to understand the individual, organization, and sociocultural factors that impacted women athletic trainers in the workplace. This presentation focuses on the sociocultural structures that constrain women athletic trainers in the workplace.

**Results:** Three sociocultural structures that impact women athletic trainers in the workplace were identified: (a) structures of gender, (b) culture of over-dedication, and (c) culture of respect. Structures of gender were deeply rooted in patriarchy, stemming from the historical foundations of the profession. Experiences described centered around gender roles, sexism, and inappropriate behavior toward women in the workplace. Culture of over dedication described a strong sense of professional identity, working excessive hours, and feelings of not being able to take time off work. Women in this study resisted the gendered, patriarchal structures of athletic training through a culture of respect. They sought a work culture that recognized and respected their value as healthcare professionals as well as their desire for work-life balance. Data analysis revealed acts of opposition toward historical structures of the profession, which permeated the dialogue throughout the study. Despite resistance to structures of gender and culture of over dedication, data analysis unveiled unintended consequences of action that reproduced these structures. To avoid conflict and create easier work environments, instances of reproduction of gender-related power structures occurred. Some women in the community seemed to have an almost innate, obligatory tendency toward extreme dedication to their work.

**Conclusions:** The findings of this study suggest that women athletic trainers' experiences in the workplace are shaped by the historical culture, social structures, and expectations of a male-dominated patriarchy. The implications and knowledge gained in this study are valuable for women athletic trainers, athletic training leadership, employers, and researchers as it can help address and change patterns and structures that negatively impact the experiences of women athletic trainers in the workplace. Outcomes of this study could inform changes that could help with retention of women athletic trainers in the field and benefit all those in the profession who seek a more sustainable work environment. This study also demonstrated the feasibility of conducting a participatory research project with clinically-practicing athletic trainers and its usefulness in gaining in-depth insights of research topics and achieving relevant, action-oriented outcomes. While there is robust use of evidence-based medicine and collaborative athletic training research, the use of participatory methods would allow for increased collaborative opportunities and more equitable approaches to knowledge creation.

**Who Serves Those Who Serve? The Availability of Athletic Trainers in Reserve Officers' Training Corps Programs**

Carbone C, Sacko RS, Uriegas NA, Fraley AL: University of South Carolina, Columbia, SC, and The Citadel, Charleston, SC

**Context:** The Reserve Officers' Training Corps (ROTC) consists of collegiate programs to prepare physically-active Cadets to become officers in the United States (US) military. Due to rigorous branch-specific physical activity training sessions, this population is susceptible to musculoskeletal injuries with injury rates similar to their collegiate-athlete peers. However, ROTC cadets are more likely to miss training sessions and miss training time due to a lack of access to athletic training (AT) services, a standard level of care for collegiate athletes. Despite a substantial number of ROTC programs nationwide, previous research indicates a lack of awareness regarding healthcare access among Cadets. Therefore, the primary aim of this study was to identify the access of AT services provided to ROTC programs within the US.

**Methods:** This study used a cross-sectional survey design to assess AT availability utilizing a verbal phone-based survey. Professors of Military Science and Senior Enlisted Staff were contacted; a description of the athletic training profession was included, followed by survey questions on access to AT services, roles and responsibilities of the AT, employment details, accessibility to other healthcare resources, and future intentions regarding ATs. Data collection occurred during the fall and spring semesters of the 2022-2023 academic year. Of the 1,008 identified collegiate ROTC programs in the US, 74% (746 programs) were contacted by phone and voicemail and had the opportunity to reply and provide responses over a 4-month timeframe. Non-respondents constituted a substantial portion of programs, with 21 choosing to participate.

**Results:** Completed surveys extended nationwide, reflecting a diverse geographical distribution of responses. Eighty percent reported not having access to an AT. Additionally, the majority of responding programs conducted physical training sessions 3-5 times per week; however, only 4 of the 21 programs reported having ATs available or present for these training sessions. All 21 respondent programs reported access to alternative healthcare services in the absence of ATs, with 11 programs expressing satisfaction with their healthcare access. Fifty percent responded favorably to adding an AT to their program in the future.

**Conclusions:** Survey results shed light on the availability of ATs in collegiate ROTC programs, revealing that a minority of programs have access to AT services. The limited response rate makes it challenging to draw definitive conclusions regarding AT availability; however, if this trend persists among non-respondent programs, it suggests that the majority lack AT support to ensure the health of Cadets. The low response rate may be attributed to factors such as time constraints, communication preferences, and reluctance to disclose the absence of AT availability. While only a few programs reported having designated ATs, half of the respondents expressed a desire for future AT implementation, emphasizing the need for more consistent, knowledgeable healthcare and reduced injury wait times.

NATA Foundation Master's Grant

**Women Athletic Training Business Owners: A Narrative Case Series**

Curry AL, Young JP, Mair KEF, Eberman LE: Indiana State University, Terre Haute, IN, and Go4, Claymont, DE

**Context:** Historically, women athletic trainers (ATs) have left the profession around age 28, while men ATs tend to shift settings in their 40s. Generally, ATs have left the athletic training workforce after age 30. However, much has changed over the last decade and ATs have expanded their practice settings to include independent business ownership. Little is known about this setting, particularly for women. This case series aims to describe the experiences of women ATs who own a business.

**Methods:** We used a narrative case series with a multiphase semi-structured interview to meet the aims of the study. Five women AT business owners (age=37±11 years; years in business=9±10 years) participated in the interviews, sharing their experiences as ATs and AT business owners, while describing current business ventures and goals for the future. We analyzed data using a qualitative, narrative approach to describe the experiences of each participant.

**Results:** While we did not conduct a thematic analysis because of the study design, there were notable similarities across all cases. All cases indicated they had exposure to various clinical practice settings in the past, prior to and while engaged in business ownership. All cases also reported experiencing gender-based discrimination, a lack of clinical practice autonomy, struggles with work-life integration and work-family conflict. No participant had or pursued coursework in business but indicated they sought various levels of mentorship or training prior to starting their business. Though cases shared similarities, their paths towards business ownership and the products they deliver were unique to each, depending on life experiences, personal needs, and interests. Case 1 reported "chronic, professional burnout", exacerbated by an accident, as the catalyst for considering an alternative professional pathway. Case 1 provides sports medicine services and manages 3 employees. She works extensive hours each week but feels she is better able to compartmentalize her time and integrate work with life as a business owner. Case 2 started her sports medicine business over 20 years ago and more recently started a second business in which she teaches fitness classes and does aquatic therapeutic rehabilitation. Case 2 is not engaged in either business full-time, but experiences improved work-family balance and better financial stability while taking on a few business clients "on the side" of primary role as a teacher. Case 3 started her business following a period of "feeling overwhelmed" in her athletic training position. Working in an outreach position contracted to different schools, she experienced last minute schedule changes that created work-family conflict. She transitioned to business ownership with support and mentorship from family members who are also business owners. Case 4 desired more clinical practice autonomy, schedule flexibility, financial freedom, and joy in life, leading to her business ventures. She owns both an apparel and sports medicine consultation business, which allow her to pursue multiple interests simultaneously. Case 5 worked in various settings with some reportedly "unhealthy leaders," feeling a lack of autonomy, and difficulty going against the traditional scholastic sport-culture of athletic training. She is an AT and a sports dietitian and she attributed the spark for her transition to her unique background in nutrition. She primarily targets the high school athletic population educating them on basic eating strategies, eating disorders, and supplementation. Future goals include building the online component of her business.

**Conclusions:** The BOC Practice Analysis has historically recognized an ATs role in business practices (Domain 5), yet participants indicated a lack of formal education on the topic. Business ownership appears to be a mechanism for professional retention for women ATs. As such, additional training may be necessary for ATs to successfully transition into business ownership, as described by participants in our study.

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**Differences in Mental Health Scores Among Collegiate Student-Athletes Utilizing University-Sponsored Mental Health Services**

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**Context:** Mental health is an epidemic that continues to worsen among young adults. Healthcare providers and educational institutions have a duty to provide holistic care that prioritizes all aspects of health, including mental health, especially for those suffering from mental health concerns. The purpose of this study was to determine differences in The International Olympic Committee Sport Mental Health Assessment Tool 1 (SMHAT-1) scores in collegiate student-athletes based upon their utilization of university-sponsored mental health services.

**Methods:** Collegiate student-athletes completed an online longitudinal survey in conjunction with their annual pre-participation physical exam (n=104; 63.5% female; 22.4% first-year students; 61.5% White; response rate=71.9%). Student-athletes consented to their data being used in this study. The SMHAT-1, which has been tested and validated (internal consistency: $\alpha$=0.59-0.91; convergent validity: r=0.70-0.73) was used for this study. SMHAT-1 has 7 sections (triage (form 1), anxiety, depression, sleep, drug use, alcohol use, disordered eating (form 2)) and consists of 47 questions. Optional screening sections for Attention-deficit/Hyperactivity Disorder, Bipolar Disorder, Post-traumatic Stress Disorder, gambling, and psychosis were not completed for this study. Dependent variables included SMHAT-1 section scores whereas the independent variable was mental health service utilization (yes versus no). An independent sample t-test was performed to compare each SMHAT-1 outcome between those saw a counselor and those who did not.

**Results:** Nine participants (9%) were previously diagnosed with depression, anxiety, or another mental health disorder. Most participants (n=83; 79.8%) scored below the threshold of concern ( < 17 points) on the triage screening, meaning no immediate danger. Most participants who reported anxiety (n=23; 22.1%) and depression (n=18; 17.3%) symptoms reported mild symptoms (anxiety=78.3%; depression=61.1%). All participants scored above the threshold of concern for sleep disturbance (n=104; 100.0%) and nearly all for disordered eating (n=88; 84.6%). Nearly all participants scored above the threshold ( > 16 points) for their total mental health screening (n=98; 94.2%) indicating the need for clinical assessment and management. After screening, only 22 participants (21.2%) utilized university-provided mental health services and saw a counselor. Those who saw a counselor had significantly different scores (compared to those who did not see a counselor) for the Triage, Anxiety, Depression, Disordered Eating, and Total Form 2 scores (Table 1). Those who saw a counselor did not have significantly difference scores (compared to those who did not see a counselor) for Sleep, Drug Use, or Alcohol Use (Table 1).

**Conclusions:** Most participants scored above the threshold of concern for overall mental health. Those who used mental health services scored significantly higher on most domains but the majority did not seek care. Universities should provide mental health services to meet the diverse needs of student-athletes at their institution but efforts should also be made to encourage student-athlete participation in mental health services.

**Table 1. Two Independent Sample T-Test Results**

| Dependent Variable | Counselor Mean (SD) | No Counselor Mean (SD) | Degrees of Freedom | t-score | p-value |
|---|---|---|---|---|---|
| Triage | 20.6 (9.1) | 12.5 (3.9) | 23 | 4.085 | <0.001* |
| Anxiety | 6.1 (6.6) | 1.3 (2.1) | 22 | 3.325 | <0.001* |
| Depression | 6.6 (7.7) | 1.2 (2.3) | 22 | 3.220 | <0.001* |
| Sleep | 18.9 (4.2) | 16.0 (3.3) | 24 | 1.883 | 0.102 |
| Drug Use | 0.3 (0.6) | 0.2 (0.5) | 28 | 2.985 | 0.090 |
| Alcohol Use | 1.9 (1.4) | 0.6 (1.2) | 28 | 9.954 | 0.125 |
| Disordered Eating | 8.8 (5.6) | 6.4 (3.1) | 29 | 3.745 | <0.001* |
| Total Form 2 | 63.0 (29.4) | 38.2 (10.0) | 22 | 3.890 | <0.001* |

*Denotes significance at alpha=0.05.

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