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Free Communications, Poster Presentations

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 2022 NATA Clinical Symposia & AT Expo as part of the NATA Foundation Free Communications Program.

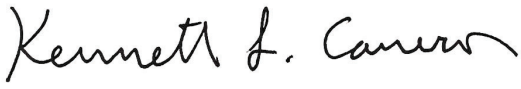
The Free Communications Program provides certified athletic trainers, students and other healthcare providers an opportunity to present and learn about the latest in athletic training research. Research is presented in oral and poster formats and includes general research, NATA Foundation-funded research and clinical case reports. Abstracts of the research are printed here by day of presentation at the 2022 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 undergraduate and graduate 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 at 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 over 400 peer-reviewed submissions this year. This year's Free Communications Program is exciting. It contains a fantastic mix of high-caliber research reports and clinical case studies delivered as e-posters and live in-person oral presentations for the first time in three years. We appreciate the presenters' time and commitment to offering amazing content to attendees.

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 subcommittee members are:

Michelle Boling, PhD, ATC
Cathy Brown Crowell, PhD, ATC
Shannon David, PhD, ATC
Tamerah Hunt, PhD, ATC, FACSM
Christopher Kuenze, PhD, ATC
Kevin Laudner, PhD, ATC
Sakiko Oyama, PhD, ATC
Brian Pietrosimone, PhD, ATC
Riana Pryor, PhD, ATC
Jacob Resch, PhD, ATC
Justin Rigby, PhD, ATC
Melissa Snyder, PhD, ATC, CSCS
Erik Wikstrom, PhD, ATC, LAT-Chair Elect

I also acknowledge the unwavering support and guidance from Kenneth Cameron, PhD, MPH, ATC and the rest of the NATA Foundation Board and staff. Lastly, I wish to thank Leslie Neistadt and the staff at 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 Philadelphia. Please take the opportunity to view the virtual posters and attend the Free Communications oral and meet-the-poster presenter sessions. We look forward to returning to in-person sessions where we can foster lively discussions to share the latest findings and discuss their implications for clinical practice. Please note that projects funded by the NATA Research & Education Foundation are specified in this Supplement. Finally, please offer your thanks to those recognized above if you have the opportunity.

Sincerely,

Jeffrey Driban, PhD, ATC, CSCS
Chair, NATA Research & Education Foundation Free Communications Committee

Medal for Distinguished Athletic Training Research

Steven P. Broglio, PhD, ATC

University of Michigan

Steven Broglio started college as a genetics major and soon realized that field wasn't for him. A friend introduced him to Bill Davis, MS, ATC, head athletic trainer at The Ohio State University. Broglio shadowed Davis for a day and quickly fell in love with athletic training and being on the field. During his undergraduate education at the University of North Carolina at Chapel Hill, he had a class with Kevin Guskiewicz, PhD, ATC: "the nicest man on the planet." He also started helping with laboratory research and completed his own study as a senior. He truly "walked into a lab and never walked out."

As Broglio continued his graduate education at the University of Georgia, he continued to be drawn to research. The more he pursued research, the more he felt he could have a positive impact on the profession. In particular, he realized that better tools were needed to help clinicians evaluate and manage patients with concussions. Although much is still to be learned about concussions, he believes that important progress is being made.

Broglio feels fortunate to be able to work with so many outstanding researchers during his career. He is excited to see the field continue to advance in ways he couldn't have imagined when he started out, as both young and experienced researchers add to the knowledge base.

The ability to intervene at a critical point in a patient's life, manage care, and help the individual return to normal activity is Broglio's favorite aspect of athletic training. He enjoys how the relationships athletic trainers have with patients are fostered by meaningful therapeutic interventions.

When Broglio heard he had been awarded the Medal for Distinguished Athletic Training Research Award, he honestly thought there was a mistake. Broglio feels humbled to even be considered as he reflects on past winners, including Kevin Guskiewicz; Jay Hertel, PhD, ATC; Chris Ingersoll, PhD, ATC; Dave Perrin, PhD, AT Ret, and other icons of athletic training.

As mentors, Broglio also recognizes Mike Ferrara, PhD, ATC, and Scott Lephart, PhD, ATC. His concern that he will leave someone out speaks to the value of his network, which has provided opportunities and friendships for which he is most grateful.

Outside of his research, Broglio spends time with his daughter, Lily, and his partner, Heather. Although he loves his job and enjoys the 24/7 nature of athletic training, he values his time with his family and friends and thanks them for their support.

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

Lindsey K. Lepley, PhD, ATC

University of Michigan

Lindsey Lepley began her undergraduate career at Grand Valley State University, toggling between athletic training and nursing. A mentor asked about the activities she enjoyed the most and whether she preferred to spend time inside or outside. Those conversations showed her that athletic training was a better fit. While an athletic training student, Lepley was exposed to patient care. She fell in love with a profession whose practitioners want to help others and was excited to learn about new discoveries that could promote better patient recoveries.

Originally, Lepley saw herself staying in the clinic, as she thoroughly enjoyed the rehabilitation side of athletic training. However, she became frustrated as she began to realize that treatment types and times were largely dictated by what insurance companies would cover. She realized that she wanted to be on the other side, where she could be more prescriptive in aiding patients with musculoskeletal injuries that are difficult to overcome.

Lepley first became involved in research as a requirement as part of her master's in education degree at the University of Virginia. She was "gently shoved" through the door by her professor mentors. She did not expect research to become her career but was bitten by the "research bug."

Lepley's research focuses on why muscles get so sick after traumatic joint injuries and ways in which different therapies may alter outcomes. Her research involves both rodents and humans, depending on the question. The rodent experiments are aimed at understanding the natural evolution of injury and why muscle recovery is so difficult to treat. The human investigations evaluate different technologies that can characterize the muscle and new interventions at a clinical level to see if they work better than the standard of care. Lepley hopes that finding a way to save the muscles after a joint injury may reveal a way to save the joint.

On learning that she had been awarded the Dr. Freddie and Mrs. Hilda Pang Fu New Investigator Award, Lepley was extremely honored. Given the many distinguished researchers who have received this award, she is humbled to even be considered.

As vital to her success, Lepley recognizes her husband, Adam Lepley, PhD, ATC. She describes him as a "true keeper": they've been together since their undergraduate days, and he is a solid source of scientific and personal support. She particularly admires the resilience he displays in every aspect of their lives. She also recognizes Riann Palmieri-Smith, PhD, ATC (doctoral mentor); Tim Butterfield, PhD, ATC (postdoctoral mentor); Lindsey DiStefano, PhD, ATC; and Dustin Groooms, PhD, ATC, and the huge supportive network of colleagues at the Universities of Connecticut and Michigan, where she served as a faculty member. She thanks all those around her who have allowed her to lean on them as needed. In addition, Lepley thanks her 10-year-old golden retriever, Maggie, who has listened to every presentation of both Dr. Lepleys. (She believes Maggie is the best-informed dog in the area of neuromuscular control.) Lepley enjoys family dinner conversations that range from the latest Disney movie to a new research idea being considered. Much of her spare time is spent just trying to keep up with her 4-year-old daughter, Hazel, and 2-year-old son, Emerson.

To any young or aspiring athletic trainer, Lepley advises that there is no prescription for being successful. Every journey is unique, and each person needs to find the niche that works for you and allows you to add to the field. Research benefits from new ideas, perspectives, and people thinking about the problem. She encourages people to "own it, be you, and be flexible."

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, and 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

Samantha Scarneo-Miller, PhD, ATC
West Virginia University

From a young age, Samantha Scarneo-Miller knew she wanted to work in a health care profession. As a high school athlete, she experienced several patellar subluxations and dislocations, underwent 2 surgeries by age 16, and "basically lived" in the physical therapy clinic in town. She became interested in athletic training after being hired as a physical therapy aide and realizing she wanted to work with physically active individuals.

Scarneo-Miller pursued her undergraduate degree at the University of New Hampshire in Durham. While there, she asked question after question, and Erik Swartz, PhD, ATC, and Dan Sedory, MS, ATC, finally told her to "stop asking questions and do a research study because we don't know." Her initial research with Summer Cook, PhD, and Rick McAvoy, PT, DPT, CSCS, involved evaluating physiological changes during shallow-water sprinting. After completing this project, Scarneo-Miller believed that she wanted to be a high school athletic trainer, but Erik Swartz suggested she consider a career in research.

After some convincing, Scarneo-Miller attended the University of Connecticut under the direction of Lindsay DiStefano, PhD, ATC, where she studied the translation of kinetic and kinematic changes from an aquatic-based injury-prevention program. While completing her master's degree, she also worked as a graduate assistant at a high school in Hartford, Connecticut, that had no team physician, no standing orders, a poor emergency action plan, and no documented policies and procedures. Therefore, she spent time creating this important documentation and realized that her passion was in the administrative side of athletic training. When offered the opportunity to obtain her doctorate with Dr. DiStefano and Douglas Casa, PhD, ATC, Scarneo-Miller decided that policies and procedures were not her "middle school crush" but her "long-term love" and focused her attention on catastrophic sport injury and emergency preparedness in the high school setting. She also evaluated the barriers and social determinants affecting a school's ability to develop an appropriate emergency action plan.

When Scarneo-Miller found out she had been awarded the David H. Perrin Doctoral Dissertation Award, she was "absolutely shocked." She was surprised to even hear of her nomination among all the amazing new researchers in the field. She later found out that she was nominated by a high school athletic trainer, which meant the world to her because it indicated that her dissertation work was useful to clinicians. As she continues her

work and research in athletic training after having her newborn son, Scarneo-Miller focuses more on how we can make sports safer for all children from a catastrophic injury perspective.

She recognizes Erik Swartz; Douglas Casa; Lindsay DiStefano; Johna Register-Mihalik, PhD, ATC; Rebecca Stearns, PhD, ATC; Craig Denegar, PhD, PT, ATC; and Stephanie Singe, PhD, ATC, for being instrumental to her dissertation project. She also recognizes that it would be nearly impossible to list everyone who has assisted in her career journey thus far. She thanks her husband, Jelan Miller; her dog, Milo; and her son, Jrue, for being her biggest supporters at home along with her mom, Meg Scarneo; brother, Dr. Scott Scarneo; and her entire family for their unwavering support. In addition, she appreciates the Foundation Committee for dedicating their time and efforts to reviewing all of the nominations.

To young and aspiring athletic trainers, Scarneo-Miller advises finding good mentors who will entertain both professional and personal questions; having those people in your corner is extremely helpful. To students working on their dissertations, she advises "a good dissertation is a done dissertation."

David H. Perrin, PhD, AT Ret, FNATA, FACSM

David H. Perrin, PhD, 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 is dean of the College of Health and professor of 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.

The Immediate Impact of Ankle and Knee Injuries on Health-Related Quality of Life in Adolescent Athletes: A Report From the Athletic Training Practice-Based Research Network

Lam KC, Marshall AN: A.T. Still University, Mesa, AZ, and Appalachian State University, Boone, NC

Context: Health-related quality of life (HRQOL) is an important patient-reported outcome that supports patient-centered, whole person care. Although evidence suggests sport-related injuries can have a long-term, negative impact on HRQOL, little is known about the immediate impact of sport-related injuries on HRQOL. We identified the immediate impact of ankle and knee injuries on HRQOL and determined if these injuries impacted HRQOL differently in adolescent athletes. **Methods:** Patients were adolescent athletes who were under the care of an athletic trainer within the Athletic Training Practice-Based Research Network and diagnosed with an ankle or knee injury. Patients received usual care from an athletic trainer and completed the Pediatric Quality of Life Inventory (PedsQL) within a week of injury. The PedsQL is a valid, reliable, and responsive patient-reported outcome instrument that assesses HRQOL. The PedsQL generates a total score and four subscale scores [physical functioning (PF), emotional functioning (EF), social functioning (SOF), school functioning (SCF)]. All scores range 0-100, with higher scores indicating better HRQOL. Descriptive statistics (frequencies, percentages, mean±SD) were reported for each score. We also reported the percentage of patients with scores lower than previously reported reference values for the PedsQL in healthy adolescent athletes (total=89.4, PF=90.0, EF=87.7, SOF=90.5, SCF=82.6). Generalized linear models were used to compare potential group differences for scores reported by patients with ankle and knee injuries ($p<.05$, two-tailed). **Results:** One hundred ninety-five patients (male=114, female=81, age=15.5±1.2 years) were diagnosed with an ankle (n=119) or knee (n=76) injury during the study period. Patients represented twelve different sports including football (n=62, 31.8%), basketball (n=44, 22.6%), soccer (n=21, 10.8%) and volleyball (n=21, 10.8%). Common diagnoses for the ankle were ankle sprain (n=91, 46.7%) and tibiofibular ligament sprain (n=17, 8.7%), and for the knee were medial collateral ligament sprain (n=10, 5.1%) and patellar subluxation or dislocation (n=10, 5.1%). Over two-thirds of patients reported lower total (n=129, 66.2%) and PF (n=143, 73.3%) scores when compared to reference values. Moreover, almost half of patients reported lower EF scores (n=94, 48.2%) and one-third reported lower SOF (n=68, 34.9%) and SCF (n=68, 34.9%) scores when compared to reference values. Significant differences were reported between patients with ankle and knee injuries for total scores (p=0.03; ankle=81.7±13.9, range=44-100, knee=76.8±18.4, range=30-100). However, no significant group differences were reported for subscale scores: PF (p=0.05; ankle=69.6±26.7, range=0-100, knee=61.3±29.4, range=0-100), EF (p=0.06; ankle=85.4±15.7, range=40-100, knee=80.2±22.4, range=15-100), SOF (p=0.36; ankle=92.4±11.3, range=35-100, knee=90.7±14.0, range=40-100), SCF (p=0.21; ankle=86.7±14.9, range=35-100, knee=83.8±18.1, range=30-100). **Conclusions:** Adolescent athletes who suffer ankle and knee injuries report an immediate and negative impact on HRQOL, particularly in physical and emotional functioning. Addressing emotional aspects of HRQOL is essential to providing comprehensive, whole person care for patients following sport-related injuries.

This study was funded by an NATA Foundation Grant (1516OGP001).

A Multi-Year Assessment of the Impact of Sport Participation During the COVID-19 Pandemic on the Physical Activity and Quality of Life of Adolescent Athletes

McGuine TA, Biese K, Hetzel SJ, Reardon CL, Brooks MA, Bell DR, Schwarz A, Watson A: University of Wisconsin-Madison, Madison, WI

Context: Research has demonstrated that sport cancellations early in the COVID-19 pandemic had a significant negative impact on the health of adolescent athletes. During the late summer 2020 and during the 2020/21 academic year, US adolescents were once again provided with sport participation opportunities. The impact of restarting sport participation during the COVID-19 pandemic on the health of adolescent athletes has not been described. The purpose of this study was to identify the impact of sport participation on physical activity and quality of life for adolescent athletes prior to and during the COVID-19 pandemic. **Methods:** Wisconsin adolescents who participated in sport during the summer 2020 or the 2020/21 academic year were recruited via social media to complete an anonymous online survey in the spring of 2021. Participants were asked to provide demographic information regarding their age, sex, sports played and to complete the Hospital for Special Surgery Pediatric Functional Activity Brief Scale (HSS-PFABS) to measure their physical activity and the Pediatric Quality of Life Inventory 4.0 (PedsQL) to measure their Quality of Life (QoL). Data from this cohort (Spring21, n=1906 age=16.0+1.2, female=49%) was compared with data collected on similar cohorts from spring 2020 when sports were cancelled (Spring20, n=3243, age=16.2+1.2, female=58%), and prior to the pandemic in the years 2015-2018 (PreCOVID-19, n=5231, age=15.7+1.1, female=65%). Comparisons of the scores (mean [95%CI]) between the groups for the HSS-PFABS, PedsQL physical summary score, PedsQL psych-social summary score and PedsQL total score were made via ANOVA models with age and sex as covariates. **Results:** HSS-PFABS scores were higher in Spring21 than Spring20 but lower than PreCOVID-19 (Spring21 = 21.9 [21.6, 22.2], Spring20 = 13.5 [13.3, 13.7], PreCOVID-19 = 23.1 [22.7, 23.5]). Similarly, the PedsQL scores were higher in Spring21 than Spring20 but lower than PreCOVID-19 for the Physical summary score (Spring21 = 88.4 [87.8, 88.9] Spring20 = 85.5 [85.1, 85.9], PreCOVID-19 = 93.7 [93.4, 94.0]), Psycho-social summary score (Spring21 = 82.1 [81.5, 82.7] Spring20 = 78.1 [77.7, 78.6], PreCOVID-19 = 92.4 [92.0, 92.8], and PedsQL total scores (Spring21 = 84.3 [83.8, 84.8], Spring20 = 80.7 [80.3, 81.1], PreCOVID-19 = 92.8 [92.5, 93.1]). **Conclusions:** The resumption of sport participation opportunities for adolescent athletes was associated with significant improvements in physical activity and quality of life compared to scores recorded early in the COVID-19 pandemic when sports were cancelled. However, adolescent athletes reported lower levels of physical activity and worse quality of life scores than those recorded prior to the COVID-19 pandemic. This suggests that while sport participation during the COVID-19 pandemic has a significant positive impact on the health of adolescents, the negative health impacts reported early in the COVID-19 pandemic among adolescent athletes may persist for some time.

Funding for this study was provided by the National Federation of State High School Associations (NFHS) Foundation. None of the authors have any other financial disclosures or relationships.

Child SCAT5 Premorbid Factors Are Not Predictive of Clinical Recovery Among Concussed Middle School Athletes

Erdman NK, Kelshaw PM, Caswell SV: George Mason University, Fairfax, VA, and University of New Hampshire, Durham, NH

Context: Previous literature has suggested an association between the length of clinical recovery following a concussion and premorbid factors, such as age, gender, prior concussion history, and other medical conditions (e.g., ADD/ADHD, psychiatric disorders, etc.). However, these relationships have not been thoroughly investigated in children who sustain concussions while participating in organized physical activities, such as middle school sports. Therefore, the purpose of our study was to identify premorbid factors that predict the length of clinical recovery following a diagnosed concussion in middle school athletes. **Methods:** Our convenience sample consisted of 84 middle school athletes (73.8% boys, 26.2% girls; age=12.6?0.91 years) who were clinically diagnosed with a concussion while participating in school-sponsored sports. The Advancing Healthcare Initiatives for Underserved Students (ACHIEVES) Project provided certified athletic trainers who were responsible for providing onsite clinical care, including diagnosis and management of concussion. Participants completed an annual baseline concussion assessment prior to sport participation that consisted of the administration of health history questionnaires via the Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5). Athletes were removed from sport immediately upon suspicion of a concussion and did not return to sport participation until they were determined to be asymptomatic and had completed a graduated return-to-sport progression. For our study, the length of clinical recovery was calculated as the number of days between the date of injury and the date of unrestricted return-to-sport. Independent variables included the participants' (1) gender (boy, girl), (2) grade level (6th, 7th, and 8th grade), (3) prior concussion history (0 or 1+ previous concussions), and (4) previously diagnosed medical conditions (hospitalization for head injury, diagnosis of a headache disorder or migraines, learning disability, dyslexia, ADD/ADHD, or a psychiatric disorder). Kaplan-Meier curves with log-rank tests and Cox proportional hazards regression modeling were used to predict the length of clinical recovery from the four independent variables. All analyses were assessed at p=0.05 **Results:** The length of clinical recovery following concussion diagnosis was 16.3+/-8.88 days (median=15.0 days, mode=13.0 days, range=0-61 days). No independent variables adequately predicted the length of clinical recovery (Log-rank tests: p's=0.17-0.79; Hazard ratios: p's=0.52-0.83; Table 1). **Conclusions:** Premorbid factors recorded during baseline administration of the Child SCAT5 did not predict the length of clinical recovery among concussed middle school athletes. Our findings do not align with previous literature that reported slower clinical recovery of children (5-18 years old) who were assessed in outpatient clinical settings (e.g., concussion clinics, hospitals) and endorsed premorbid factors. Future investigation of other underrepresented variables in research, such as primary language, race, and ethnicity, along with outcome measures from the Child SCAT5 is warranted.

The Advancing Healthcare Initiatives for Underserved Students (ACHIEVES) project is supported by non-restrictive grant funding from Prince William County Public Schools.

Table 1. Cox proportional hazards regression results for predicting the length of clinical recovery among concussed middle school athletes.

Variable	β[a]	*p*[b]	Hazard Ratio[c]	95% Confidence Interval Lower Limit	95% Confidence Interval Upper Limit
Gender	0.13	0.62	1.13	0.69	1.87
Grade Level	-0.94	0.52	0.91	0.68	1.21
Previous Concussion History	-0.10	0.65	0.90	0.58	1.41
Previous Medical Condition	-0.06	0.83	0.95	0.57	1.56

[a] β = standardized regression coefficient for each variable.
[b] Overall significance of the model: *p*=0.90
[c] Hazard ratios greater than 1 are predictive of shorter time to clinical recovery. Hazard ratios with 95% confidence intervals that do not include 1 are considered significant.

Changes in Patient-Reported Outcome Measures in Adolescent Athletes With Hamstring Strains

Farraye BT, Wohl T, Criss CR, Haggerty A, Grooms DR, Simon JE: Ohio University, Athens, OH, and The Ohio State University, Columbus, OH

Context: Assessment of patient-reported health is necessary to determine the effectiveness of athletic training treatments, but prospective longitudinal research is limited. Therefore, the purpose of this study was to evaluate changes in patient-reported outcome measures (PROs) in adolescent athletes with hamstring strains at time of injury, return-to-play (RTP), and 6-months post RTP. **Methods:** Twenty-nine adolescent athletes were prospectively enrolled (10 female, 16.17±1.14yrs, 174.47±8.62cm, 76.61±16.19kg). Inclusion criteria included an acute hamstring strain diagnosed by an athletic trainer, time loss of at least 24 hours, and receiving treatment from an athletic trainer. Individuals completed the Patient-Reported Outcomes Measurement Information System (PROMIS) survey, a generic PRO that incorporates 7 sub-scales to evaluate overall health (physical function, anxiety, depression, fatigue, sleep disturbance, social roles, and pain interference) and the Lower Extremity Functional Scale (LEFS), a region-specific PRO to evaluate lower extremity perception and functionality. Participants completed the PROs at time of injury, RTP, and 6-months post RTP. The independent variable was time (time of injury, RTP, 6-months RTP) and the dependent variables were the 7 PROMIS sub-scales and LEFS. Descriptive statistics were calculated for each dependent variable by time. A repeated measures ANOVA was conducted for each dependent variable with the within-subjects factor time with $\alpha/<\backslash 0.05$. At the individual level, change scores from time of injury to RTP and to 6-months post RTP were calculated and compared to the MCID of 9 points for the LEFS. **Results:** The average time lost was 5±2.75 days (range: 2-13 days). The PROMIS physical function, anxiety, sleep disturbance, and pain interference were significant over time ($p/<\backslash 0.05$). All other PROMIS scales were not significant. For the LEFS, there was a significant difference over time ($p/<\backslash 0.001$). Table 1 shows the descriptive statistics for all dependent variables. Specifically, the PROMIS physical function, anxiety, sleep disturbance, and pain interference showed significant improvements from time of injury to RTP with the largest difference seen in the pain interference scale (mean difference: 14.52±1.79, $p/<\backslash 0.001$). There were significant improvements in LEFS scores from time of injury to RTP (mean difference: 14.31±1.17, $p/<\backslash 0.001$) and also from RTP to 6-months post RTP (mean difference: 2.89±0.56, $p/<\backslash 0.001$). At the individual level 26/29 (89.65%) met the MCID for the LEFS from time of injury to RTP. At 6-months post RTP compared to initial injury all individuals had met the MCID for the LEFS. **Conclusions:** Adolescent athletes who sustained a hamstring strain indicated significant improvements in PROs from time of injury to RTP after receiving athletic training treatments. However, only the LEFS, a region-specific PRO had significant improvement from RTP to 6-months RTP. Therefore, athletic trainers should use global and region-specific PROs to evaluate treatment efficacy.

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Exploring the Relationship Between Social Support and Mental Health Symptoms in Adolescent Athletes

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Context: Adolescents are particularly vulnerable to mental health symptoms due to increased susceptibility to psychosocial stressors such as academic responsibilities and navigating social interactions. Social support in the form of emotional support received from family and peers may help mitigate negative effects of stress, thus minimizing the presence of mental health symptoms. Therefore, the purpose of this study was to investigate the association between social support from family and peers on symptoms of depression and anxiety in adolescent athletes. **Methods:** This study utilized a cross-sectional design. A total of 174 high-school athletes from five participating high schools completed an electronic battery utilizing the National Institutes of Health (NIH) Toolbox iPad Application with NIH Toolbox and Patient Reported Outcome Measures Information System (PROMIS) health measures. Social support was the exposure of interest and assessed using three questionnaires: Emotional Support (Ages 8-17), Pediatric Family Relationships, and Pediatric Peer Relationships. Mental health symptoms were the outcomes of interest assessed using separate eight-item Pediatric Depression and Pediatric Anxiety questionnaires. All measures were self-reported and validated in a pediatric population by the NIH. Scores were separately summated for each questionnaire, with higher scores indicating more of the measured construct. All exposure and outcome measures ranged from 8-40 total points except for emotional support which ranged from 7-35 points. Data were analyzed using descriptive statistics and linear regression models in SPSS. Statistical significance was set a priori $p \leq .05$. **Results:** The mean age of the sample was 15.47±1.2 years. The means for social support measures were 25.86±6.1, 32.75±7.5, and 30.98±6.0 for emotional support, family relationships, and peer relationships, respectively. The sample averaged 15.56±7.45 in depressive symptoms and 15.54±7.04 in anxiety symptoms. Overall, the results suggest an inverse association in that as emotional support increases, symptoms of depression (β=-.320, $p < .000$) and anxiety (β=-.218, $p < .001$) decrease. Additionally, when family relationships were reported as more supportive, depression (β=-.467, $p < .000$), and anxiety (β=-.374, $p < .000$) symptoms decreased. Lastly, when peer relationships were reported as more supportive, depression (β=-.166, $p < .006$) symptoms decreased. **Conclusions:** These results indicate having higher levels of social support in the form of emotional support from family and peers likely helps to decrease mental health symptoms in adolescent athletes. Thus, social support may serve as an effective means of preventing the manifestation of depression and/or anxiety symptoms in this population. Notably, these measures were assessed in athletes and sports participation may improve access to emotional support in the form of having coaches and teammates around. Individuals who work with adolescent athletes must not underestimate the positive influence social support may have on this population and must consider the effects a strong social support network may have on mental health symptomatology.

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The Role of Cervical Strength on Head Impacts in Youth Football Athletes

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Context: Most head impact related research has focused on high school, college, and professional football athletes. Contraction of the cervical muscles is proposed to create rigidity to counter external forces to reduce head acceleration upon collision. Additional research has investigated cervical strength as a potential factor to reduce impact severity. In older athletes, cervical stiffness contributes to a decreased risk of sustaining moderate to severe impacts. However, it is not known if younger athletes with undeveloped musculature experience the same relationship following impact. Therefore, the purpose of this study was to determine the effect of cervical strength on head impact magnitudes in male youth football tackle athletes. We hypothesize decreased cervical strength would cause an increase in head impact magnitudes. **Methods:** A prospective cohort design was used for this study. Youth tackle football players from 2 teams (n=25 total, age=12.2±0.4yrs, height=161.5±9.7cm, mass=55.2±15.2kg) completed a pre-season measure to capture cervical isometric strength using the Multi-Cervical Unit. The average cervical peak strength (N) served as the independent variables and were determined from 3 trials at each of following directions: flexion, extension, and left and right lateral flexion. Participants wore Triax SIM-G sensors throughout 4 games each. The sensors recorded magnitude and head impact frequency of impacts over 14g. Linear acceleration (g) and rotational velocity (rads/s) determined impact magnitudes from a subset of games from a partially completed season (n=8 games) that served as the dependent variables. Separate random-intercept general linear models were used to determine the effect of each cervical strength measure on log-transformed peak linear acceleration (g) and rotational velocity (PRV). The α value was set to P=0.05 a priori. Results: The 8 games produced a total of 588 head impacts, 24±11.6 impacts per athlete. Peak flexion ranged from 79.19-353.25N, extension 118.32-226.86N, left lateral flexion from 68.51-173.04N, and right lateral flexion 80.96-148.13N. Peak linear acceleration ranged from 16.03-102.70g and peak rotational acceleration from 12.70-49.30rads/s. There was no significant association between any of the peak cervical strength directions and linear acceleration (p range: 0.148-0.723) or rotational velocity (p range: 0.070-0.899). Conclusions: Cervical peak strength did not significantly affect head impact magnitudes during games. Our findings are similar to previous research that show no significant findings between cervical strength and head impact severity. Youth athletes may have slower collision speeds, allowing them to see oncoming collision developing and resulting in a more rapid contraction of the cervical musculature. Future research should consider analyzing dynamic cervical strength and head impact severity.

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Differences in Strength, Flexibility and Balance Among Sport Specialization Levels in Adolescent Long-Distance Runners

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Context: In recent years, nearly 500,000 high school athletes participated in interscholastic cross-country. Of these, 59-68% have reported a prior running-related injury and those who are high-specialized may have a higher risk of overuse injury. Lower extremity strength, flexibility, and balance are often thought to be factors that influence injury; however, it is unknown if there are differences in these variables in adolescent long-distance runners across sport specialization levels. The purpose of this study was to compare strength, flexibility, and balance among adolescent long-distance runners of different sport specialization levels. **Methods:** Adolescent (ages 9-19) long-distance runners (F=49, M=46; age=14±3 y; height=159.7±13.8 cm; mass=49.2±12.7 kg) participated in this single-session study. Participants were categorized into sports specialization levels of low (n=46), moderate (n=22), and high (n=27). Participants' strength, flexibility, and balance were assessed. Strength of the hip abductors, adductors, extensors, flexors, internal and external rotators, and knee extensors and flexors were measured isometrically and normalized to body mass (N / kg). Flexibility during ankle dorsiflexion (weight-bearing lunge, cm), knee extension (popliteal angle, °), and passive hip internal and external rotation range of motion (°) were measured. The lower-quartile Y-Balance Test (YBT) normalized reach distance (% leg length) was used to measure lower extremity dynamic balance. ANCOVAs for each dependent variable (covariate=age) were used to compare sport specialization levels with Sidak pairwise comparisons. Significance was set a p ? .05. **Results:** Significant main effects among sport specialization levels, while controlling for age, were observed for the weight-bearing lunge test (p=.015) and YBT-posterolateral reach (p=.006). High specialized runners had greater dorsiflexion flexibility (high=8.4±3.5 cm, moderate=5.5±3.5 cm, p=.020) and greater YBT-posterolateral reach distance (high=92.5±8.2%, moderate=84.6±8.1%, p=.004) than moderately specialized runners. No significant differences were observed for any other variables (p > 0.05; Table 1). **Conclusions:** Minimal differences exist in strength, flexibility, and balance among adolescent long-distance runners of different sport specialization levels. Differences among sport specialization levels were only seen for ankle dorsiflexion flexibility measured by the weight-bearing lunge test, with highly specialized runners demonstrating greater flexibility. Less dorsiflexion range of motion has been linked to greater knee valgus which might mean lower injury risk for runners who are more highly specialized, contrary to what is expected from the literature. Specialization in runners may be different than in athletes of other sports so it is unclear the importance of these results. More research is necessary in runners to understand the role of specialization in running-related injury.

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Table 1. Strength, Flexibility, and Balance among Sport Specialization Levels in Adolescent Long-Distance Runners

	Low (n=46)			Moderate (n=22)			High (n=27)			ANCOVA
	Mean	SD	95% CI	Mean	SD	95% CI	Mean	SD	95% CI	p-value
Strength										
Hip Abduction	2.4	0.5	(2.2-2.6)	2.4	0.5	(2.2-2.6)	2.3	0.6	(2.1-2.6)	0.946
Hip Adduction	2.4	0.6	(2.2-2.5)	2.4	0.6	(2.1-2.6)	2.5	0.6	(2.3-2.8)	0.354
Hip Extension	3.1	1.1	(2.8-3.4)	3.0	1.4	(2.4-3.6)	3.0	1.1	(2.6-3.4)	0.986
Hip Flexion	3.8	1.1	(3.5-4.1)	3.5	1.1	(3.0-4.0)	3.2	0.8	(2.9-3.6)	0.143
Hip IR	1.5	0.4	(1.4-1.6)	1.5	0.3	(1.3-1.6)	1.6	0.5	(1.4-1.8)	0.729
Hip ER	1.4	0.3	(1.3-1.5)	1.3	0.3	(1.1-1.4)	1.4	0.3	(1.2-1.5)	0.246
Knee Extension	4.9	1.3	(4.6-5.3)	4.2	1.3	(3.6-4.8)	4.2	1.2	(3.8-4.7)	0.231
Knee Flexion	2.9	0.9	(2.7-3.2)	2.5	0.7	(2.2-2.8)	2.9	0.8	(2.5-3.2)	0.147
Flexibility										
Sit & Reach	33.0	9.5	(30.0-36.0)	38.4	14.3	(31.5-45.2)	36.6	9.5	(32.4-40.8)	0.561
Weight-Bearing Lunge†‡	5.9	3.3	(4.9-6.9)	5.5	3.5	(4.0-7.1)	8.4	3.5	(7.0-9.7)	**0.015**
Popliteal Angle	13.7	10.9	(10.5-17)	10.8	14.3	(4.4-17.1)	20.0	13.0	(14.8-25.1)	0.063
Hip ER ROM	46.4	8.0	(44.0-48.8)	44.5	7.3	(41.3-47.8)	41.3	7.5	(38.3-44.3)	0.518
Hip IR ROM	42.6	7.8	(40.3-44.9)	43.3	6.2	(40.5-46.0)	42.5	6.8	(39.8-45.2)	0.635
Balance										
YBT-Anterior	53.6	6.7	(51.6-55.6)	56.4	4.9	(54.2-58.5)	57.1	6.2	(54.6-59.5)	0.792
YBT-Posteromedial	88.0	8.6	(85.4-90.6)	88.9	8.1	(85.3-92.5)	94.8	8.8	(91.3-98.2)	0.164
YBT-Posterolateral*	84.5	6.4	(82.6-86.5)	84.6	8.1	(81.0-88.2)	92.5	8.2	(89.2-95.8)	**0.006**
YBT-Composite	226.7	20.0	(220.7-232.7)	229.8	18.0	(221.8-237.8)	245.0	20.5	(236.7-253.3)	0.097

BOLD=significant, p<.05, *Moderate<High (p=.004), †Moderate<High (p=.020), ‡Low<High (p=.055)
IR=internal rotation, ER=external rotation, ROM=range of motion, YBT= y-balance test

Pre-Pubertal Long-Distance Runners Demonstrate Greater Movement Variability

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Context: Low movement variability may increase the susceptibility of sustaining a running-related injury due to repetitive localized tissue loading. During adolescence, boys and girls develop and refine motor skills and experience a period of motor incoordination (i.e., high movement variability). It is unknown if there are differences in movement variability among adolescent long-distance runners. The purpose of our study was to compare sagittal plane movement variability among adolescent long-distance runners of different stages of physical maturation. We hypothesized that post-pubertal adolescents would have less movement variability than pre- and mid-pubertal adolescents. **Methods:** Adolescent long-distance runners (F=59, M=65, age=13.4±2.8y, BMI=18.6±2.7kg / m2) participated in this secondary analysis of a larger cross-sectional study. Participants completed a single lab visit, undergoing an instrumented 3-dimesional running analysis. Following a 5-minute treadmill warmup at a self-selected velocity, participants were instructed to run at a comfortable velocity. Participants repeated trials over the 20m runway until a minimum of 5 successful trials were recorded for the left and right foot (i.e., striking the force plate, within 5% of self-selected velocity). Marker trajectory data were collected at 120Hz using a 12-camera system. Data from the right leg were analyzed during stance phase. For each successful trial, peak sagittal plane hip, knee, and ankle angles were identified. Movement variability was quantified as the standard deviation of the peak joint angles among the successful trials, similar to previous studies. Participants were stratified by sex and stage of physical maturation (pre-, mid-, & post-pubertal) and two-way ANOVAs (sex-maturation) compared the movement variability among groups. Pairwise comparisons with Bonferroni correction were used when significant results were observed ($p \leq .05$). **Results:** Participants ran at a self-selected speed (mean=3.60±0.68 m·s-1). We observed no significant sex-maturation interactions (p=.11-.60) or sex main effects (p=.33-.98; Table 1). We observed significant maturation main effects for peak hip extension ($p < .001$), hip flexion ($p < .001$), knee extension (p=.006), knee flexion (p=.004), and ankle dorsiflexion (p=.003; Table 1). Specifically, pre-pubertal runners demonstrated significantly greater hip extension ($p < .001$), knee flexion (p=.007), and ankle dorsiflexion (p=.02) movement variability than mid-pubertal runners as well as significantly greater peak hip extension ($p < .001$), hip flexion ($p < .001$), knee extension (p=.003), knee flexion (p=.005), and ankle dorsiflexion (p=.002) movement variability than post-pubertal runners. Mid-pubertal runners demonstrated significantly greater hip flexion (p=.04) movement variability than post-pubertal runners. **Conclusions:** Pre-pubertal long-distance runners demonstrated greater movement variability than mid- and post-pubertal runners. Limited variability may increase the risk of overuse injury from repetitive loading of a tissue. However, excessive variability may result in unstable positions and also increase the risk of injury. Prospective research is needed to better understand the interaction between movement variability and running-related injuries.

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Table 1. Lower extremity strength comparisons among sex and maturation.

	Female			Male			Sex-Mat	Sex	Mat
Peak Angle	Pre [n=12]	Mid [n=20]	Post [n=27]	Pre [n=21]	Mid [n=23]	Post [n=21]	*p*	*p*	*p*
Hip Ext [°]	2.4±0.9	1.5±0.8	1.5±0.8	2.7±1.3	2.0±1.0	1.5±0.8	.59	.16	<.001*†
Hip Flex [°]	2.4±1.5	2.4±1.1	1.8±0.6	3.1±1.1	2.3±1.0	1.7±0.7	.19	.55	<.001†‡
Knee Ext [°]	2.2±1.2	2.3±1.5	1.9±0.8	3.1±1.2	2.1±0.9	2.0±0.8	.11	.34	.006†
Knee Flex [°]	2.4±0.9	2.1±1.0	1.9±0.8	2.9±1.2	1.9±0.8	2.1±1.2	.39	.33	.004*†
Ankle PF [°]	2.4±1.2	2.7±1.8	2.4±1.3	2.8±1.4	2.5±1.2	2.5±1.2	.60	.78	.73
Ankle DF [°]	1.8±0.9	1.6±0.7	1.3±0.6	2.0±0.9	1.4±0.7	1.4±0.9	.54	.98	.003*†

Abbreviations: Flex=flexion, Ext=extension, Add=adduction, PF=plantarflexion, DF=dorsiflexion

Significant differences ($p \leq .05$): *pre- and mid-pubertal, †pre- and post-pubertal, ‡mid- and post-pubertal

Flexibility, Balance, and Strength Comparisons Between Adolescent Long-Distance Runners With and Without A History of Bone Stress Injury

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Context: Bone stress injuries (BSIs) are prevalent in adolescent long-distance runners. Many factors have been associated with BSIs in adolescent athletes, including high training load, low bone mineral density, low energy availability, and poor sleep habits. However, it has not been reported if neuromuscular capabilities (e.g., flexibility, balance, and strength) are different in adolescent long-distance runners with a history of BSI. The purpose of this study was to compare flexibility, balance, and isometric strength between adolescent long-distance runners with and without a history of BSI. **Methods:** The study was a cross-sectional design. Ten currently uninjured adolescent long-distance runners who reported a history of BSI (F=6, M=4, time since injury=16.3±10.2 months) were identified from a cohort of 93 adolescent runners and matched with runners with no history of BSI (controls, n=10) according to sex, physical maturation, and weight. Participants underwent flexibility (weight-bearing lunge [cm], popliteal angle [°], total passive hip rotation range of motion [°]), balance (composite lower-quartile Y-balance test [% leg length]), and isometric strength normalized to body mass [N/kg] (hip abduction, hip extension, hip internal and external rotation, knee extension) assessments. Independent t tests compared flexibility, balance, and strength assessments between runners with a history of BSI and the matched controls ($p < .05$). The magnitude of the effect size was assessed using Cohen's d. **Results:** Runners with a history of BSI demonstrated significantly less total passive hip rotation range of motion than controls (BSI=83.4±8.7°, controls=91.1±6.8°, p=.04, d=0.99, Table 1). No significant group differences were found for weight-bearing lunge, popliteal angle, lower-quartile Y-balance test, or isometric strength (p=.17-.82, d=0.10-0.64). **Conclusions:** We observed minimal differences in flexibility, balance, and isometric strength between adolescent long-distance runners with and without a history of BSI. Runners with a history of BSI demonstrated less total passive hip rotation range of motion than controls, but the importance of this difference is unknown. A medium effect size (p=.17, d=0.64) suggests a clinically meaningful difference in hip extension strength and with a larger sample size, runners with a history of BSIs may have greater hip extension strength than controls. These findings are limited by the retrospective nature of the study since participants' BSIs were on average over 16 months prior to testing. Participants may have received rehabilitation that improved neuromuscular capabilities. Since other factors such as training load, bone health, energy availability, and sleep habits have been previously found to be related to BSIs, perhaps adolescent long-distance runners should focus more on these factors than on flexibility, balance, and strength when considering BSIs.

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Free Communications, Oral Presentations: Diversity, Equity, Inclusion, Accessibility in Sports Medicine

Moderator: Dani Moffit, PhD, LAT, ATC

Wednesday, June 29, 2022; 1:30 PM-2:25 PM; Room 201BC

The Association Between Social Context Factors and Concussion Education and Symptom Knowledge Among Black and White Middle School Parents

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Context: Middle school (MS) parents may benefit from education supporting timely concussion identification and care-seeking in their young children. However, such education may not consider individual needs with varying social context factors, including lower socioeconomic status (SES) or different racial backgrounds. This study used data from a national survey of MS children's (aged ~10-15 years) parents to examine the relationship between social context factors and previous concussion education and knowledge, while exploring race as a potential effect measure modifier. **Methods:** Data from this study originated from a nationally representative cross-sectional study of MS parents. Survey Sampling International recruited a sample fitting inclusion criteria (US residents aged ≥18 years identifying as parents of MS children) September-October 2018 from a pool of participants agreeing to participate in online survey research (n=1362). Participants completed a self-administered online questionnaire that was previously validated and pilot-tested for face validity with MS parents. Outcomes included whether participants received previous concussion education (since 2017; yes/no) and concussion symptom knowledge (Cronbach $\alpha = 0.90$); 25 concussion symptoms were identified via "yes", "no", and "maybe" answers (correct answers=2 points; "maybe"=1 point; and incorrect answers=0 points; range=0-50; higher scores=better knowledge). Main exposures were parent's race (Black/White) and social context factors including: parental educational attainment (< Bachelor's degree/ Bachelor's degree / >Bachelor's degree); MS child's school (public/private); and community-level factors, based on reported zip code, from the American Community Survey (2013-2017): % residents aged 25+ with ≥Bachelor's degree; % nonwhite residents; % households below poverty level. Analyses were restricted to 1248/1362 respondents identifying as black (20.1%) or white (79.1%) [62.7% female; median age=38, interquartile range (IQR)=33-46] with complete data for pertinent variables. Chi-square and Wilcoxon Rank Sum tests compared outcome distributions by race. Multivariable logistic regression models including covariates (e.g., sex, age, concussion history) estimated odds ratios (OR) and 95% confidence intervals (CI) regarding previous concussion education and higher symptom knowledge levels (i.e., 26-50 vs. 0-25). Models were performed separately by race to assess effect measure modification. **Results:** Black participants were more likely than white participants to report previous concussion education (69.5% vs 60.5%, p=0.009). Distributions of concussion symptom knowledge differed between black and white participants [Median (IQR)=37 (30-43) vs. 40 (34-44), p=0.001). Social context factors were not significant predictors in all individual multivariable models; however, among white participants, a higher percentage of nonwhite residents in one's zip code was associated with a 12% decrease in the odds of higher symptom knowledge (10%-increase-OR=0.88; 95%CI: 0.79-0.98). **Conclusions:** Among MS parents, race may not serve as an effect measure modifier in the association between social context factors and concussion-related knowledge. However, differences were found between participants by race regarding previous concussion education and concussion symptom knowledge. Concussion education interventions may benefit from being tailored to specific groups and circumstances.

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The Validation of a Focused History Script for the Social Determinants of Health in Secondary School Athletic Training

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Context: The social determinants of health (SDOH) are external factors that play a role in one's well-being, with individuals negatively affected by multiple SDOH having an increased susceptibility to health conditions. Current SDOH tools exist to assess patient exposure; however, a recent study identified athletic trainers (ATs) are unsure how to effectively integrate SDOH knowledge into clinical practice. Secondary school ATs may serve as the main access to healthcare for their adolescent patients thus emphasizing their role in mitigating the adverse effects of the SDOH. The purpose of this study was to establish content validity for a focused history script designed to facilitate SDOH conversations between clinicians and adolescents in the secondary school setting. **Methods:** The research team used a Delphi study to establish content validity of the script. Six individuals (1 AT, 5 educators/researchers; experience: mean= 15.75 years, range= 4-26 years) participated as expert panelists. For rounds 1 and 2 of the Delphi, panelists received a document with proposed script items and were asked to respond with corrective feedback on the file. For rounds 3-7, panelists were provided an electronic questionnaire via Qualtrics asking experts to indicate agreement on a 6-point Likert scale (1=strongly disagree, 6=strongly agree). We calculated mean and standard deviation for each revision, and accepted items when the mean equaled 5.0 or above and percent agreement was 80% or higher, suggesting consensus on the revised item. For round 7, in addition to indicating agreement level with each revision, we instructed panelists to indicate entire script agreement on the same 6-point Likert scale. **Results:** Seven rounds of the Delphi panel occurred to achieve content validity of the original 25-item instrument. In round 1 panelists rejected 2 items, added 14 items, an introductory statement, and requested revisions of remaining items. Round 2 proposed a 37-item script, where panelists added 5 items and requested revisions of remaining items. In round 3, 40.5% (17/42) items were accepted, 2 items removed, and remaining items modified. In round 4, 43.5% (10/23) of the remaining items were accepted, 2 items removed, and 11 remaining items modified. In round 5, 25% (3/12) items were accepted, 1 item added, 1 item removed, and the remaining items modified. In round 6, 50% (4/8) of items were accepted, 2 items added, and 4 remaining items modified. In round 7, panelists accepted all remaining items, and 100% of panelists agreed with the final 40-item script. Consensus for each construct is included in Table 1. **Conclusions:** The focused history script for the SDOH is content validated for ATs working with patients in a secondary school setting. The use of the script will provide ATs guidance on creating conversations with patients on factors that affect their life, work, and play.

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Professional Experiences of LGBTQA+ Athletic Trainers and the Resources Needed

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Context: There are many professional challenges associated with being a member of the lesbian(L), gay(G), bisexual(B), transgender(T), queer(Q), asexual(A) + (LGBTQA+) community in healthcare and athletics. Previous research has explored perceptions of LGBTQA+ athletes, coaches, nursing, and physicians; however, there is a paucity of research examining the experiences of LGBTQA+ community members as athletic trainers (ATs) within the profession. Therefore, the purpose of this study was to explore experiences of LGBTQA+ athletic trainers specifically related to the profession of athletic training. **Methods:** In this phenomenological qualitative study, thirty ATs (aged 32?11 years) who identify as LGBTQA+ were interviewed via phone or video on Zoom. Participants identified as L:15, G:6, B:5, T:1, Nonbinary/T/B:1, B/Q:1, A:1. Participants worked in the following settings: secondary school:11, college/university:16, clinic/hospital:2, clinic/secondary school:1). Data saturation guided the number of participants. Participants were recruited via purposive sampling through an email blast from the National Athletic Trainers' Association. Participants were included if they were a member of the LGBTQA+ community and practiced clinically. Participants were interviewed via phone or video based on participant comfort using a semi-structured interview guide. Interviews were recorded and transcribed verbatim. Data were analyzed through phenomenological reduction, with data coded for common themes and subthemes. Trustworthiness was established via member checking, peer review, and multi-analyst triangulation. **Results:** Four themes emerged that described professional aspects of being part of the LGBTQA+ community in athletic training: representation, professional challenges, community, and resources. Participants felt representation matters; seeing other members of the LGBTQA+ community in clinical practice and in leadership positions provides a sense of belonging and recognition that LGBTQA+ ATs can be successful in their role. However, participants felt athletic training leadership positions lacked representation. Participants also faced professional challenges, such as acceptance in athletic training, feeling like they belong in the profession, and feeling support from other ATs. Additional challenges include the lack of discussion related to LGBTQA+ issues and successes, and often feeling overlooked; but participants feel the NATA LGBTQ+ Advisory Committee is making positive progress in spearheading the discussion. Potentially one of the largest challenges is neutrality from other ATs, in which ATs are not openly hostile or discriminatory, but they are also not doing anything to provide support to or advocate for LGBTQA+ ATs. Community was also very important to participants, as those who had a network and were able to collaborate with others who faced similar challenges felt more supported in their role as an AT. While some participants did not feel they had a network, they desired a community of other LGTBQA+ ATs so they would know if others were facing similar challenges and not feel isolated as an LGBTQA+ AT. Participants also identified resources they used to be successful in their roles, such as resources produced by the NATA LGBTQ+ Advisory Committee and social networking groups on Facebook and GATher. However, participants wished there were groups specific to LGBTQA+ ATs, since they may face different challenges. Participants felt they needed a community for support and collaboration in addition to continuing education related to LGBTQA+ issues for all ATs. **Conclusions:** Overall, participants identified challenges associated with being an AT and a member of the LGBTQA+ community. Representation and recognition are important and the profession needs more members from the LGBTQA+ community in leadership positions. Education for all ATs on acceptance, working with LGBTQA+ patients and colleagues, and creating safe spaces would be beneficial, and should potentially be included as a required part of continuing education for ATs. The NATA should facilitate a community of support for LGBTQA+ ATs, so members can develop a network, collaborate, and get advice for managing challenges.

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Organizational and Personal Experiences of LGBTQA+ Athletic Trainers in Clinical Practice

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Context: Historically being a member of the lesbian, gay, bisexual, transgender, queer, asexual, plus others (LGBTQA+) community has presented challenges for healthcare providers. While there have been greater levels of acceptance, policy changes, and positive change in attitudes, disparities still exist for LGBTQA+ members within healthcare. Research indicates that LGBTQA+ healthcare providers face discrimination, assumptions, and non-inclusive policies; however, there is a lack of research examining the organizational and personal experiences of LGBTQA+ community members as athletic trainers (ATs). The purpose of this study was to examine organizational experiences of ATs who are members of the LGBTQA+ community in clinical practice. **Methods:** Thirty ATs in the LGBTQA+ community practicing clinically participated in this phenomenological qualitative study (aged 32?11 years). Participants identified as L:15, G:6, B:5, T:1, Nonbinary/T/B:1, Bisexual/Queer:1, A:1. Data saturation guided the number of participants. Participants were recruited via purposive sampling through an email blast from the National Athletic Trainers' Association. Inclusion criteria were ATs who identify as LGBTQA+ and practice clinically. Participants were interviewed via phone or video using a semi-structured interview guide. Interviews were recorded and transcribed verbatim. Data were coded for common themes and subthemes through phenomenological reduction. Peer review, member checks, and multi-analyst triangulation established trustworthiness. **Results:** Four themes emerged that described the organizational experiences: personal, role as AT, organizational culture, and challenges. Participants described personal aspects of their role, including the ability to be their authentic self. As participants developed relationships, felt supported, and gained comfort in their role, they felt they could be themselves and live authentically. However, some participants felt they lived a double life, as they could not truly be themselves at work. Participants reported the emotional aspect, such as anxiety and mental stress, and overcoming stress to fulfill their role as an AT. In their role, participants felt being part of the LGBTQA+ community allowed them to provide better patient care, as they could create an inclusive and safe space for athletes and patients. They also felt they could provide a strong role model, especially for those in the secondary school or college/university settings. While participants felt they provided better care, they also acknowledged that an AT is an AT, and sexual orientation or preference does not impact their ability to provide care. Challenges arose for participants, including overcoming assumptions or stereotypes, learning who to trust, and a lack of education and ignorance from others. Participants also experienced discrimination and heard a lot of discriminatory language. While participants recognized it was often the "toxic masculine" culture of certain sports (e.g., football, ice hockey), they still tried to intervene and educate athletes so they could create a safe space in the athletic training facility. Participant that intervened reported most secondary school and college-aged athletes responded well to education, which often resulted in fewer instances of derogatory language. Challenges faced and the participants' ability to live authentically were often influenced by the organizational culture. Participants who worked in organizations with diverse, inclusive, and supportive environments felt they could intervene in the face of discrimination, could advocate with LGBTQA+ issues, and felt more successful in their roles as ATs. Organizational culture was often impacted by geographical setting and administration. **Conclusions:** Participants felt being members of the LGBTQA+ community positively impact patient care; however, many were frustrated when faced with assumptions, discrimination, and derogatory comments. Organizations should aim to provide inclusive environments so all employees and stakeholders (e.g., students) can feel safe living authentically. If employees do not feel safe and comfortable in their role, they may feel increased anxiety and stress, which ultimately impacts their ability to fulfill roles.

This study was funded through the District 3 Research and Grant Award.

The Impact of the Social Determinants of Health on Athletic Trainer Availability: Economic Stability, Neighborhood, and Social/Community Context

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Context: The Social Determinants of Health (SDOH) are the circumstances individuals are born, work, live, and age in that influence health outcomes. Though previous research has demonstrated disparities in socioeconomic status and athletic trainer (AT) availability, this research has primarily examined economic stability, only one of the SDOH. The purpose of this study was to examine SDOH characteristics of Indiana secondary schools based on AT availability. **Methods:** We used a cross-sectional, database study design to determine AT availability for each school in Indiana using the ATLAS project database. Schools were classified as having a full-time AT (full-time AT), a part-time AT only (part-time AT), or no AT (no AT). The SDOH variables were gathered for each school at either the school-level or the county-level. Table 1 provides the categories, definitions, and sources for the SDOH variables. Data were summarized using measures of central tendencies. We used one-way ANOVAs to examine differences in normally distributed SDOH variables based on school AT availability. For non-normally distributed data we used Kruskal-Wallis one-way analyses of variance by ranks. **Results:** A total of 426 schools were included (Public N=352, 82.6%, Private N=74, 17.4%). The majority of schools (N=358/426, 84.0%) reported providing one full-time AT (N=233/426, 54.7%. Alternatively, other schools provided part-time AT (N=125/426, 29.3%) or no AT (N=68/426, 16.0%). Schools with less AT availability were located in counties with more of the population experiencing severe housing problems (full-time AT: 12.5±3.1%, part-time AT: 12.3±2.6%, no AT: 13.5±3.1%, p=0.02). There was no significant difference in AT availability in counties with larger proportions of the population experiencing severe housing cost burden (full-time AT: 10.6±3.1%, part-time AT: 10.4±2.5%, no AT: 11.4±3.3%, p=0.06). There was no significant difference in AT services based on the proportion of the county population living in a rural area (full-time AT: 34.9±28.3%, part-time AT: 38.4±25.0%, no AT: 34.7±23.0%, p=0.50). There were no significant differences in AT availability based on the three social and community context variables (p>0.05). Schools with more AT availability were located in counties with greater median household incomes (full-time AT: $54,718 [$50,500-$60,596], part-time AT: $54,674 [$48,606-$57,367], no AT: $52,301 [$48,409-$55,518], p=0.001). Finally, there was greater AT availability in counties with a smaller percentage of children living in poverty (full-time AT: 17.2±6.1%, part-time AT: 18.8±5.6%, no AT: 19.2±5.9%, p=0.007). **Conclusions:** AT availability varied based on several SDOH characteristics, with less AT availability in counties with a greater proportion of the population experiencing severe housing problems or with more children living in poverty. SDOH data may provide a broader perspective regarding the factors that influence AT availability beyond economic stability. Future research should attempt to determine the factors that predict AT availability at the secondary school level.

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Variable	Definition	Source
Economic Stability		
County Median Household Income	The income where (1/2) households earn more and half of households earn less.	US Census Bureau – Small Area Income and Poverty Estimates (SAIPE)
Children in poverty	Percentage of people under age 18 in poverty.	
Neighborhood/Build Environment	Percentage of households with at least 1 of 4 housing problems: overcrowding, high housing costs, lack of kitchen facilities, or lack of plumbing facilities.	US Department of Housing and Urban Development (HUD)
Severe housing problems		
Severe housing cost burden	Percentage of households that spend 50% or more of their household income on housing.	American Community Survey (ACS)
Rural	Percentage of population living in a rural area.	US Census Bureau – Population Estimates Program (PEP)
Social/Community Context	Number of reported violent crime offenses per 100,000 population.	Federal Bureau of Investigation – Uniform Crime Reporting (UCR) Program
Violent Crime		
Residential Segregation	Index of dissimilarity where higher values indicate greater residential segregation between non-White and White county residents.	American Community Survey (ACS)
Children in single-parent households	Percentage of children that live in a household headed by single parent.	American Community Survey (ACS)

The Impact of Social Determinants of Health on Athletic Trainer Availability: Access and Quality of Education and Health Care

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Context: Previous investigations into access of athletic trainer (AT) availability have primarily focused on economic influences. However, the overall health of patients are influenced by the social determinants of health (SDOH), which include the context in which patients are born, learn, work, and live. Two important SDOH categories include education access / quality and health care access / quality. The purpose of this study was to investigate differences in these two SDOH categories based on AT availability in Indiana secondary schools. **Methods:** We used a cross-sectional study using publically available databases. We determined AT availability for each school in Indiana using the ATLAS project database. Schools were classified as having a full-time AT (full-time AT), part-time AT only (part-time AT only), or no AT (no AT). Education access/quality data were gathered at the school-level from the Indiana Department of Education, which included student enrolment, school race / ethnicity demographics, and the percentage of students eligible for free or reduced lunch at the school (%Free). Health care access / quality data were collected for each county from County Health Rankings and Roadmaps project. Data were summarized using measures of central tendency. We used one-way ANOVAs to determine differences in normally distributed SDOH variables based on school AT availability, and Kruskal-Wallis one-way analyses of variance by ranks were used to determine differences in non-normally distributed SDOH variables. **Results:** 426 schools were included (Public N=352, 82.6%, Private N=74, 17.4%) and 358 schools (84.0%) reported providing AT services (full-time AT=233, 54.7%; part-time AT=125, 29.3%), while 68 (16%) provided no AT services. School enrollment was larger in schools with greater AT availability (full-time AT: 747 [489-1390], part-time AT only: 500 [357-735], no AT: 274 [183-440], $p<.001$). The proportion of non-white students was also greater in schools with more AT availability (full-time AT: 14.2% [7.5-31.2%], part-time AT only: 8.5% [5.7-18.2%], no AT: 7.7% [4.9-44.6%], $p=0.002$). There was greater AT availability in counties with higher high school graduation rates (full-time AT: 87.4±6.6%, part-time AT only: 89.7±5.5%, no AT: 88.4±6.4%, $p=0.03$). Schools with less AT availability tended to be located in counties with a slightly higher percentage of the population uninsured (full-time AT: 10% [8-11%], part-time AT only: 9% [8-10%], no AT: 10% [9-12%], $p=0.02$). Finally, schools with greater AT availability were located in counties with fewer primary care physicians relative to the population size ($p=0.03$). **Conclusions:** Most notably we identified that AT availability was greater in counties where there were fewer primary care providers, greater proportion of the population uninsured, and higher high school graduation rates. Athletic trainers in areas with more uninsured patients and fewer primary care providers can serve as a vital resource for health care and influence the outcomes of patients in these areas.

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Cultural Competence and Race Concordance in Athletic Training

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Context: Cultural competency is an important knowledge and skill for all health care providers. Additionally, race concordance, when both the patient and provider are of the same race, has been shown to affect patient experiences. The purpose of this study was two-fold. 1) to determine if cultural competence training and gender affects cultural competency levels in athletic trainers and 2) to identify if racially discordant athlete/provider relationships affect patient perceptions of their athletic trainer. **Methods:** A nationwide cohort study was completed via an electronic survey through Qualtrics. A survey was sent to athletic trainers in the college/university setting. Emails were obtained from the NATA email database. Sports Medicine Directors from NCAA and NAIA institutions were asked to forward the electronic survey onto athletes in their athletic programs. Four hundred forty-seven (32.21±9.05years, 276 females, 170 males, 1 gender non-conforming) athletic trainers participated. Two hundred eighty (19.87±1.39years, 187 females, 93 males) student-athletes participated. The athletic trainers completed a demographics section and a slightly modified Cultural Competence Assessment (CCA). The CCA assesses both individual behavior and individual awareness and sensitivity. Student-athletes completed a demographics section followed by a slightly modified 10 item perceived similarities measure (PSM). The PSM assesses patient's perceived ethnic and cultural similarities with their provider. An ANOVA was conducted with the between subjects factor for athletic trainer cultural competence training (yes or no) and the total CCA score. A MANOVA was conducted with the between subject's factor for athlete race concordance (yes or no) and the 10 perceived similarities questions. Alpha level α/<\0.05 for all analyses. **Results:** Athletic trainers who received cultural competence training scored significantly higher (92.69±12.68) than those who did not (85.57±13.68) ($F(1,445)= 24.572$, p/<\0.001). Female athletic trainers (93.49±12.53) who received cultural competence training scored significantly higher than males (86.92±13.48) ($F(2,444)=13.73$, p/<\0.001). For the athletes in the study, 75% (N=210) were in a racially concordant relationship, of which, only 2.9% (N = 8) were minority athletes. Athletes that were in racially concordant relationships with their athletic trainers scored significantly higher on 5 of the 10 PSM questions than athletes in discordant relationships (p/<\0.05) (Table 1). **Conclusions:** Athletic trainers who received cultural competence training have increased cultural competence scores measured by the CCA. Minority student-athletes are more likely to be in racially discordant relationships (race not matching their providers race). However, when minority student-athletes are in a racially concordant relationship, they report feeling ethnically similar to their athletic trainer. Increasing the number of ethnically diverse athletic trainers may improve the ratio of race concordance between student-athletes and athletic trainers. Ensuring cultural competence training is comprehensive for both current athletic trainers and future athletic trainers will benefit student-athletes in racially discordant relationships.

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Table 1. Descriptive Statistics on the 10 Perceived Similarities Questions by Race Concordance.

	Concordant (N=209)	Disconcordant (N=71)
The way my athletic trainer and I speak is _____.	4.74±1.233	4.76±1.213
The way my athletic trainer and I reason about problems is _____.	4.73±1.113	4.90±1.110
My athletic trainer and I have _____ styles of communication.	4.89±1.071	4.86±1.187
My athletic trainer and I have _____ general values in life.	4.80±.978	4.77±1.098
My athletic trainer and I have _____ spiritual beliefs.	4.09±1.150	3.82±1.345
My athletic trainer and I have _____ ethnic backgrounds.*	5.03±.963	2.44±1.565
The types of people I spend my free time with and the types of people my athletic trainers spends their free time with are _____.*	3.62±1.329	3.21±1.413
My athletic trainer and I are _____ in terms of race.*	5.55±.826	2.37±1.658
My athletic trainer and I are _____ in terms of culture. *	4.98±1.038	2.86±1.543
My athletic trainer and I are _____ in terms of skin color. *	5.73±.683	2.55±1.827

*significant between groups (p<0.05)

Fundamental Movement Skills Vary Between Children of Different Races

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Context: The promotion of safe physical activity participation, through the acquisition of appropriate neuromuscular control and fundamental movement skills (FMS), is widely endorsed for children. Minority children are specifically at risk for being physically inactive, which may be a result of inadequate neuromuscular control that may also predispose them for future musculoskeletal injury. The purpose of this study was to evaluate FMS competency and movement control, which is an aspect of neuromuscular control associated with injury risk, between children of color (CoC) and Non-children of color (NCoC) in males and females. **Methods:** A multi-site, cross sectional study design was used for this investigation. Participants were recruited to complete a single test session from schools and youth sport organizations across the country. All participants (n=288, males=132, females=156) and their parent/legal guardian provided informed assent and consent, respectively. Race, gender and age were reported on a questionnaire completed by parents/legal guardians. Participants were grouped into 2 categories based on their self-reported race (CoC: African American, Asian-American, Hispanic/Latino, or Other; NCoC: Caucasian or white). FMS competencies, were assessed using the validated PLAYfun assessment tool and divided into five domains: locomotor, balance, upper extremity object control (UEOC), lower extremity object control (LEOC) and running. Each domain consisted of discrete tasks. Each task was measured using a 100-point visual analog scale (100= proficient, 0= not competent). The average total score across all tasks within each domain was calculated for 5 separate composite competency scores. Movement control was assessed during three trials of a standardized jump-landing task, and evaluated using the LESS. The average total LESS score across 3 trials was used for analyses. Separate analyses of variance were used to compare competency in each FMS domain (locomotor, balance, UEOC, LEOC and running) and LESS scores between CoC and NCoC in males and females. ($P < 0.05$). **Results:** CoC and NCoC differed in locomotor (males: p=0.002, CoC=64.38± 13.75, NCoC=72.85±13.80; females: p=0.001, CoC= 66.13±14.11, NCoC =74.52±13.15) and balance (males: p=0.011, CoC=64.92±17.56, NCoC=72.69±14.49; females: p=0.001, CoC=64.66±16.45, NCoC=74.02±13.71). Differences between CoC and NCoC were also observed for females with LEOC (p=0.043; CoC=57.30±25.81; NCoC=65.63±18.19). No significant differences in LESS scores were observed ($P > 0.05$). **Conclusions:** CoC demonstrate lower competency during locomotor, balance and LEOC tasks, which may influence their future physical activity. These differences may be attributed to fewer opportunities for skill development and emphasize the need for interventions within this population. Despite differences in FMS, children of all races exhibited similar movement control. This study is limited in combining all people of color to a single category. These groups have individual experiences, which future research should acknowledge.

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Perceptions of Microaggressions in Athletic Training Clinical Practice

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Context: Microaggressions, identified as implicit discrimination, experienced in health care settings have the potential to develop negative physical and mental health outcomes for patients; consequently, contributing to health disparities and health inequities. Perceived implicit discrimination by a health care provider also has the potential to negatively affect health care utilization, causing a decline in patient adherence. Research regarding microaggressions in athletic training clinical practice and its impact on patient health and/or the patient-clinician relationship has not been widely studied. The purpose of this study is to investigate and to analyze the types of microaggressions experienced by student athletes during patient care or while recovering from injury. **Methods:** The study employed a cross-sectional research design to explore the prevalence of microaggressions in athletic training clinical practice. Athletic administrators from 1,113 NCAA Division I, II, and III member institutions were asked to distribute a recruitment email and electronic survey link to all student athletes from their institution. The electronic survey distributed to student athletes explored their experience of perceived health care discrimination via intersectional microaggressions and their perceived impact on patient care. The survey link consisted of the Perceptions of Microaggressions in Athletic Training Clinical Practice (PMATCP) measurement scale which included 3 validated assessment tools: the Racial Microaggression in Medical Practice Scale (RMMPS), the Discrimination in Health Care Measure, and the Racial Microaggression Scale (RMAS). Student athletes were allowed to provide an open comment/explanation if a microaggression occured. The target population was 1,000 student athletes aged 18 years or older participating in any NCAA sport from Division I, II, and III NCAA member institutions. SPSS was utilized for quantitative data analysis. Descriptive statistics were utilized for demographics. **Results:** The preliminary results include the following: Participants to date are 106 NCAA student athletes aged 18 years or older (aged 18-24 N= 101; aged 25+ N=5). Sixty-nine percent of student athletes self-reported as female. The most prevalent microaggressions reported to date included gender and ability with 25% (N=27) of respondents reporting a microaggression. Eleven percent of respondents reported being treated with less courtesy than other people because of their race, gender, sexual orientation, socioeconomic status, religion, or ability. **Conclusions:** Microaggressions impact patients in varying ways and have the potential to undermine the principles of culturally competent, patient centered care. They can have a deleterious effect on patient compliance and patient outcomes. The preliminary findings of this study indicate microaggressions in athletic training clinical practice are rare occurrences. However, because they do occur, there is a need for athletic training clinicians to become aware of the complexities of microaggressions and their impact on patients to develop strategies to eliminate their use in clinical practice.

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Medical Deserts and Athletic Training Services in Secondary Schools Across the United States

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Context: The term "medical desert" is defined as the region where the population has inadequate access to healthcare. Many secondary school (SS) athletes participating in sports activity in these regions have limited access to emergency care. Since injury is an inherent risk to sport participation, catastrophic injuries in SS athletes do happen despite mitigation efforts. It is essential for all athletes to have prompt access to appropriate care following catastrophic injuries. Although athletic trainers (ATs) can provide emergency care in these situations, the status of SS ATs services in medical deserts is unknown. Therefore, the purpose of this study was to quantify and describe SSs located in medical deserts and the odds of having AT services across the United States. **Methods:** The geographic coordinates of SSs (n=21,140) were extracted from the Athletic Training Locations and Services (ATLAS) project. All schools were geocoded and mapped using Tableau Desktop (version 2021.3). U.S. Level 1 and 2 trauma centers (n=449) were identified and geocoded to calculate the distance between each school and the closest trauma center. All schools were categorized into 4 classes based on the distance; Class 1= < 60 miles, Class 2= 61-90 miles, Class 3= 91-120 miles and Class 4= >120 miles. Classes 2-4 (>60 miles) were in medical deserts. The total number and percentage of each distance class by NATA District were reported. Additionally, the status of SS AT services (yes or no) was extracted from the ATLAS project. Those schools with unknown status were assumed as not having AT services at the time of analyses. Pearson's Chi-Square, odds ratio (OR) with 95% confidence intervals (CI), and likelihood ratios (LR) were calculated in order to determine the relationship between SS AT employment and distance from the closest trauma center. **Results:** Twenty percent of SSs in the US are located >60 miles from the closest trauma center. The number and percentage by distance class and by NATA District are displayed in Table 1. The odds of having AT services were significantly greater in schools located < 60 miles to the closest trauma center compared to other 3 classes (Class 2: OR=1.57; [CI:1.44-1.72]; $\chi 2$=99.87 ; P<0.001, Class 3: OR=2.04; [CI:1.79-2.33]; $\chi 2$=114.34; P<0.001, Class 4: OR=2.50; [CI:2.20-2.85]; $\chi 2$=202.611; P<0.001). **Conclusions:** This was the first study to identify AT medical deserts in SSs across the US. Twenty percent of SSs in the US were located > 60 miles from the closest trauma center with reduced odds of having AT services. Identifying SSs located in medical deserts and the status of AT services are critical first steps to encourage the improvement of healthcare access to SS athletes in these regions and prevent fatal consequences of catastrophic injuries in the future.

The Korey Stringer Institute is a non-profit organization within the Department of Kinesiology at the University of Connecticut. Corporate partners of KSI include the National Football League, Gatorade, the National Athletic Trainers' Association, Nielsen-Kellerman, CamelBak, Defib Tech, and First Line Technology. This original research abstract utilizes data from the Athletic Training and Locations Services (ATLAS) Project, which is co-owned by the NATA and KSI.

Risk of Upper Extremity Musculoskeletal Injury Within the First Year Following Concussion

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Context: Emerging evidence suggests that athletes are at increased risk for lower extremity musculoskeletal injury following concussion; however, no prospective studies have examined the association between concussion and subsequent upper extremity (UE) musculoskeletal injury. The purpose of this study was to prospectively examine the association between concussion and UE musculoskeletal injury risk within the first year after unrestricted return-to-activity. **Methods:** A nested case-control design was used to examine the association between concussion and subsequent UE musculoskeletal injury among military cadets enrolled in the Concussion Assessment, Research and Education Consortium. From August 2015 to May 2018, 316 cases of concussion were observed among 290 cadets (170 Male, 120 Female). Active injury surveillance within the cohort was conducted for 12-months following unrestricted return-to-activity to identify any incident cases of UE musculoskeletal injury. UE musculoskeletal injury was defined as any acute injury (i.e., fracture, strain, sprain) to the shoulder, elbow, arm/forearm, wrist/hand, or finger/thumb as the result of a single traumatic event and recorded by a medical provider in the cadet's medical record. Contusions, blisters, abrasions, and chronic injuries were excluded. Injury surveillance during the follow-up period was also conducted for nonconcussed controls who were matched on sex and sport level (i.e., intramural, club, varsity). Other potential risk factors considered included baseline Brief Symptom Inventory-18 anxiety, depression, and somatization scores and UE musculoskeletal injury history. The primary outcome of interest was time from return-to-activity following concussion to incident UE injury in concussed cases and nonconcussed controls. Kaplan-Meier survival estimates were calculated by group (concussed vs nonconcussed). Univariate and multivariable Cox proportional-hazards regression models were used to estimate hazard ratios (HR) and 95% confidence intervals (95%CI) between cases and controls and time to UE injury during the surveillance period. **Results:** During the surveillance period, 19.3% of concussed cases and 9.2% of nonconcussed controls sustained an UE injury. Kaplan-Meier survival estimates for UE injury for concussed cases and nonconcussed controls are presented in Figure 1. In the univariate model, concussed cases were 2.25 times more likely (HR=2.25, 95%CI: 1.45-3.51, p=<0.001) to sustain an UE injury during the 12-month follow-up period when compared to controls. In the multivariable model, adjusted for concussion history, sport level, somatization, and UE injury history concussed cases were 1.84 times more likely (HR=1.84, 95%CI: 1.10-3.07, p=0.019) to sustain an UE injury during the surveillance period compared to controls. Sport level remained an independent risk factor for UE musculoskeletal injury. **Conclusions:** Athletes who sustained a concussion were twice as likely to sustain an UE injury within the first 12-months after unrestricted return-to-activity when compared to nonconcussed controls. Further investigation into the deficits that may contribute to the increased risk of UE musculoskeletal injury following concussion observed in the current study is warranted.

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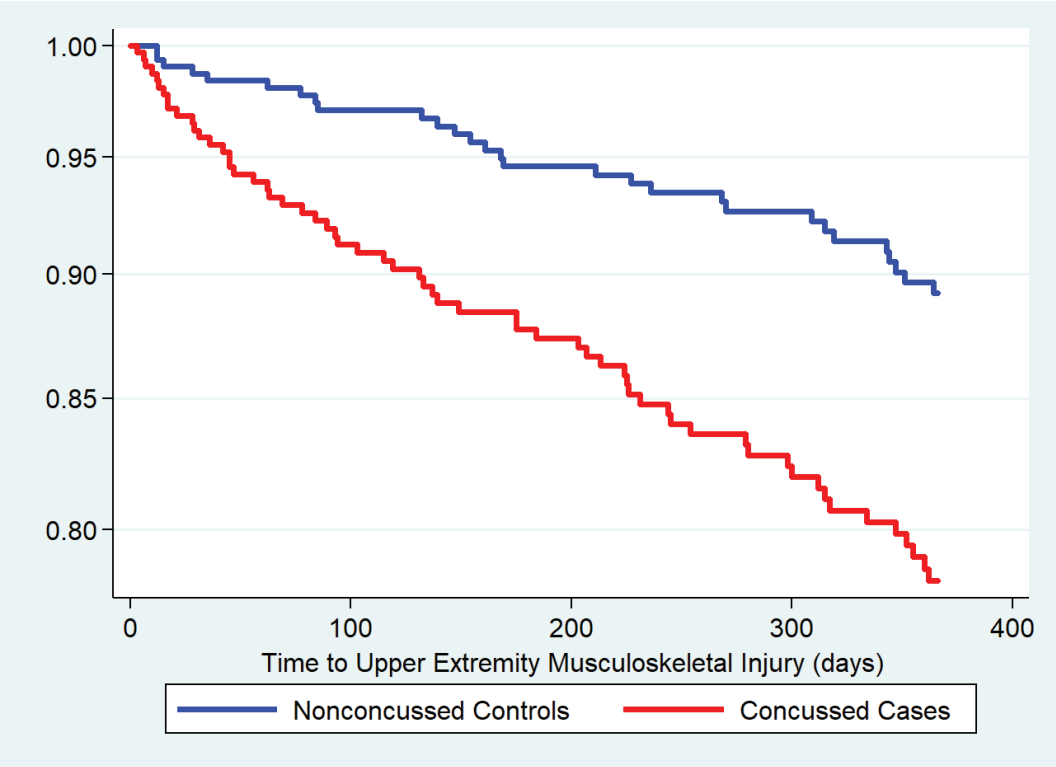
Figure 1. Kaplan-Meier survival estimates for incident upper extremity musculoskeletal injury in concussed cases and nonconcussed controls over the 12-month follow-up period.



Premorbid Migraine Negatively Impacts Baseline Concussion Measures in Collegiate Student-Athletes

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Context: Migraine and concussion share common pathophysiological origins and directly affect more than 539,000 student-athletes in the United States annually. Pre-morbid migraine has been identified as a risk factor for worse outcomes following concussion; however, there remains a paucity of research on migraine and commonly used concussion assessment and quality of life. Differences in performance may have implications in additional referrals, test interpretation, and concussion management post-injury. **Methods:** The current study was a cross-sectional design completed in the Sport Concussion Laboratory. Student-athletes were recruited during their annual baseline concussion assessment and signed the institutional review board informed consent to have their data included. Student-athletes completed demographic/health history questionnaires including migraine history, neuropsychological exam (i.e., Standardized Assessment of Concussion, ImPACT), vestibular/ocular motor exam, and postural control. Student-athletes were grouped on migraine history. Independent t-tests and MANOVA's were used to determine differences between groups (migraine and non-migraine) and concussion assessments. **Results:** A total of 199 NCAA and club student-athletes (88 males, 110 females, 1 non-binary) from 7 sports (cheerleading/dance, ice hockey, karate, rowing/crew, rugby, soccer, volleyball) were included in the study. Freshman comprised 35% of the sample. Twelve percent of the population (25 individuals) were identified as having migraine. The migraineurs had greater vestibular ocular motor screening (VOMS) symptom provocation (mean = 1.36(2.74), non-migraine = 0.41(1.59); $t(197) = -2.498$, $p = 0.013$) and reported higher anxiety and depression symptoms on the Hospital Anxiety and Disability Scale questionnaire (anxiety mean = 8.68(4.44) non-migraine mean = 5.66(3.73); $t(197) = -3.574$, $p < 0.001$; depression mean = 2.84(2.63), non-migraine mean = 1.63(2.06); $t(197) = -2.645$, $p = 0.009$). Near point of convergence scores, though not statistically significant, were both above the clinical cut-off point (>5cm) for concussion (migraine mean = 6.00cm (7.12); non-migraine mean = 5.66cm (3.72); $t(197) = -0.377$, $p = 0.707$). The migraine group also reported higher symptoms on the Post-Concussion Symptom Scale (migraine mean = 7.28(9.45), non-migraine mean = 4.34(9.08); $t(197) = -1.508$, $p = 0.133$) and on the VOMS (migraine mean = 0.76(1.27), non-migraine mean = 0.32(1.19); $t(197) = -1.728$, $p = 0.086$) though neither reached statistical significance. Cognitive/neuropsychological assessments and postural control tests were not significantly different between migraine and non-migraine groups. Post-hoc analysis revealed significant power for the significant outcome measures. **Conclusions:** Collegiate student-athletes with migraine reported greater vestibular ocular motor symptoms and worse quality of life (i.e., anxiety and depression) disability during baseline assessments than peers without migraine. Once identified, the athletic trainer can work within their scope to manage migraine as needed or as part of the healthcare team to make appropriate referrals and improve patient outcomes.

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Changes in Head Impact Exposure Through the Duration of a High School Football Game

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Context: Despite strategies for reducing head impact exposure (HIE) in football, head impacts are still a common occurrence. To our knowledge, characteristics of HIE throughout the duration of a game has not previously been reported. Due to fatigue or other factors, we hypothesized that HIE would increase in frequency over the course of a game. **Methods:** Following approval by the University of Hawai'i- Mānoa IRB, participants were recruited from 2 local private high school football programs. Players received Riddell® helmets fitted with InSite impact sensor technology. Insite has been previously reported in the literature. Head impact data outputs were recorded as HIE frequency and location (front, top, right side, left side, or back) in low (15-28 g's), medium (29-63 g's), and high (>63g's) force magnitude categories, and in addition to 'Alert' impacts designated as >95th percentile rank of a normative data set. Researchers monitored data capture at all games and recorded time sequences for quarter changes and half-time. Data export to cloud storage permitted review for systemic irregularities using the Riddell® InSite Training Tool software. Prior to analysis, data were filtered for spurious impacts by use of time stamp and attendance records. Descriptive and comparative analyses of frequency and location (front) for combined HIE and Alerts were carried out using the data from quarters 1 through 4 (Q1-Q4). We focused our analyses on comparison between Q1-Q2 and between Q3-Q4. To account for pairwise blocking by player, we performed paired t-tests as well as Wilcoxon signed-rank tests (R software, $p=0.05$), with the alternative hypothesis that Q2-Q4 data are greater than Q1-Q3, respectively (resp.). **Results:** Results: Study participants (n=178) represented 2 varsity (n=108) and 1 junior varsity (n=70) teams having a distribution of 32 freshman, 65 sophomore, 51 junior, and 30 seniors. Participants recorded 5115 game-related head impacts (HIE, 4891; Alerts, 224). Combined HIE and Alert frequency data indicated significant positive differences in head impacts between Q2 and Q1 and between Q4 and Q3, with both the paired t-tests ($p=0.01$ and $p=0.02$, resp.) and the Wilcoxon signed-rank tests ($p=0.02$ and $p<0.01$, resp.). (Figure 1) Combined HIE and Alert data indicated a significant positive difference in front location impacts between Q2 and Q1 and between Q4 and Q3, from the Wilcoxon signed-rank tests only ($p=0.02$ and $p=0.04$, resp.). (Figure 1) All other tests resulted in non-significance. **Conclusions:** HIE frequency increased across two successive quarters of play, and those impacts stemmed from impacts sustained to the front of the helmet. This suggests that players' technique for avoiding head-first impact may deteriorate over time. Whether this increase in HIE is due to fatigue, competitive intensity, or other factors is important for future research in order that interventions can be designed to sustain head-safe behaviors during game-play.

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Investigating the Associations of Concussion History and Repetitive Head Impact Exposures With BESS Test Performance and Sensorimotor Cortex Structure and Function in Former Football Players

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Context: Prior studies have reported subtle sensorimotor deficits in athletes beyond clinical recovery from sport-related concussion and following a single season of contact sport participation (e.g., associated with repetitive head impacts). The degree to which these deficits may persist several years later, and their neural correlates, are unknown. We explored associations of concussion history and repetitive head impact exposure with BESS test performance as well as measures of structural and functional brain health within sensorimotor cortices of relatively young former football players. **Methods:** In this cross-sectional study, 46 male former collegiate football players (aged 37.9±1.5 years; BMI=30.5±4.3 kg/m2) volunteered to complete advanced MRI and BESS evaluations at 1 of 2 research sites approximately 15-years after discontinuing sport participation. Participants self-reported lifetime concussion history (CHx) and completed a semi-structured interview regarding their football playing history. Years of play and playing position(s) at each level of play were utilized to calculate each participant's adjusted Head Impact Exposure Estimate (HIEE), a surrogate for accumulated head impact exposure from playing football. Structural (T1- and T2-weighted images) and resting-state functional MRI data were pre-processed using standard pipelines in Freesurfer and the FMRIB Software Library (FSL), respectively. Outcomes of interest were: (1) BESS Total Errors; (2) cortical thickness of the precentral gyrus (primary somatomotor cortex) and postcentral gyrus (primary somatosensory cortex); and (3) resting-state functional connectivity (rsFC; average Pearson r correlations of neural activity between regions of interest within a given network) of two large-scale functional networks centered in the pre- and postcentral gyri (somatomotor dorsal, SMD; somatomotor lateral, SML). A multivariable linear regression model was fit for each outcome with both CHx (ordinal groups: 0-1 [n=18]; 2-4 [n=8]; 5-7 [n=9]; and 8+ [n=11] lifetime concussions) and HIEE (continuous) as independent variables. Data acquisition site (site A n=36; site B n=10) was included as a covariate. Analyses were performed on SPSS with an a-priori α set at 0.05. **Results:** Lifetime CHx and HIEE were not significantly associated (all ps >0.05; Table) with BESS Total Errors or with measures of brain sensorimotor region structure (precentral and postcentral cortical thicknesses) or function (rsFC within the SMD and SML networks). However, notable effect sizes were observed for the relationship between HIEE and both postcentral gyrus thickness and rsFC in the SMD. **Conclusions:** Our findings generally do not support the notion that long-term sensorimotor changes and balance test performance deficits inevitably result from prior head trauma in former collision-sport athletes. Significant effects of concussions and repetitive head impacts were not observed in relation to measures of somatosensory and somatomotor brain health in these relatively young former football players. Longitudinal studies across the lifespan are required to understand the onset and magnitude of neurologic complications related to concussions and contact sport participation.

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Girls Middle School Soccer Athletes Have Greater Rate of Concussion and Longer Recovery Than Boys

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Context: Soccer is among the most popular sports played around the world, particularly among children and adolescents. Prior researchers have demonstrated that females have greater rates of concussion than males across age and level of play. However, little research has examined this issue among middle school age athletes participating in school-sponsored sport. Therefore, the purpose of this study was to compare the rates of concussion and days lost among middle school girls' and boys' soccer athletes. **Methods:** As a part of the Advancing Healthcare Initiatives for Underserved Students (ACHIEVES) Project, a retrospective descriptive epidemiology study of middle school soccer athletes was conducted. Data were collected from nine (years: 2015/16 to 2018/19) and 16 (years: 2019/20) middle schools, respectively. Certified athletic trainers collected injury information and athlete exposure (AE) data for all school-sponsored practices and competitions. An AE was defined as one soccer athlete participating in one school-sponsored event. Injury rates (IRs) were calculated per 1000 AE. Injury rate ratios (IRR) with 95% confidence intervals (CI) were then calculated to compare IRs between girls and boys overall, and by competitions and practices. IRRs with 95% CIs that did not include the value of 1.0 were considered statistically significant. Mann Whitney U tests compared restriction form sports participation (i.e., days out) between girls and boys. **Results:** Twenty-six concussions were reported for 22,199 AEs during girls' soccer (IR=1.17, 95% CI:0.72-1.62) while 15 concussions were reported for 37,713 AEs during boys' soccer (IR=0.40, 95% CI:0.20-0.60). Overall, girls were nearly three times more likely to sustain a concussion than boys while participating in soccer (IRR=2.94, 95% CI:2.17-4.00). During competitions, girls were twice as likely to sustain a concussion than boys (Girls: n=16, IR=2.57; 95% CI:1.31-3.83; Boys: n=12, IR=1.26; 95% CI:0.55-1.97; IRR=2.04 95% CI:0.97-4.30). At practices, girls were nearly six times more likely to sustain a concussion than boys (Girls: n=10, IR=0.63, 95% CI:0.24-1.01; Boys: n=3, IR=0.11, 95%CI:-0.01-0.23; IRR=5.87, 95% CI:2.78-12.42). Further, girls took significantly longer to return to sports participation than boys following concussion (Girls: 24.47±21.46 days, median=19, IQR=14.50-24.00; Boys: 12.90±6.05, median=13, IQR=9.75-14.75; $p<0.01$). **Conclusions:** Our findings reinforce prior reports that adolescent female soccer athletes have greater risk of concussion than their male counterparts. In our study, girls were 3 times more likely to sustain a concussion and IR were higher for both girls and boys than prior findings. Additionally, girls took twice as long (on average) to return to sports participation. Our findings suggest that further research is needed to examine reasons for higher rates and protracted recovery among girls' soccer athletes. This should include examining sport-specific mechanism of injury differences between the genders. Collectively, such information may inform gender-specific, primary prevention concussion mitigation strategies in soccer.

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A Qualitative Study of Factors and Perceptions Impacting Concussion Care Among Collegiate Club Sport Athletes

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Context: Timely and appropriate identification and disclosure of concussion-related symptoms are integral to proper care and management of sport-related concussions. There are few concussion-related studies concerning collegiate club sport athletes, despite high number of athletes participating at this level. It is essential we understand the factors impacting concussion-related care-seeking/disclosure in collegiate club sport athletes to better prevent and manage concussions in this population. Therefore, the objective of this study was to explore and identify factors and perceptions regarding sport-related concussion care-seeking and disclosure among collegiate club sport athletes. **Methods:** The study followed a consensual qualitative research tradition (CQR) rooted in phenomenology. A convivence sample of twenty-five collegiate club sport athletes representing nine sports (11 males; 14 females; age = 20.48±1.39 years) were interviewed in person in a university lab setting using a semi-structured format. The interview guide was piloted and reviewed by experts in cognitive interview techniques and concussions. Participants were recruited via convenience sampling. Data saturation guided the total number of participants. The interview served two purposes: 1) addressing the purpose of the current study (7 open-ended questions); and 2) evaluating an interactive concussion education platform (20 open-ended questions). Each interview was recorded and transcribed verbatim. A four-person research team with varying degrees of familiarity with CQR (novice to expert) individually coded the data into themes, categories, and subcategories and then met to attain consensus and comprehensiveness. An internal auditor reviewed the results. **Results:** Participant interviews highlighted two themes concerning concussion care: 1) disclosure; and 2) club sport dynamics. The disclosure theme included the categories of individualized experience, peer experience, barriers, and facilitators. Athletes described their previous experience with concussion disclosure, whether personally or as witnessed in their peers. Athletes also discussed barriers and facilitators towards disclosure. When detailing their concussion disclosure experience and reasons they chose not to disclose, the perception that disclosing and seeking care would be letting their team down was cited most. Facilitators included encouragement from coaches and teammates and the presence of and access to athletic trainers. The club sport dynamics theme encompassed the categories (and subcategories noted in parentheses) of culture, team dynamics, organizational structure (rules; regulations), and resources (presence of a medical professional). When explaining the culture and dynamics of club sports, participants described a general understanding of concussions but a lack of accountability in following best practices for prevention, disclosure, and treatment in the club sport environment. Participants also expressed a desire for more consistent medical resources, specifically athletic trainers being physically present at practices and games. **Conclusions:** Results suggest that the team culture of club sports and the presence of a healthcare provider, specifically an athletic trainer, may impact a collegiate club sport athlete's willingness to disclose concussion-related symptoms. These findings illustrated the importance of prioritizing athletic trainer presence at club sport athletic activities and a supportive team culture for creating an environment where athletes feel safe and encouraged to disclose concussion-related symptoms. This study also underscores the need for club sports organizations and medical personnel to understand athletes' perception of the concussion management process and improve the presence and access to healthcare professionals in club sports. It is crucial to consider barriers and facilitators of club sport dynamics that may play a role in an athlete's concussion care-seeking decisions and to educate and encourage club sport athletes on the steps to take when they experience concussion-related symptoms.

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Increased Risk of Sport Concussion Following a Lower Extremity Injury in Division I Collegiate Athletes

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Context: Previous research suggests collegiate athletes are at an increased risk of lower extremity injury (LEI) following a sport concussion (SC). However, the inverse relationship has yet to be explored. The purpose of this study was to determine the risk of SC in collegiate athletes with a history of time-loss LEI. We hypothesized that athletes with a prior history of time-loss LEI(s) would have an increased risk of SC during a 12-month period. **Methods:** This prospective study consisted of 352 Division I collegiate athletes (193 males, 159 females). Participants were on average 18.6+/-1.2 years old, 178.2+/-10.6 cm tall, and weighed 79.2+/-18.5 kg. Prior to the start of their respective sport seasons, all participants were administered a medical history form which asked them to self-report their history of time-loss LEI(s). Time-loss LEI(s) included in the intake form were hamstring and quadriceps strain(s), anterior cruciate, medial collateral, lateral collateral, and posterior cruciate ligament tear(s), meniscus tear(s), Achilles tendon rupture(s), ankle sprain(s), and ankle fracture(s). No additional time-loss LEIs were considered. Participants were subsequently divided into two groups based on if they self-reported (n=92) or did not self-report (n=260) a history of time-loss LEI(s). All concussions were diagnosed by an athletic trainer or physician and recorded for a 12-month period following pre-season assessment. As a prior concussion history has been demonstrated to be a risk factor for subsequent concussions, all participants with a history of concussion were excluded from our analyses. Descriptive data were analyzed using independent t-tests and chi square (x2) analyses. Effect sizes were calculated using Cohen's d with [95% confidence intervals]. The association between SC following LEI was established by calculating likelihood (LR) and odds (OR) ratios. All analyses were performed with alpha =0.05. **Results:** Groups were statistically similar in in height, age, and sex (all p>0.10). However, participants with a history of LEI weighed significantly more (82.9+/-20.45) than participants without a history of LEI (77.9+/-17.58), (t(350)= -2.23, p=0.03, d=-0.27[-0.51,-0.03]). Of those participants with a history of LEI and those without, approximately 16.3%(15/92) and 6.8%(18/263) were diagnosed with a SC, respectively. Participants with a history of LEI were at an increased risk of SC with a LR of 6.36(p=0.01) and an OR of 2.62[1.26-5.44]. **Conclusions:** Our findings suggest DI collegiate athletes with a history of LEI are at an increased risk of SC within 12-months of a pre-season assessment when controlling for prior history of concussion. Our findings expand upon related literature that suggests an increased risk of LEI following a diagnosed SC by providing evidence that supports the opposite relationship may also be true.

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Symptom Profiles Do Not Correlate With Driving Performance in Athletes Post-Concussion

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Context: Driving is a complex task requiring drivers to respond quickly and accurately to a multitude of stimuli. Driving post-concussion may pose a threat to the individual driver, but also to other drivers and pedestrians because of impairments to vision, cognition, and motor function. Acute symptom profiles such as cognitive, emotional, sleep, and somatic are well-established and may negatively affect driving performance outcomes such as speed exceedances, lane excursions, missed stop signs, and collisions in individuals experiencing an acute concussion. Driving recommendations can be made by healthcare professionals if they can identify factors influencing driving performance post-concussion. Therefore, our study purpose was to assess the relationship between symptom profiles and driving performance among collegiate student-athletes acutely post-concussion. We hypothesized only cognitive and sleep symptom profiles would moderately correlate with driving performance. **Methods:** A cross-sectional cohort study was conducted with 19 Division I student-athletes (females = 9, driving experience = 1-6 years) who were evaluated for a concussion within 72 hours of sustaining a physician diagnosed concussion. A SCAT5 symptom checklist was completed to identify acute symptom severity prior to completing a simulated drive scenario. Symptom severity profiles were derived by separating the 22 SCAT5 symptoms into cognitive, emotional, sleep, or somatic profiles, and summing symptoms within each profile as previously established. The simulated drive was completed on 3, 25in surrounding monitors using an instrumented steering wheel, brake pedal, and accelerator pedal controls via STISIM drive software, model 100WS, version 3 (STI Inc, Hawthorne, CA) sampling at 60Hz. Student-athletes completed a 2 minute familiarization drive to ensure comfort with the simulator and controls. Then student-athletes completed the simulation consisting of an 8-mile route with 11 simulated daily traffic scenarios. Driving simulator performance outcome variables included collisions, speed exceedances, missed stop signs, and lane excursions. We used a Pearson's r or Spearman's rho bivariate correlations to determine if symptom profiles correlated with speed exceedances, lane excursions, or missed stops. Binary logistic regressions calculating odds ratios (OR) with 95% confidence intervals were used to determine whether each symptom profile had altered collision odds (α=0.05). **Results:** Acute symptom profiles did not significantly correlate with speed exceedances (r= 0.162-0.344, p=0.149-0.509), lane excursions (rho= 0.062-0.295, p=0.221-0.802), missed stop signs (rho= -0.420- -0.224, p=0.074-0.356), and did not predict collision odds(p=0.879-0.935). **Conclusions:** Our results suggest that symptom profiles are not related to driving performance within 72 hours of injury. Assessing driving performance may offer unique and vital safety insights beyond the current post-concussion clinical measures, but may be challenging for widespread clinical implementation. Further research is needed to identify clinical measures that would be indicative of impaired driving outcomes in concussed patients.

None of the authors have any financial disclosures.

Free Communications, Oral Presentations: Who, What, Where and When Working as an Athletic Trainer

Moderator: Alicia Lacy, PhD, ATC

Wednesday, June 29, 2022; 1:30 PM-2:25 PM; Room 204BC

Differences in Work-Family Conflict and Work-Family Guilt Based on Employment Factors of Collegiate Athletic Trainers

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Context: Individual, sociocultural, and organizational factors are antecedents to experiences of work-family conflict (WFC) and work-family guilt (WFG) and can lead to transition out of the field. Organizational factors (i.e., factors related to the workplace) are consistent across employees, less subject to change, and have been a focus of research. Employment factors such as years of employment, contract length, sport responsibilities, and income are highly individualistic and have not been explored. Our purpose was to examine employment factors and their relationship with WFC and WFG. **Methods:** An online survey using a cross-sectional design was sent to 6110 athletic trainers in the NCAA DI, DII, and DIII settings. The survey consisted of demographic, workplace, and employment questions and previously validated WFC and WFG scales. 615 participants (10% response rate) were eligible for the study and included in data analyses. Participants (female=391, male=222, gender variant/non-conforming=1, preferred not to answer=1) were 33±9 years of age and BOC certified for 10±8 years. 405 participants (66%) had a partner and 193 participants (31%) had at least one child (1±1). Spearmen's correlations determined relationships among WFC and WFG scores with years of employment, contract length, number of primary sport responsibilities, and household income. Kruskal-Wallis tests identified differences between WFC and WFG scores based on years of employment, sport responsibilities, and income. Mann-Whitney U test determined differences based on contract length. **Results:** Significant correlations were found between WFC and years of employment (r=.120, p=.003), number of primary sport assignments (r=-.105, p=.009), and income (r=.109, p=.007). There were significant correlations between WFG and years of employment (r=.260, p=<.001), contract length (r=.114, p=.006), sports responsibilities (r=-.100, p=.016), and income (r=.262, p<.001). There were no significant differences in WFC scores across years of employment (H(2)=3.759, p=.153) or contract lengths (U=35930, p=.467). Significant differences were found for WFC scores across number of primary sport assignments (H(3)=9.005, p=.029) and household income (H(2)=11.230, p=.004). There were significant differences in WFG scores across years of employment (H(2)=26.316, p<.001), contract lengths (U=35565, p=.013), sport assignments (H(3)=13.784, p=.003), and income (H(2)=45.921, p<.001). **Conclusions:** Employment factors impacted experiences with WFC and WFG among collegiate athletic trainers. More years of employment, less sport assignments, and higher income related to higher WFC and WFG scores. Longer contracts also related to higher WFG. Those with 0-5 years of employment and 8-10-month contracts had less WFG. Athletic trainers with 1 primary sport responsibility had more WFC and WFG. Participants with low household income had less WFC and WFG. Employment factors may coincide with other individual, sociocultural, and organizational factors to impact athletic trainers' experiences. Understanding the factors that affect WFC and WFG are important for maintaining longevity in the profession to promote a healthy work environment and provide optimal patient care.

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Table 1: Differences in WFC and WFG scores

		WFC Score	WFG Score
Years of Employment	0-5 years	45.26	3.19[ab]
	6-10 years	46.34	3.57[a]
	10+ years	48.05	3.65[b]
Contract Length	8, 9, or 10 months	45.60	3.18[c]
	11 or 12 months	45.99	3.37[c]
Number of Primary Sport Assignments	1	48.41[d]	3.55[ef]
	2	45.60	3.19[e]
	3	45.23	3.33
	4+	44.96[d]	3.25[f]
Household Income	Low ($0-$49,999)	44.15[g]	3.02[hi]
	Middle ($50,000-$99,999)	46.62	3.49[h]
	High ($100,000+)	49.27[g]	3.69[i]

Abbreviations: WFC=work-family conflict, WFG=work-family guilt

[a, b, c, d, e, f, g, h, i] = statistically significant difference

Use of Region-Specific Patient-Reported Outcome Measures by Athletic Trainers

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Context: Evidence suggests region-specific patient-reported outcome measures (RS-PROMs) are the most commonly used type of PROMs by athletic trainers (ATs). Limited information exists regarding patterns of RS-PROM use by ATs. Our aim was to describe how and when ATs use RS-PROMs in clinical practice. **Methods:** An online survey, developed and validated by PROM experts, was emailed to a random sample of 17972 ATs using the NATA membership list. The 58-item survey was split into two question sets based on whether the AT did or did not routinely use PROMs in clinical practice. For this study, we described responses from ATs who indicated routine use of PROMs. Participants were asked to describe their use of RS-PROMs including body region for which the PROMs were used (eg, knee, foot and ankle, shoulder and elbow) and names of the PROMs (eg, Lower Extremity Functional Scale [LEFS]). Participants were also asked to estimate the percentage of patients (< 50% or => 50%), types of injury (acute, chronic), and severity of injury (mild, moderate, severe) for which each named RS-PROM (eg, LEFS) was used. Summary statistics (frequency counts, percentages) were calculated to describe RS-PROMs patterns of use. **Results:** The online survey was accessed by 1935 ATs (response rate=10.7%) and completed by 1732 (completion rate=89.5%). Three hundred and seventy ATs (21.4%) indicated routine PROM use, with 88.6% of these ATs (n=328) using RS-PROMs. ATs who used RS-PROMs were 36.0±10.8 years old, had < 11 years of experience (n=172, 52.4%), and worked in colleges or universities (n=138, 42.1%), secondary schools (n=54, 16.5%), and clinics (n=54, 16.5%). The most common body regions identified for RS-PROM use were knee (n=236, 72.0%), foot and ankle (n=211, 64.3%), and shoulder and elbow (n=204, 62.2%). The most frequently endorsed RS-PROM by body region were: LEFS (n=99, 30.2%), International Knee Documentation Committee Form (n=47, 14.3%), Knee Osteoarthritis Outcome Score (n=45, 13.7%) for knee; the LEFS (n=100, 30.5%), Foot and Ankle Ability Measure (n=66, 20.1%), and Foot and Ankle Disability Index (n=52, 15.8%) for foot and ankle; and the Disability of the Arm, Shoulder, and Hand (DASH) (n=96, 29.3%), Quick DASH (n=46, 14.0%), and Upper Extremity Functional Scale (n=21, 6.4%) for shoulder and elbow. Table 1 summarizes the usage of each RS-PROM according to percentage of patients, types of injuries, and severity of injuries. **Conclusions:** ATs who use RS-PROMs implement them over 50% of the time in patient care. Whether an injury is acute or chronic does not appear to influence RS-PROM use, but severity of injury may, with higher percentage of use reported for moderate and severe injuries. Understanding factors related to PROM use may inform strategies to increase use of PROMs during clinical practice.

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Table 1. Summary of athletic trainer responses for the use of region-specific patient-reported outcome measures for the knee, foot and ankle, and shoulder and elbow (n, %).

	Percentage of Patients Used		Type of Injury		Severity of Injury		
	Less than 50%	50% or more	Acute	Chronic	Mild	Moderate	Severe
Knee							
LEFS (n=99)	27 (27.2)	72 (72.8)	90 (90.9)	91 (91.9)	69 (69.7)	93 (93.9)	88 (88.9)
IKDC (n=47)	16 (34.1)	31 (65.1)	46 (97.9)	40 (85.1)	31 (66.0)	44 (93.6)	46 (97.9)
KOOS (n=45)	19 (42.2)	26 (57.8)	40 (88.9)	45 (100.0)	33 (73.3)	42 (93.3)	45 (100.0)
Foot and Ankle							
LEFS (n=100)	37 (37.0)	63 (63.0)	90 (90.0)	91 (91.0)	69 (69.0)	93 (93.0)	88 (88.0)
FAAM (n=66)	26 (39.4)	40 (60.6)	58 (87.8)	57 (86.4)	41 (62.1)	63 (95.5)	56 (84.8)
FADI (n=52)	24 (46.2)	28 (53.8)	38 (73.1)	47 (90.4)	26 (50.0)	45 (86.5)	46 (88.4)
Shoulder and Elbow							
DASH (n=90)	33 (36.7)	57 (63.3)	82 (91.1)	82 (91.1)	57 (63.3)	87 (96.7)	81 (90.0)
Quick-DASH (n=44)	16 (36.4)	28 (63.6)	41 (93.2)	39 (88.6)	33 (75.0)	43 (97.7)	34 (77.2)
UEFS (n=18)	7 (38.9)	11 (41.1)	18 (100.0)	14 (77.8)	16 (88.9)	16 (88.9)	16 (88.9)

Abbreviations: LEFS, Lower Extremity Functional Scale; IKDC, International Knee Documentation Committee; KOOS, Knee Osteoarthritis Outcome Score; FAAM, Foot and Ankle Ability Measure; FADI, Foot and Ankle Disability Index; DASH: Disability of the Arm, Shoulder, and Hand; UEFS, Upper Extremity Functional Scale.

Defining Athletic Training in the Public Safety Job Setting

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Context: Athletic trainers have a skillset which can be utilized in a wide range of several patient populations. Public safety is a physically demanding career, which involves the welfare and protection of the public. Public safety agencies typically include law enforcement, the fire service, and emergency medical services. Athletic trainers have been identified as a feasible and acceptable healthcare provider within public safety agencies in pockets of the United States. However, the knowledge regarding the education, qualifications, and work experiences necessary for preparation needed for employment as an athletic trainer in the public safety practice setting is limited. The purpose of this study was to explore the job characteristics and experiences of athletic trainers working in the public safety practice setting. **Methods:** We used a phenomenological approach to explore the lived experiences of nine athletic trainers working in the public safety setting (6 females, 3 males; mean age=38±8 years, mean years of experience=15±8 years; mean years of experience in public safety setting = 4±3 years). Recruitment was completed via social media (Twitter and Facebook) and continued until data saturation was achieved through repetition of responses and core ideas. We completed an individual, semi-structured interview following a script. The interviews were audio-recorded and transcribed verbatim (Zoom, San Jose, CA). A 3-person data analysis team used a multi-phase process to identify emerging domains and core ideas. Credibility and trustworthiness were established via member checking, multi-analyst triangulation, and auditing. **Results:** Five domains emerged from the interviews including: current job responsibilities, educational experiences, gateways to transition, barriers to transition, and perceived beneficial skills. Multiple categories were also identified through analysis (Figure 1). Participants outlined their administrative duties, such as the facilitation of care between healthcare providers and public safety personnel, and the use of differing care delivery methods. They felt their didactic and clinical educational experiences were adequate for transitioning into the job setting; however, they noted missing experiences related to exposure to the setting and a need to create their own informal knowledge on operational logistics to be successful. Participants who transitioned to working with public safety wanted to expand on their sense of purpose in their career and described the existence of a mentor who facilitated exposure to the public safety setting. Participants noted that individuals looking to move into the public safety setting must have an advanced understanding of athletic training principles to be able to translate them to patients working in public safety, as they often have different work and life responsibilities than adolescents and young adults competing in sport. Participants also noted that emotional intelligence is necessary to build successful relationships within a public safety agency and develop therapeutic alliances with patients. Finally, participants described the importance of seeking out and taking action on an opportunity to transition to the public safety job setting. **Conclusions:** Overall, athletic trainers noted that working in the public safety sector as a developing opportunity for the profession. Successful integration into the public safety settings requires skills beyond basic athletic training principles. The skills include an entrepreneurial spirit and the capability to create a practice without an exemplar model. Public safety agencies are not well versed on the role of an athletic trainer, as such they were consistently asked to demonstrate their value to agency leadership. As the public safety practice setting continues to mature, athletic trainers and athletic training educators should consider collaborating with the current cohort of athletic trainers in the public safety job setting to create opportunities for exposure to the setting.

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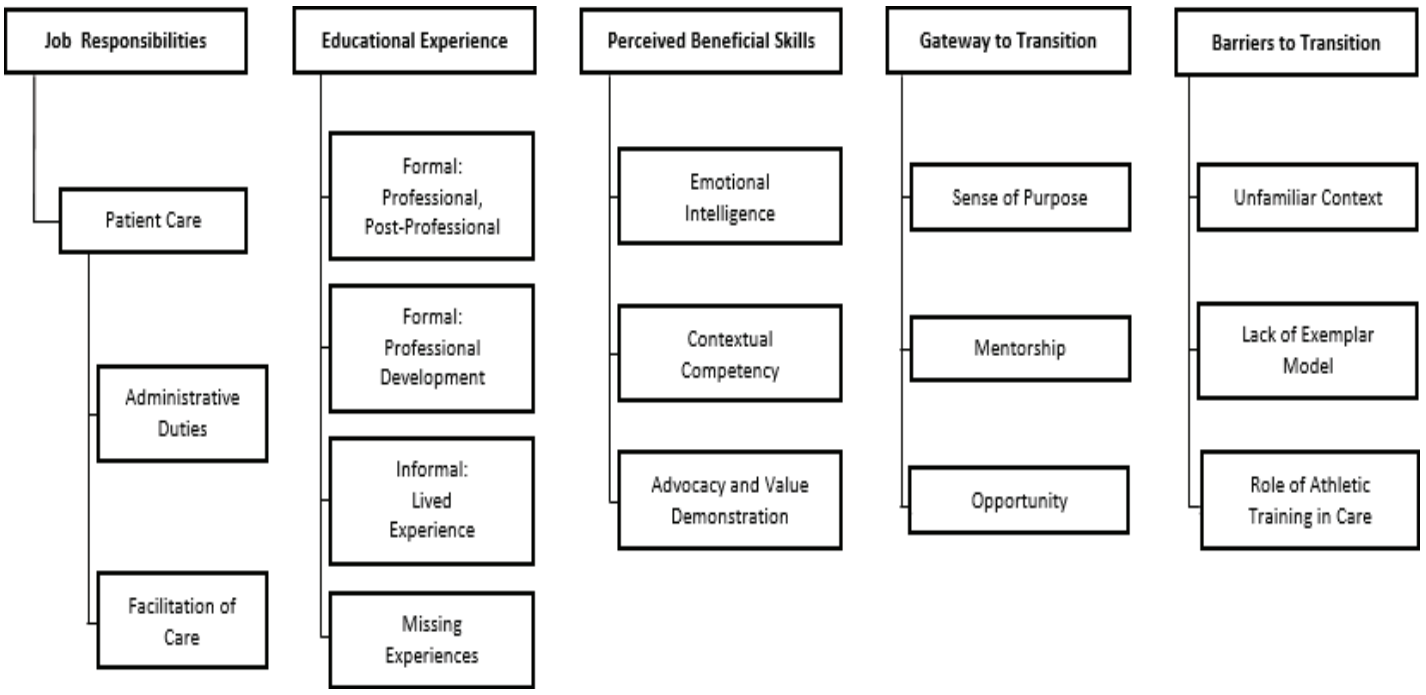

Lived Experiences of Small Business Athletic Trainers

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Context: As the athletic training profession continues to mature, athletic trainers owning their own small business to provide clinical care appears to have increased in recent years. Much of the existing data surrounding small business athletic trainers has been conducted in other industries and has not been directly studied within athletic training. It is currently unknown if the results obtained from these studies are related and applicable to the athletic training profession. Therefore, the purpose of our study is to examine the lived experiences among athletic trainers who are self-employed business owners. **Methods:** We used a grounded theory approach to explore the lived experiences of ten self-employed athletic trainers (female = 8, male = 2, age = 33.7 ± 4.4 years, credentialed experience = 10.7 ± 4.4 years, small business athletic trainer = 5.3 ± 3.1 years). Participants were recruited through social media posts and word of mouth to participate in this study. Recruitment and data collection continued until data saturation was achieved. All participants met the following inclusion criteria: 1) certified athletic trainer, 2) own and operate their own business, and 3) engaged in 15 hours per week of clinical practice through their delivery of athletic training services. Participants were excluded from participating if they were not engaged in 15 hours per week of clinical practice or considered themselves to be a part-time self-employed athletic trainer. The primary investigator carried out the individual interviews via a web-based conference call platform with each participant. All interviews were audio-recorded and transcribed verbatim. We used a multi-phased analysis with a three-member coding team, who discussed the domains and categories for a final consensus codebook to be established. Credibility and trustworthiness were established via member checking, multi-analyst triangulation, peer discussion among researchers, and auditing. **Results:** Five domains were identified: 1) intrinsic provider characteristics, 2) challenges of business ownership, 3) job responsibilities, 4) perceived advantages of self-employment, and 5) transition to self-employment. Participants revealed important characteristics of what it takes to be self-employed, such as, being autonomous, maintaining a growth mindset, and having the ability to problem solve. When discussing the challenges of self-employment, participants discussed the lack of business education within athletic training, the difficulty to self-advocate, not having enough time in the day, networking, and the uncertainty of finances. When considering daily duties, participants acknowledged how being a self-employed business owner comes with more responsibility than an organizational employee, where they not only focus on patient care and healthcare administration, but are also responsible for the business administration such as human resources, payroll, etc. Though self-employment comes with its own set of challenges and obstacles, participants revealed their sense of fulfillment as a self-employed athletic trainer and how this role allows them to have flexibility in both their work and life. Further, the participants also described the advantage of an unlimited earning potential in which would not be available to them if they were not self-employed. Lastly, participants described the variability in the journey to self-employment, which was different for each participant, however, whether it was a defining moment, customer acquisition, or the opportunity to scale and grow, each participant had similarities in how they transitioned to self-employment. **Conclusions:** Self-employed athletic trainers have paved their own way within the realm of business. Although a multitude of factors and characteristics have allowed them to be successful, due to the challenges of business ownership and the uncertainty, those interested in self-employment should take these perceived advantages with caution. Athletic training education programs and continuing education providers may consider implementing some form of business education into their offerings.

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Collegiate Athletic Trainers' and Student-Athletes Collaborative Management of Mental Health Conditions

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Context: The NCAA mental health best practice document identified the athletic trainer (AT) as the coordinator in managing mental health concerns and the facilitator for referrals. Between 10-21% of collegiate student-athletes (SAs) experience mental health disorders. ATs have previously reported managing 2±3 mental health emergencies within the past year at their clinical site. The purpose of this study was to explore training, management, and experience with mental health conditions perceived by the AT and collegiate SA. **Methods:** We conducted a cross-sectional study to assess experiences with mental health conditions. We recruited all college/university ATs via the NATA research database and recruited collegiate SAs via their AT. The ATs (n=188; age=36±11 y; female=119, 63.3%, male=68, 36.2%, non-binary=1, 0.5%, experience=13±10 y) were mostly from NCAA Division 1 institutions (n=77, 41.0%). The collegiate SAs (n=25; age=19±1 y; female=19, 76.0%, male=6, 24.0%) were mostly from NCAA Division 3 institutions (n=17, 68.0%). Both groups completed a web-based survey containing similar items on the management of and experience with mental health, as well as the mental health portion of the National College Health Assessment (NCHA) to evaluate intentional non-suicidal self-injury (NSSI), suicidal ideation, suicide attempt, and seeking help. Data were analyzed using descriptive statistics. **Results:** Most collegiate ATs reported receiving helpful training and education on how to identify (n=147, 78.2%), refer (n=140, 74.5%), and provide support (n=129, 68.6%) to patients with mental health conditions. In their current job, most ATs reported evaluating (n=131, 69.7%), managing (n=144, 77.0%), and referring (n=162, 86.2%) a patient for a mental health condition. On the NCHA, most ATs reported either never or not in the last year evaluating, referring, or supporting a collegiate SA for NSSI (n=135, 71.8%), suicidal ideation (n=141, 75.0%), or suicidal attempt (n=167, 88.8%). The ATs reported they have referred a patient to a counselor/psychologist (n=175, 93.1%) and to other medical providers, such as clergy or university health (n=151, 80.3%), but less likely to refer to a psychiatrist (n=93, 49.5%). Interestingly, 64% (n=16) of collegiate SAs reported experiencing a mental health concern; however, on the NCHA, most collegiate SAs reported never or not in the last year experiencing NSSI (n=22, 88.0%), suicidal ideation (n=23, 92.0%), or suicidal attempt (n=25, 100%). The SAs reported they had not received mental health services from a counselor/psychologist (n=16, 64.0%), psychiatrist (n=21, 84.0%), or other medical providers (n=21, 84.0%) for their concerns. **Conclusions:** Data suggests that while collegiate ATs have received training for mental health conditions, most have not had experience with NSSI and suicidality. In addition, most collegiate SAs stated they have experienced a mental health concern but have not received help from a specialist. It appears there is a disconnect in the collaborative management of mental health conditions in collegiate athletics.

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Parent Perceptions of Athletic Trainers at the Secondary School Setting

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Context: Having athletic trainers (ATs) who are educated and trained in the prevention, recognition, and treatment of emergent injuries can decrease catastrophic injuries and deaths in the secondary school setting. Previous studies have examined coaches' and athletic directors' perceptions of ATs in the secondary school setting, but a thorough understanding of parent perceptions of the skills and abilities of ATs working at the secondary school setting remains unknown. Therefore, the purpose of this study was to gain an understanding of parents' perceptions of ATs in the secondary school setting. **Methods**: Our exploratory, qualitative study included online, semi-structured interviews via Zoom that we recorded and transcribed verbatim. We recruited 13 parents (age=45.92±4.89, 10=females, 3=males) who currently had one or more child(ren) participating in school sanctioned sports at a secondary school in the mid-Atlantic region with a full-time AT. We created a 17-question semistructured interview guide to organize the interview to ensure consistency. We had the interview guide validated by 2 experts (defined as researchers with extensive experience with qualitative research and youth sport safety) via content review and completed 2 pilot tests with individuals meeting our inclusion criteria to confirm comprehensiveness, clarity, and flow. We selected a general inductive approach to analyze the data and used multiple analyst triangulation and peer review to ensure credibility. Coding began on a line-by-line basis and ended with the development of themes that emerged from the data. During multi analyst triangulation, 2 research team members read and coded the data independently and then met to negotiate over the findings until they reached 100% agreement. To fulfill peer review, we had a 3rd researcher, an expert in qualitative research, examine the coding structure and verify the final study results. **Results**: Four themes emerged that describe parent perceptions of ATs at secondary school settings. Parents demonstrated a *general understanding* of the skills and primary duties of ATs such as providing medical coverage for athletic activities, injury prevention, and diagnosis of various medical conditions. However, parents had an *incomplete appreciation* of ATs' roles and responsibilities. Participants had a large gap in knowledge of the complete scope of the athletic training profession, especially regarding emergency care and administrative duties. Parents were also unaware of the educational requirements and clinical training as well as how ATs stay current with new techniques and knowledge. Parents had *positive interactions* and communication with ATs and stated they trusted the knowledge and decisions of the AT at the secondary school their child(ren) attended. Unanimously, parents found ATs to be a *critically important* part of high school athletics and would recommend ATs for every high school athletic event. Although parents said they would feel uneasy if an AT was not present to provide medical coverage during sport participation, they would still allow their child(ren) to participate depending on their perception of risk involved. **Conclusions**: Although parents of secondary school student athletes had a *general understanding* of the roles and responsibilities of ATs, they lacked *complete appreciation* regarding specific job tasks, educational training, and continuing education for ATs and most parents failed to know if an AT was present at the sporting events their child(ren) participated in. All participants stated ATs were *critically important* to secondary school sports due to their ability to provide a safe environment for athletics. However, interestingly, parents would consider allowing their child(ren) to participate in sports regardless of whether an AT was present suggesting a lack of cultural capital. Although ATs are trusted healthcare providers in secondary schools, efforts to improve perceptions of the athletic training professional identity should continue.

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Experiences of Athletic Trainers in Tactical Athlete Settings When Managing Mental Health Conditions

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Context: Research has demonstrated that the physical and mental demands of the job take a toll on the mental health of tactical athletes. However, the stigma surrounding mental health in tactical athlete settings and limited access to resources that assist with such issues prevent these individuals from receiving proper care and coping skills. As a result, athletic trainers (ATs) working in this setting tend to be the first, and sometimes the only, point of contact regarding mental health concerns. Previous research has indicated that most ATs, regardless of job setting, desire more training and experience with psychosocial evaluation. Moreover, ATs in the tactical athlete setting are skeptical if their professional education prepared them to effectively work in this sector. Therefore, the purpose of this study was to investigate ATs' preparedness and experiences managing patients with mental health conditions in the tactical athlete setting. **Methods:** This study used a phenomenological qualitative design. We recruited ATs in tactical athlete settings (n=274) that were in the NATA research database. The research team completed interviews with fifteen ATs [males=7, females=8; age=36±10 years; experience in tactical athlete setting=4 years (range = 6 months-20 years); military=12, law enforcement=2; fire service=1] until data saturation was achieved. Participants completed a 30-minute, semi-structured interview using Zoom teleconferencing that followed a 9-question protocol focused on preparation for the job setting, mental health training, and perceived role managing mental health concerns. Interviews were audio recorded and transcribed verbatim using Otter.ai virtual transcription service. Transcriptions were sent to the participants for member checking before analysis. A 3-person coding team convened to analyze the data using the consensual qualitative research tradition, creating a codebook for the domains and categories. An external auditor reviewed the codebook and transcripts to check the work of the code team. Credibility and trustworthiness were established using a stability check, member checking, and multi-analyst triangulation. **Results:** Four domains emerged surrounding ATs experiences working in tactical athlete settings specific to managing patients with mental health concerns. These domains included 1) population norms, 2) provider preparation, 3) provider context, and 4) structure of job responsibilities. Participants expressed that population norms in tactical athlete settings raised concern for mental health and were commonly associated with perceived or real stigma relative to reporting and seeking care. Most ATs shared that their educational experiences did not provide comprehensive training for recognition and management of mental health concerns. Some participants shared they had formal employer resources such as suicide prevention training that were either optional or mandatory as part of their job. However, some ATs had to seek out self-education, such as journal articles, lectures, and workshops to feel prepared working in this setting. Many participants suggested that future ATs seek professional development in the areas of behavioral and mental health specific to tactical athletes. Participants also shared that unfamiliar experiences, such as deployment, divorce, and demographics posed additional challenges in the job setting. Participants reported using their previous AT experiences to compare their competency managing tactical athletes versus traditional athletes. The ATs expressed overall concern with the structure of their job responsibilities. Specifically, most participants did not have a policy in place to manage or refer patients with mental health concerns, often citing it was not part of their job and were unsure of role delineation. Additionally, some had issues surrounding collaboration, both formal and informal, within the setting. **Conclusions:** ATs working in tactical athlete settings felt that additional education and training relative to mental health recognition and management are needed. The athletic trainers also indicated a need for improvement in job structure regarding clarity of role delineation and establishment of policies.

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Awareness of Best Practices Among Athletic Trainers in Secondary Schools

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Context: Current health and safety policy best practice dissemination relies on passive transmission by one focus area at a time (e.g., concussion or emergency planning). Disseminating interventions using a comprehensive model may enhance policy adoption and effectiveness. Formative research aiming to understand policy adoption is needed prior to larger-scale study and implementation. This formative research study's purposes were: identify the best practices ATs are unaware of needing a written policy for, and pilot the effectiveness of a comprehensive best practice information took-kit in a sample of secondary schools. **Methods:** A randomized (school-level) research design evaluated preliminary effectiveness of tailored versus targeted resources on safety best practice adoption in nineteen schools, stratified by state (NC, CT). A convenience sample of schools were recruited to be heterogenous based on size, socioeconomic status, and location. ATs employed at enrolled schools completed a questionnaire regarding their school's written policies before (PRE) and after (POST) a year-long intervention period. The questionnaire had established construct and content validity using the Precaution Adoption Process Model (PAPM) to scale each school's readiness to adopt a best practice written policy. Best practices were identified from state mandates and NATA position statements. The PAPM uses a 7-point scale to stage readiness to act (e.g., unaware of the need, considering, acting, maintaining, not acting). ATs received access to a comprehensive resource toolkit after completing the PRE questionnaire. The TAILORED group's resources were tailored according to their stage of PAPM readiness. Responses were coded for 51 best practices using a binary system of "unaware" or "aware" from the PAPM data. Chi-square tests of association were used to compare the proportion of ATs reporting an unaware status between groups at POST, and groups collapsed across time ($P < 0.05$). **Results:** Eighteen ATs completed PRE / POST questionnaires. The most common best practices with an "unaware" response at PRE were: requiring follow-up after positive pre-participation examination (PPE) findings (n=4;21%), requiring the AT (n=4;21%) or nurse (n=9;47%) to review PPE results, including PPE concussion history questions (n=8;42%), reporting concussions to required entities (n=6;32%), having an emergency action plan (EAP) describing catastrophic injury management (n=6;32%), and requiring teams to perform a preventive training program (PTP)(n=6;32%). Despite no awareness differences between intervention groups ($p > 0.05$), both groups demonstrated improved awareness from PRE to POST for following-up from PPE (100% improvement), reporting concussions (100%, chi-square(1,17) = 3.86, $p = 0.04$), having an EAP for catastrophic injuries (67%, chi-square(1,17) = 4.15, $p = 0.04$), and a PTP (67%, chi-square(1,17) = 4.15, $p = 0.04$). **Conclusions:** Provision of resources in a comprehensive manner, whether tailored or targeted, may improve written best practice adoption in secondary schools. Future research should examine larger scale studies including comprehensive approaches and electronic technologies to further improve dissemination.

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Written Policy Adoption for Emergency Preparedness and Environmental Injuries in West Virginia High Schools

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Context: Nationwide, studies have looked at the adoption of individual sports medicine policies, yet there has been paucity in the literature in the evaluation process of comprehensive policy adoption for emergency preparedness and environmental injuries in high schools (HS) with access to athletic training services. The purpose of this study was to investigate written EAPs, exertional heat illness (EHI) prevention and treatment policies, and lightning (LIGHT) policies within West Virginia HS as reported by athletic trainers (ATs). **Methods:** ATs (n=9) employed in West Virginia HS were recruited and asked to complete a web-based questionnaire on the written policies their HS had for EAP, EHI, and LIGHT. The questionnaire was developed based on the relevant NATA Position Statement(s) (NATAPS) and content validated by a group of experts. A comprehensive policy was defined as the AT reporting their HS had a written policy inclusive of all components from the NATAPS. Scores for each policy adoption were summed as a composite (COMP) of EAP, EHI and LIGHT (total possible components = 78). ATs were also asked to report participant characteristics such as highest level of education (Master's degree = 66.7%, Bachelor's = 33.3%), years of experience at their HS (<5 years = 44.4%, 5+ years = 55.6%), employment model (district = 33.3%, clinic/outreach = 66.7%), and responsible party for policy development at their HS (AT=44.4%, athletic director = 55.6%). Data analyses include presentation of proportional data with 95% confidence intervals (95% CI), median number of components adopted, mean and standard deviation (SD). Independent t-tests were run to determine if there were differences in participant characteristics (independent variables) and the proportion of policy components within each of COMP, EAP, EHI, and LIGHT (outcome variables). **Results:** Overall, 88.9% (n=8/9; 95% CI= 51.75,99.72) of ATs reported their school had a written EAP, 66.7% (n=6/9; 95% CI= 29.93,92.51) had a written EHI policy, and 66.7% (n=6/9; 95% CI= 29.93,92.51) had a written LIGHT policy. ATs reported their HS adopted 40.59% (COMP= 31/78) of all components of the three policies (Table 1). No AT reported their HS had a comprehensive EAP (n=0/9, 0%) and one AT reported their HS had a comprehensive EHI or LIGHT policy (1/9; 11.1%). There was no difference between the proportion of policy components adopted in COMP, EAP, EHI, or LIGHT across participant characteristics (p>0.05). **Conclusions:** Though EAP adoption is higher than EHI and LIGHT adoption, no AT reported adopting a comprehensive EAP and we observed overall low COMP policy adoption. As participant characteristics did not influence policy adoption, further research investigating factors influencing policy adoption in HS is needed. ATs working in HS should aim for the inclusion of all written best practices in written policies from NATAPS to reduce catastrophic outcomes.

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Table 1. Descriptive Data for Number and Proportion of Policy Components Adopted in West Virginia High Schools.

	EAP (14 components)	EHI (51 components)	LIGHT (13 components)	COMP (78 components)
Median Number of Components Adopted	8	15	6	28
Mean Number of Components Adopted ± SD	7.22±4.5	18.89±18.69	5.56±4.90	31.66±26.65
Mean Proportion of Components Adopted ± SD	51.59%±32.49%	37.04%±36.66%	42.74%±37.70	40.59%±34.18%

Information Seeking in Athletic Trainers Related to Exertional Heat Illness – A Qualitative Exploration

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Context: Exertional heat illnesses (EHIs) are a related group of illnesses that can occur during sport participation. Exertional heat stroke (EHS) is the most severe type and is a leading cause of sudden death in athletes, yet such deaths are preventable with proper recognition and treatment. Evidence suggests not all athletic trainers (ATs) utilize best practices for managing EHIs, including EHS. ATs access to evidence-based research related to EHIs may play a role in best practice utilization. This qualitative study served as the initial inductive exploration into the knowledge acquisition and information seeking habits of ATs related to EHIs, including EHS, and is currently being used to inform larger-scale quantitative work. **Methods:** Semi-structured interviews were conducted with 8 practicing ATs (2 males, 6 females; 2 secondary school, 6 collegiate; age = 27 ± 4 years; experience = 6 ± 4 years) from across the United States. ATs were recruited using a snowball sampling approach from the researchers' professional network, with data saturation guiding recruitment. Interviews were completed using a semi-structured interview guide developed by the research team, which was informed by the current literature and underwent content evaluation by a group of experts prior to use. Content focused on factors affecting ATs' ability to access and implement EHI-related information. Interviews were conducted using the Zoom software application (Zoom Video Communications, San Jose, CA), audio recorded, and transcribed verbatim using automated audio transcription in conjunction with review by a research team member. Based in grounded theory and a phenomenological approach, the four progressive analytic stages in the consensual qualitative research tradition were utilized for data analysis. Study personnel reviewed each interview transcript and identified key words and initial code domains. Categories and themes were created, and cross-analysis of interviews was completed to finalize the codebook. Consensus meetings were held between study personnel to resolve coding discrepancies. **Results:** Four major themes related to accessing EHI-related information emerged: 1) education, 2) information seeking, 3) knowledge implementation, and 4) access and barriers. Related to education, ATs highlighted the importance of the knowledge gained during their initial education coming from both didactic and clinical settings, with hands-on practice specifically increasing confidence in using EHI best practices. ATs reported seeking information from numerous sources, most commonly position statements, employer policies, government legislation, and various continuing education opportunities including scientific conferences and webinars. ATs reported using social media to access evidence-based resources more easily via provided links. Motivating factors for seeking out EHI-related information included practicing in environments with perceived higher EHS risk, fear (i.e., an adverse outcome resulting from improper care), and working with athletes with previous EHS histories. Barriers to information seeking and access centered around logistics, technology and database access, time, finances, and administrative support. Reported barriers to implementing acquired knowledge in clinical practice included a lack of support from stakeholders (e.g., supervisors, administrators, and coaches), organizational related factors related to employment organization (i.e. protocols and access to team physicians), the physical environment in which practice occurs, and perceived legal ramifications. **Conclusions:** Findings highlight that ATs access various information sources to inform their clinical practice related to EHI, including position statements, continuing education, and social media platforms (which are often leveraged to gain access to evidence-based sources). Situational factors reportedly influenced both the ability to access information sources and to implement acquired knowledge in clinical practice. Additionally, ATs reported greater confidence from hands-on education. Given the didactic nature of most continuing education and existing information sources, the effectiveness of hands-on continuing education as it relates to best practices for EHIs and EHS should be considered.

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Prevalence of Legal Proceedings Following Traumatic Injury Sudden Death in Athletes

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Context: Traumatic injuries are less frequent than non-traumatic but have the same catastrophic consequences. Primary prevention efforts in football and pole vault have led to a reduction in traumatic-injury deaths in those sport. Equally as important, a lack of secondary or tertiary prevention efforts can result in legal proceedings. The aims of this study were to: 1) establish the frequency of traumatic-injury-related deaths that resulted in legal proceedings; and 2) determine the association between the publication of evidence-based emergency preparedness position statements and presence of legal proceedings. **Methods:** Data, provided by the National Center for Catastrophic Sport Injury Research (NCCSIR), included organized sport-related sudden death events occurring between 1982-2021 involving youth to collegiate athletes. Base level information (name, age, injury type, location) was used to perform a retrospective legal case review. County/state court databases and digital media were examined for associated legal proceedings. Events were coded for presence of legal proceedings: yes, no. Base level data included in analysis was coded by NCCSIR (sex, injury type, and year). Events occurring before the publication of NATA position statement on emergency preparedness in 2002 were coded as pre, with events after coded as post. Frequencies and proportions were calculated for: legal proceeding (yes/no), athlete sex (male/female), traumatic injury type [TBI/spine fracture/spinal cord injury/commotio cordis/organ injury], decade of sudden death, and pre/post 2002. Fisher exact tests and risk ratios (RRs) with 95% confidence intervals (CIs) quantified associations between traumatic injury type or pre/post 2002 with legal proceeding presence. **Results:** A total of 1,052 sport-related sudden deaths were reported; of those, 207 events (19.7%) were from traumatic injury. Of traumatic sudden death events, 10.6% (n=22) had legal proceedings. Legal proceedings predominately involved males (90.9%, n=20), and occurred following 2002 position statement publication (77.3%, n=17). TBI-related sudden deaths accounted for 68.1% deaths (n=141/207) and 63.6% of lawsuits (n=14/22, Table). There was no association between traumatic injury type and a legal proceeding (?2 (4)=0.12, p=0.855). TBI-related deaths were not less likely to result in legal proceedings compared to all other injury deaths (RR=0.82, 95% CI= 0.36, 1.86). Legal proceedings from traumatic injury-related death were more frequent following the 2002 position statement (RR=4.17, 95% CI= 1.60, 10.87). **Conclusions:** Few traumatic injuries resulted in legal proceedings but may be underestimated due to some state court databases limiting access. Of all traumatic injury deaths, TBI accounted for the greatest proportion of legal proceedings yet were no more likely than other injury types. Legal proceedings were associated with the publication of evidence-based emergency preparedness position statements which provide a standard of care for traumatic injuries and sudden death; this in addition to cultural changes in the U.S. may have influenced the frequency of legal proceedings.

Kristen Kucera is Director of the National Center for Catastrophic Sport Injury Research (NCCSIR) which is supported by the American Football Coaches Association (AFCA), the National Collegiate Athletic Association (NCAA), the National Federation of State High School Associations (NFHS), the National Athletic Trainers' Association (NATA), the American Medical Society for Sports Medicine (AMSSM), and the National Operating Committee on Standards for Athletic Equipment (NOCSAE).

Table. Traumatic Injury Sudden Deaths by Injury Type

	Type	Frequency	Percent
Traumatic	Spinal Cord Injury- No Fracture	3	2.4
	Spine Fracture	14	6.8
	TBI	141	68.1
	Commotio Cordis	20	9.7
	Organ Injury	29	14.0
	Total	207	100.0
Legal Proceedings	Spinal Cord Injury- No Fracture	0	0
	Spine Fractures	2	9.1
	TBI	14	63.6
	Commotio Cordis	2	9.1
	Organ Injury	4	18.2
	Total	22	100.0

Prevalence of Legal Proceedings in Exertional/Medical Causes of Sport-Related Sudden Death

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Context: Emergency preparedness for sudden death due to exertional/medical conditions (E/MC) reached greater awareness in the healthcare community after publication of the first evidence-based statements on emergency planning and heat illness in 2002. Research indicates emergency preparedness for such events is low, which may result in negligence or wrongful death legal cases. The purpose of this study was to determine the proportion of sudden deaths due to E/MC that resulted in legal proceedings. The secondary purpose was to determine if the proportion of cases differed by type of death and before/after 2002. **Methods:** A retrospective legal case review examined sport-related sudden deaths documented within the National Center for Catastrophic Sports Injury Research (NCCSIR) database. All sudden death events occurring 1982-2021 at all levels of sport (youth through collegiate) were analyzed. Using basic information provided by NCCSIR (name, age, date, and city), researchers searched state and county public court databases. Presence of a legal proceeding was coded as: yes (existed within the database) or no (court database did not indicate a legal proceeding existed). If no legal proceeding existed, or if the state did not allow free access, media sources were searched with the same information. If any evidence existed that a lawsuit was initiated within the media, the case was recoded. Frequencies and proportions were calculated for legal proceeding (yes/no) and type of death (cardiac, heat stroke, exertional sickling, other). The association between type of death and before/after 2002 (independent variables) and legal proceeding (outcome variable) was assessed with Chi-Squared Tests (X2) and risk ratios (RR) with 95% confidence intervals (CI). **Results:** Of the 1052 sudden death events that met criteria, 74.5% (n=784) were due to an E/MC. Eleven percent (10.6%, n=83) resulted in a legal proceeding. Sudden deaths from E/MC were due to 9 causes (see Table). Type of death was associated with legal proceeding (X23=134.1, p<0.001). Compared to cardiac deaths, exertional heat stroke (RR=8.48, 95% CI=5.60, 12.84), exertional sickling (RR=8.11, 95% CI=4.36, 15.09), and other (RR=4.82, 95% CI=2.43, 9.54) deaths were more likely to result in a legal proceeding. Legal proceedings were more likely to be filed after 2002 compared to before (14.6% versus 4.5%; ?21=20.6, p<0.001, RR=3.28, 95% CI=0.89, 5.55). **Conclusions:** While a small percentage of E/MC sudden death events resulted in legal proceedings, it is likely an underestimation due to restrictive databases in some states. Despite the majority of E/MC events being cardiac, events of exertional heat stroke, exertional sickling, and other deaths were more likely to result in legal action in which evidence-based primary prevention strategies are critical to preventing death. General culture shifts of more lawsuits, or families of athletes to expect institutions to have greater emergency preparedness, could explain the higher proportion of cases after 2002.

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Analysis of High School and College American Football Deaths By Player Position

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Context: Understanding the burden of sport-related death is the first step for identifying athletes at greater risk for these events. Historically, American football has the highest number of catastrophic sport-related deaths. While rule and policy modifications have reduced American football injuries, deaths continue each year. Currently, no study has examined player position within American football as it relates to the top causes of sport-related death. Therefore, the purpose of this analysis was to describe American football deaths by player position and cause of death. **Methods:** Catastrophic sport-related deaths in high school and college American football from 7/1/2013 through 6/30/2020 captured in the National Center for Catastrophic Sports Injury Research (NCCSIR) database were included in this descriptive epidemiological study (n=106). Any non-sport related deaths were excluded. Event details were captured through systematic media searches of publicly available news reports, as well as reports submitted directly to the NCCSIR. Characteristics of the athlete, event, and injury were summarized and stratified by age, player position (lineman, non-lineman, unknown) and event type (traumatic injury (TI), sudden cardiac arrest (SCA), exertional heat stroke (EHS), exertional sickling (SCT), and other/unknown), see Table. Percent of player deaths by position and by cause of death were calculated. Fishers Exact Test was used to compare differences in cause of death and player position (lineman vs. non-lineman) for the 2 by 5 table (alpha=0.05). Post-hoc pair-wise comparisons were performed with Fisher's exact tests with Bonferroni adjustments (p=0.005). **Results:** 106 American football deaths in high school (n=83) and college (n=23) were captured over the seven-year period. Of these, 15.1% (n=16) were due to EHS, 32.1% (n=34) from TI, 36.8% (n=39) from SCA, 4.7% (n=5) were due to SCT and 11.3% (n=12) were other/unknown. When analyzed by position, 43.4% (n=46, age=17±3) occurred in linemen, 38.7% (n=41, age=17±2) occurred in non-linemen, and in 17.9% (n=19, age=15±1) the position was unknown (see Table). The cause of death varied by position (p<0.0001). Lineman accounted for 46.2% of SCA deaths, 87.5% of EHS deaths, and 8.8% of TI deaths. The observed number of EHS deaths among linemen (14, 87.5%) was greater than non-lineman (p<0.001) and the observed number of TI deaths among non-linemen (25, 73.5%) was greater than lineman (p<0.001). Neither the number of SCA deaths nor the number of SCT deaths among linemen was different compared to non-linemen (p=0.23, p=0.19, respectively). **Conclusions:** Two-thirds of sport-related American football fatalities result from SCA (36.8%) and EHS (32.1%) – both preventable causes of sudden death. EHS deaths disproportionately affect lineman (87.5%). In contrast, TI deaths were largely non-linemen (73.5%). Targeted prevention strategies for EHS in linemen, universal emergency planning for EHS and SCA, and TI prevention strategies specifically in non-linemen, are needed to prevent catastrophic sport-related death in American football.

The National Center for Catastrophic Sport Injury Research (NCCSIR) is supported by the American Football Coaches Association (AFCA), the National Collegiate Athletic Association (NCAA), the National Federation of State High School Associations (NFHS), the National Athletic Trainers' Association (NATA), the American Medical Society for Sports Medicine (AMSSM), and the National Operating Committee on Standards for Athletic Equipment (NOCSAE).

High School and College American Football Sport-Related Deaths by Player Position, Academic Years 2013/14-2019/20

	Traumatic injury, n (column %)	Sudden cardiac arrest, n (column %)	Exertional heat stroke, n (column %)	Complications from sickle cell trait, n (column %)	Other or unknown cause of death, n (column %)	Total, n (column %)
Lineman	3* (8.8%)	18 (46.2%)	14* (87.5%)	4 (80%)	7 (58.3%)	46 (43.4%)
Non-lineman	25 (73.5%)	12 (30.8%)	0 (0%)	0 (0%)	3 (25.0%)	41 (38.7%)
Quarterback	1 (2.9%)	1 (2.6%)	0 (0%)	0 (0%)	0 (0%)	2
Linebacker/Running backs	9 (26.5%)	6 (15.4%)	0 (0%)	1 (20%)	2 (16.7%)	18
Safety/Defensive backs	10 (29.4%)	2 (5.1%)	0 (0%)	0 (0%)	0 (0%)	12
Receivers/Tight ends	1 (2.9%)	3 (7.7%)	0 (0%)	0 (0%)	1 (8.3%)	5
Special teams	4 (11.8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4
Unknown position	6 (17.7%)	9 (23.1%)	2 (12.5%)	0 (0%)	2 (16.7%)	19 (17.9%)
Total	34	39	16	5	12	106

*indicates significant differences (p<0.001) by player position (lineman vs non-lineman) within respective cause of death

Impact and Experiences Relative to Critical Incidents and Critical Incident Stress Management

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Context: Typically, athletic trainers (ATs) have relied on an external support network to debrief after a critical incident (CI). ATs report focusing more on improving work-related processes after incident rather than their emotional response. The purpose of this study was to identify the short-term emotional impact of CI and what care strategies ATs use to address their emotional response to critical incidents. **Methods:** We used a cross-sectional, web-based survey to explore the perceived effects of critical incidents on athletic trainers. The instrument included items on demographics (9 items), characteristics, and experiences surrounding the critical incident (7 items). Questions related to critical incidents were open-ended (3 items) and "select all that apply" (4 items). We used criterion sampling among a random sample of NATA members (April 2021). Inclusion criteria consisted of participant involvement in a critical incident in the previous 12 months. Participants (n=73, 36±11y) were primarily women (n = 53, 72.6%), working in the college / university practice setting (n = 40, 54.8%), with 7±3y of experience. The data were analyzed using descriptive statistics for demographic variables and multi-analyst inductive coding for the open-ended items amongst a 4-person team. We used a modified consensual qualitative research process to review and analyze the open-ended questions and identify domains and core ideas. Trustworthiness was established with multi-analyst triangulation and auditing. **Results:** Of the 73 responses for symptoms of emotional distress or trauma, over 80% reported thinking too much (71%, n=52), anxiety (63%, n=46), and/or sadness (60%, n=44). Expressing oneself through crying (40%, n=29) and humor (44%, n=32) as well as exercise (63%, n=46) and peer support (34%, n=25) were common coping strategies. We analyzed open-ended responses from 62 participants and identified four domains (Table 1). Participants described dissociation as feelings or actions of intentional avoidance and disconnection of oneself from their workplace, family, or friends. Deteriorated emotional state was described as negative feelings or emotions towards themselves, their workplace, or the critical incident. Participants often described straying from their normal daily tasks, relationships, and feelings of fulfillment as an outcome of the critical incident. Relative to how coping strategies have helped, the only common thematic response was how coping improved event and post-event processes, not their emotional state. **Conclusions:** ATs are describing deteriorated emotional status and disruption to their daily lives as a result of a critical incident. Various strategies are used to cope; however, the only ways in which ATs expressed coping helped was with care delivery, not the emotional impact of the critical incident. The lack of responses relative to coping strategies that improve quality of life is potentially alarming. To build resilience and persistence, organizations should consider requiring support beyond process improvement that addresses the emotional impact of critical incidents.

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Table 1. Impact of Critical Incidents on Personal and Professional Life

Domains	Count	Percent
Dissociation	27	43.5%
Deteriorated Emotional State	47	75.8%
Disruption	58	93.5%
Improved Event and Post Event Processes	12	19.4%

Multi-Sport Athlete Return to Participation Following Transmetatarsal Amputation

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Background: This patient is a 14-year-old, female multi-sport athlete involved in a utility vehicle accident. Emergency personnel determined the patient had sustained several life-threatening injuries, including an open fracture of the right interphalangeal joint of the great toe, several closed metatarsal and phalangeal fractures throughout the right foot, a significant traumatic wound to the medial malleolus, and substantial loss of blood. She had a successful open reduction, internal fixation (ORIF) of a left tibial plateau fracture, but her right foot fracture reduction surgeries were unsuccessful and a transmetatarsal amputation (TMA) was subsequently performed. Following the amputation, the patient faced many challenges to her daily and athletic life. Scar tissue formation created issues in finding a prosthetic to meet her lifestyle needs and she dealt with heightened levels of stress and anxiety following the accident. She was ultimately able to return to competitive sport activities. **Differential Diagnosis:** A TMA was performed as the tissue distal to the metatarsal joints became necrotic and a TMA was the most appropriate option to maintain maximal function long-term. A below knee amputation (BKA) was considered following the injury. **Intervention & Treatment:** The patient initially underwent open reduction and closed reduction percutaneous pinning of the right Lisfranc, 1st, and 2nd tarsometatarsal joints and intercuneiform joint. A wound vacuum assisted closure (VAC) device was placed over the lower extremity to assist in wound healing and closure. After repeated surgeries, eventual necrosis and skin loss of the right great toe and distal second metatarsal led to a TMA at the Lisfranc joint. During rehabilitation, after correcting initial gait deviations due to the right TMA and left tibial plateau fracture, therapeutic exercise was used to address muscular weakness lower extremities and diminished left ankle ROM. After discharge from formal rehabilitation the patient progressed to more advanced, athletic exercises with her school-based athletic trainer. She continued to strengthen the lower kinetic chain and achieved significant progress over the next 12 weeks, with slower progress occurring over following five months. The patient was able to return to competitive soccer approximately 10 months after the initial injury using a prosthetic foot, although she experienced pain from the accumulation of scar tissue at the first metatarsal. A custom made pad was fabricated to help regulate the pain and her foot and ankle were taped to help provide additional stabilization and leverage during activity. She engaged in competition and practices fully, but required intermittent rest to manage pain and lower extremity swelling. The patient was enrolled in professional counseling for the duration of her recovery secondary to anxiety and depression experienced following the accident. **Uniqueness:** No published data could be found on the return to sport in individuals after TMA. The comparative literature shows that TMA is typically performed in an elderly population diagnosed with Diabetes Mellitus or Peripheral Vascular Disease. TMA is not commonly seen in a young, athletic population making the case unique without definitive guidelines on the return to sport. **Conclusions:** Although a TMA is rare in a young, athletic population, the goals of rehabilitation of the patient are familiar; rebuild atrophied muscle, restore ROM, and improve proprioception. Consideration must be given to avoid potential complications with the recovery process. Given the lack of published literature, the long term impacts of this procedure in an athletic individual are unknown. This athlete may or may not be at higher risk for secondary injury by engaging in athletic activities and should be monitored for injury sequelae. Clinicians also need to be able to recognize the psychosocial component of any case as it can greatly impact recovery.

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Epidemiology of Catastrophic Head and Cervical Spine Injuries in High School and College Football 2000/01 through 2019/20

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Context: Numerous injury prevention measures have been implemented in football including new tackling techniques, safety education, rules protecting defenseless players and against head-first tackling, concussion legislation, and decreased contact-time during practice. The purpose of this analysis was to describe the epidemiology and current trends in fatal and nonfatal catastrophic head and cervical spine injuries in United States (US) high school and collegiate football during 2000/01 through 2019/20.

Methods: Catastrophic head and cervical spine football injuries were captured by The National Center for Catastrophic Sport Injury Research (NCCSIR) through media monitoring and individual reports. Athlete, event, and injury characteristics were summarized and stratified by play level (high school versus college), severity (fatal versus nonfatal), and injury (head versus cervical spine). Incidence rates (IR) per 100,000 athlete-seasons (AS) used National Federation of State High School Association and National Collegiate Athletic Association participation statistics as the denominator. Adjusted incidence rate ratios (IRR) overall and by severity and injury type were estimated for play level (college versus high school) and year (1-unit change). Due to overdispersion in rates, a test for time trend was calculated using negative binomial models, adjusted by play level (apriori alpha=0.05). **Results:** A total of 491 high school and 91 college catastrophic head and cervical spine injuries were identified in US football players for an average of 5/year for college and 25/year for high school. Injury rates appeared to decrease (figure 1); however, there was no statistically significant trend in injury rates over the 20-year period (adjusted 1-year IRR=0.98 95% confidence interval (CI):0.96-1.01; time trend p=0.1824). Results were similar when stratified by severity and injury type. Overall injury rates were higher in college (IR=6.83, 95% CI: 5.41-8.63) compared to high school (IR=2.28, 95%CI: 1.98-2.63; adjusted IRR=2.99, 95%CI: 2.28-3.93). Fifty-five percent of 311 head injuries were subdural hematomas (38% college, 58% high school) and 77% of 271 cervical spine injuries were fractures (73% college, 78% high school). Injuries occurred predominantly during competition (73% college, 79% high school) and were tackling-related (59% college, 55% high school). Eleven percent were fatal (8% college, 11% high school), 40% resulted in permanent disability (26% college, 42% high school), 46% temporary disability with recovery (66% college, 42% high school), and 4% were unknown disability status (0% college, 5% high school). Catastrophic head injuries were more often fatal (20%) compared to cervical spine injuries (3%). **Conclusions:** Incidence of catastrophic head and cervical spine injuries in US high school and college football does not appear to be decreasing significantly. This may be a result of improved reporting and capture. These findings support continued surveillance and safety efforts to ensure proper tackling techniques, reduced contact, emergency planning, and medical care for high school and collegiate football, particularly during competition.

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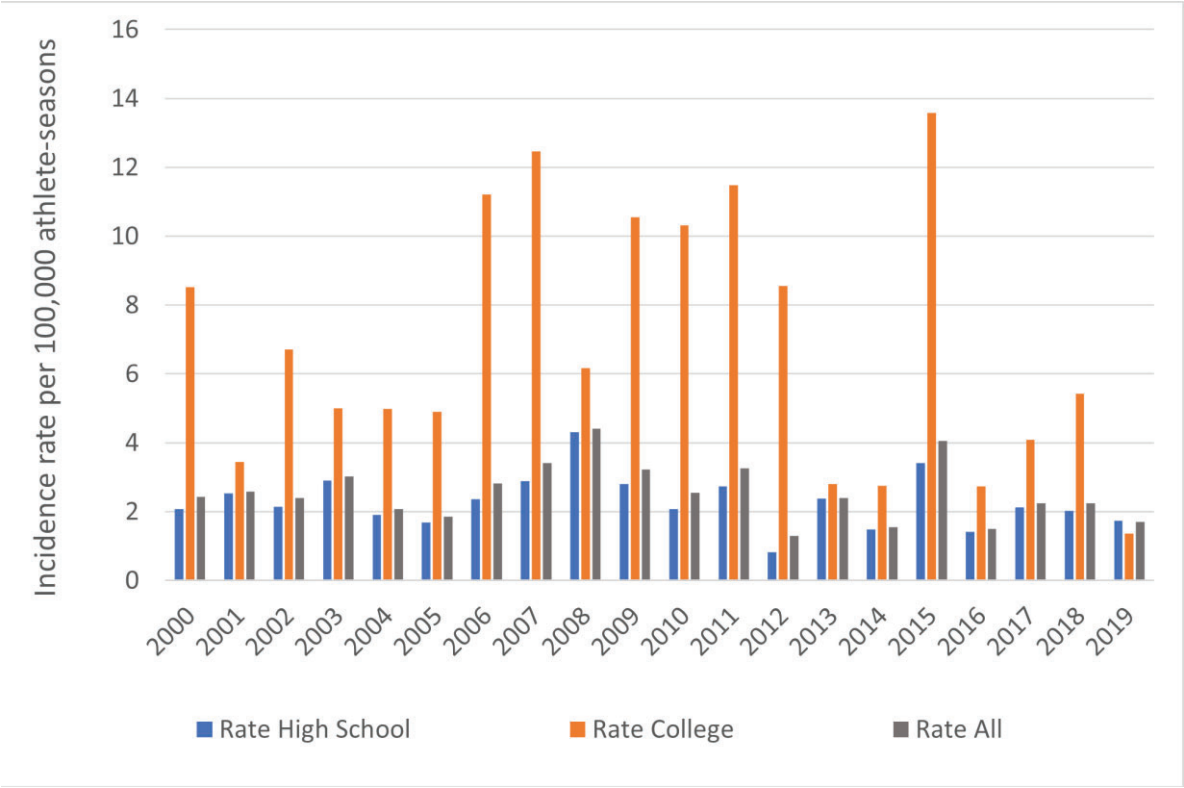
Figure 1. Catastrophic Head and Cervical Spine Football Injury Incidence rates per 100,000 athlete-seasons overall and by play level, 2000/01-2019/20.



Free Communications, Oral Presentations: Who Is Affected? Epidemiology in Sports Medicine

Moderator: Kristen Kucera, PhD, MSPH, ATC

Thursday, June 30, 2022; 10:20 AM-11:15 AM; Room 201BC

Epidemiology of Wrestling-Related Injuries Treated in U.S Emergency Departments, 2007-2020

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Context: Understanding emergency department (ED) data for wrestling-related injuries is important for all healthcare providers interacting with wrestlers, including athletic trainers, physicians, and nurses. A previous study described wrestling-related injuries treated in United States EDs from 2000-2006. Our objective was to update those findings and provide injury rates and patterns for wrestling-related injuries presenting to EDs from 2007-2020. **Methods:** In June 2021, publicly available, de-identified data were extracted from The National Electronic Injury Surveillance System (NEISS), a database managed by the U.S. Consumer Product Safety Commission which consists of a probability sample of approximately 100 EDs in the U.S. For this study, patient cases were recorded between January 1, 2007 and December 31, 2020 and weighted to provide national estimates. Abstracted variables included age (youth: 7-11 years; scholastic 12-17 years), diagnosis, location, and description of the injuries treated. Frequency counts, percentages, and incidence rates (IR) were sed to describe the injuries. Incidence rates were estimated using U.S. Census Bureau data (2007-2019) and calculated as the number of cases per 100,000 persons/year. **Results:** Between the years 2007-2020, 10,844 patients with wrestling-related injuries reported to NEISS EDs. Based on population-weighted estimates, a total of 374,020 patients were treated for wrestling-related injuries across the U.S. during the study period. Most injuries occurred in scholastic wrestlers (87.0%, n=9436). The most common body part injured was the head (15.3%, n=1659) followed by the shoulder (13.0%, n=1405), knee (8.6%, n=933), elbow (8.2%, n=891), and neck (6.5%, n=706). Strain or sprain was the most commonly reported diagnosis (30.8%, n=3336) followed by fracture (19.5%, n=2118), other/not stated (12.9%, n=1401), contusion/abrasion (10.5%, n=1143), and concussion (8.5%, n=917). Comparing age groups, the most commonly injured body part in the youth age group was the elbow (13.6%, n=191) followed by the head (12.7%, n=179) and shoulder (11.0%, n=155). Similarly, the head (15.7%, n=1480), shoulder (13.2%, n=1250), and knee (8.9%, n=839) were the most commonly injured body parts in scholastic-aged patients. The vast majority of patients were treated and released from the hospital or examined and released without treatment (96.2%, n=1049). Between 2007-2019, incidence rates increased by 5.1% with the highest IR reported in 2011 (IR=3.2) and 2012 (IR=3.2) and the lowest IR reported in 2008 (IR=2.3) and 2007 (2.4). Between 2007-2011, IR increased by 36.2%, and then decreased by 22.8% from 2011-2019. **Conclusions:** Approximately 374,020 wrestling-related injuries were treated in EDs between 2007-2020. Findings suggest a decrease in wrestling-related injury incidence rates since 2011. Sprain/strain and concussion were common reasons for ED visits. Future studies should investigate the potential for athletic trainers to reduce wrestling-related ED visits, especially for conditions such as sprains, strains, and concussions.

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Healthcare Utilization in Collegiate Student Athletes for Acute, Overuse, Time-Loss and Non-Time-Loss Upper Extremity Injuries

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Context: Upper extremity injuries are common across many intercollegiate sports, but little is known about healthcare utilization occurring due to non-time-loss (NTL) and overuse injuries. The purpose was to describe athletic training services (ATS), physician encounters (PE), and other healthcare utilization for acute and overuse upper extremity injuries in collegiate student athletes in a variety of sports, stratified by time-loss (TL) and NTL. **Methods:** We utilized a descriptive epidemiology design. De-identified electronic medical records from student athletes who provided authorization for research use were obtained from August 2017-March 2020. Member institutions migrated their injury cases for all teams to a secure cloud service provider, representing 810 team seasons (351 men's and 459 women's). Musculoskeletal upper extremity injuries were identified by onset (acute or overuse), body location (hand/fingers, wrist, elbow, shoulder, arm), then stratified by time-lost (TL or NTL). We calculated frequencies of associated healthcare utilization including ATS provided, whether any PE occurred (yes or no), and if any prescription medication, test, procedure, or surgery occurred, as well as mean ATS and any PE per team per season. **Results:** Most ATS (n=17695, 44.8%) and PE (n=651, 44.0%) were for acute-TL injuries. Overuse-TL represented 19.5% (n=7713) of ATS and 12.9% (n=191) of PE, while overuse-NTL was 15.4% (n=6059) of ATS and 10.8% (n=160) of PE. Acute-TL injuries had the highest frequency of any prescription medication (n=146, 41.4%), test (n=549, 51.6%), procedure (n=49, 39.8%), and surgery occurrence (n=170, 67.7%). Acute-NTL injuries represented 34% of prescription medication (n=120), 29.8% of test (n=316), 26% of procedure (n=32), and 13.1% of surgery (n=33) occurrence. Overuse-TL and –NTL combined accounted for 24.6% (n=87) medication, 18.5% (n=197) test, 34.1% (n=42) procedure and 19.1% (n=48) surgery occurrence. Football had the highest mean ATS and occurrence of PE for Acute-TL and -NTL. Overuse-TL and –NTL mean ATS and PE per team per season were variable, with women's water polo and softball ranked high for ATS, and baseball and men's gymnastics for PE (see Table 1 for selected sports). **Conclusions:** Upper extremity injuries that were overuse or NTL represented more than 55% of all ATS and PE provided. While individually not as large as the acute-TL category, as a group they result in considerable healthcare utilization and clinician workload. When reported per team per season, women's and "lower-risk" or "technical" sports such as softball, baseball, and swimming demonstrated substantial healthcare utilization, particularly for overuse and NTL injuries. Distinguishing between acute and overuse onset, while including NTL injuries, may better estimate healthcare utilization to support appropriate clinician staffing and develop overuse injury prevention programs in collegiate student athletes.

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Table 1. Mean Athletic Training Services and Physician Encounters per Team per Season for Upper Extremity Injuries in Collegiate Student Athletes in Selected Sports

	Mean No. ATS per team per season				Mean No. PE per team per season			
Sport	Acute-TL	Acute-NTL	Overuse-TL	Overuse-NTL	Acute-TL	Acute-NTL	Overuse-TL	Overuse-NTL
BASEBALL (M)	101.4	7.1	31.0	7.5	3.1	0.3	1.1	0.4
BASKETBALL (M)	9.3	5.4	0.8	4.6	0.8	1.1	0.0	0.0
BASKETBALL (W)	9.1	11.5	1.7	1.8	0.4	0.3	0.1	0.0
FOOTBALL (M)	195.0	97.6	33.1	17.0	5.9	6.7	0.5	0.9
GYMNASTICS (M)	35.8	9.7	12.2	23.0	2.3	0.8	0.7	1.3
GYMNASTICS (W)	39.7	6.0	33.9	9.5	1.2	0.1	0.7	0.4
SOCCER (M)	7.9	6.7	0.0	0.0	1.1	0.4	0.0	0.0
SOCCER (W)	20.8	8.7	0.0	0.3	0.5	0.3	0.0	0.0
SOFTBALL	22.7	15.2	23.1	31.4	0.9	0.7	0.3	0.6
SWIMMING (M)	3.2	1.6	1.9	4.9	0.1	0.1	0.1	0.1
SWIMMING (W)	12.5	7.2	23.3	25.4	0.3	0.4	0.3	0.2
TENNIS (M)	8.2	2.5	20.3	18.8	0.3	0.2	0.7	0.1
TENNIS (W)	7.8	8.9	13.8	11.0	0.2	0.3	0.5	0.1
VOLLEYBALL (M)	28.9	11.1	1.4	7.1	1.0	2.0	0.1	0.3
VOLLEYBALL (W)	13.0	15.4	17.0	9.6	0.3	0.4	0.2	0.2
WATER POLO (M)	5.8	8.1	6.2	4.3	0.5	0.2	0.1	0.0
WATER POLO (W)	22.0	18.4	41.1	2.8	0.5	0.3	0.4	0.0
WRESTLING (M)	55.6	22.4	12.7	1.4	3.6	1.8	0.3	0.1

ATS: Athletic training services, PE: Physician encounters, TL: time-loss, NTL: non-time-loss

Descriptive Epidemiology and Health Care Utilization Related to Musculotendinous Injuries in Collegiate Student Athletes

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Context: Musculotendinous injuries, particularly those resulting from overuse onset and/or are non-time-loss (NTL), are not well documented but may represent substantial injury and treatment resources in sports settings. The purpose was to describe the epidemiology and associated healthcare utilization of musculotendinous injuries in a population of collegiate student athletes. **Methods:** A descriptive epidemiology design was used. Electronic medical records for all teams from all conference institutions were migrated to a secure cloud service provider, and de-identified injury records were collected from August 2017 – March 2020 from student athletes who authorized their injuries could be used for research. This represented 810 team-seasons in total (351 men's and 459 women's). Injuries were identified by onset (acute or overuse) and stratified by time-lost (time-loss [TL] or NTL). Location (lower extremity) and injury type (dysfunction, inflammation, muscle strain, tendinopathy, tendinopathy/bursitis) were identified. Associated healthcare utilization including frequencies of athletic training services (ATS) provided, whether a physician encounter (PE) occurred, and any occurrence of prescription medication, test, procedure, or surgery were identified. Injury frequencies and mean number of injuries and ATS, per team per season were calculated. Quality assurance procedures were completed. **Results:** A total of 4038 musculotendinous injuries were captured, representing 20.1% of all injuries in that time period (n=20080). Acute-TL represented 39.1% (n=1578), acute-NTL 29.7% (n=1198), overuse-TL 13.4% (n=542), and overuse-NTL 17.8% (n=720). Men's football, men's track and field, women's track and field, and men's soccer had the highest rates of musculotendinous injury per team per season (27.6, 11.9, 10.4, and 9.0, respectively). In-season injuries were most frequent (n=1759, 43.6%), and were comparable for acute-TL (n=606, 34.5%) and acute-NTL (n=553, 31.4%), while overuse-NTL injuries comprised 19% of in-season injuries (n=334). A total of 35792 ATS were provided, and 973 injuries required PE, resulting in medications prescribed in 253, diagnostic tests in 484, procedures in 89, and surgeries in 34 cases. Overuse-TL injuries represented 18.8% (n=6719) of all ATS and 21.3% (n=207) of PE. Overuse-NTL injuries represented 18.3% (n=6538) of all ATS and 15.3% (n=149) of all PE. Treatment for overuse-NTL injuries resulted in 8.1 ATS per team per season (5.8 men's, 9.8 women's). **Conclusions:** Overuse-NTL injuries represented 17.8% of the total sample of musculotendinous injuries. While acute-TL injuries were more commonly documented, there was still significant injury and healthcare utilization associated with both overuse-TL and overuse-NTL injuries. Appropriately capturing those injuries may provide a fuller picture of clinician workload and offer data to support injury prevention programs targeted at overuse mechanisms.

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Time to Return to Play for Non-Surgical Upper Extremity Injuries in High School Athletes

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Context: Sports injury epidemiology researchers have reported injury data within the National Athletic, Treatment, Injury, and Outcomes Network (NATION) surveillance program to establish injury incidence, mechanisms, and preventive measures. Limited research exists on time to return to sport participation. Therefore, this study describes the time to return-to-play (T-RTP) for non-surgical upper extremity (UE) injuries in high school athletes from the NATION database between the academic years of 2014-2015 through 2018-2019. **Methods:** Data for all sports which reported a time-loss (TL) non-surgical upper extremity (UE) injury were included. T-RTP was calculated in days. If an athlete did not return to play, they were right censored at the time of season end date. Counts/frequencies were summarized for categorical variables. Kaplan Meier curves were constructed to estimate median T-RTP times. Pseudo-observation linear regression modeling was utilized to determine the restricted mean T-RTP during the first 21 days with possible confounding variables: year reported, high school rank, gender, sport, game/practice, preseason/regular, upper extremity region, injury type, recurrent injury, and whether it caused one versus multiple injuries. Previous researchers have established a TL of 21 days as a threshold of severe injuries. **Results:** Time-loss, non-surgical injuries represented 45% (n=1,058) out of 2,346 total UE injuries in NATION reported from 2014-2019. Of those, shoulder injuries were experienced the most (41.5%) followed by the hand/fingers (29.4%) and elbow (10.0%). The top injury types reported were sprain (37%), fracture (21%), and strain (19%). Contact sports represented 82% (n=868) of injuries reported. For all non-surgical UE injuries, 24% (n=255) did not RTP; a median RTP of 8 days (95% CI: 7-10) was observed. Model estimates were adjusted for year reported, UE region, injury type, and whether the event caused one or multiple injuries. Over the first 21 days, mean T-RTP was 13 days for shoulder (95% CI: 11-14), 9 days for hand/fingers (8-11), and 13 days for elbow (11-15) injuries. Both shoulder and elbow injuries had significantly longer T-RTP than hand/fingers (both $p<0.001$) injuries. Mean T-RTP for fractures was 19 days (95% CI: 17-20). Events that caused more than 1 injury had longer mean T-RTP of 12 days versus 10 days for those that caused only 1 injury ($p=0.04$). **Conclusions:** There is limited data on T-RTP for high school athletes suffering a non-surgical UE injury. This study incorporated a new statistical approach to integrate multiple factors that should be considered when providing prognosis. Although the median days to return were 8, body region, injury type, and trauma creating injury to more than one structure should be considered. This study provides health care professionals treating high school athletes with prognostic data regarding T-RTP. Further studies on T-RTP for UE injuries requiring surgery are needed.

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Fellow sponsored by Timothy Uhl, PhD, ATC, PT.

COVID-19 Infection Characteristics and Control Policies in United States Secondary School Athletic Programs: A Report From the National High School Sports-Related Injury Surveillance Study

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Context: Athletic trainers (ATs) in United States secondary schools (SS) have implemented athletic-related infection mitigation strategies as well as documented infections among athletes throughout the Coronavirus Disease 2019 (COVID-19) pandemic. The objective of this study was to assess athletic-related infection control policies and describe characteristics of COVID-19 infection among SS athletes. **Methods:** Infection data were collected as part of the National High School Sports-Related Injury Surveillance Study (more commonly known as High School Reporting Information Online (RIO)) during the 2020/21 academic year from 111 schools. Distribution and characteristics of reported infections were examined and analyzed using summary statistics (mean±SD, range, frequencies (%s)). ATs also completed a survey describing resources utilized to develop athletic-related COVID-19 policies and mitigation strategies at their respective schools; responses were also characterized using the aforementioned summary statistics. **Results:** High School RIO captured 216 COVID-19 cases in 43 schools (mean cases/school among schools with at least one case: 5.0±5.0; range: 1-20). COVID-19 infections were most commonly reported in boys' basketball (n=49; 23%) and girls' basketball (n=38; 18%). Common testing referrals were due to known exposure (n=123; 57%) and self-reported symptoms (n=108; 50%). Most athletes were symptomatic (n=132; 61%), while 31% of athletes (n=69) were asymptomatic; in 8% (n=17) of infections, athlete's symptoms were unknown/not reported. Most athletes with COVID-19 infection returned to activity in 10-21 days (all infections: n=132 [62%]; symptomatic infections: n=78 [60%]). COVID-19 infections resulted in 22 days of time loss or more (all infections: n=18 [8%]; symptomatic infections: n=12 [9%]) or were season ending (all infections: n=24 [11%]; symptomatic infections: n=14 [11%]) in comparable proportions of athletes. Few athletes were documented to have cardiac signs/symptoms (n=14 [10% of symptomatic cases]); 9 athletes reportedly had complications following recovery, 1 athlete required hospitalization. There were 87 survey responses recorded (response ratio: 78%) from ATs. Most ATs reported that their school had a written athletics COVID-19 policy (n= 81/87; 93%); the majority of ATs (n=63/81; 78%) reported being involved in sport-related policy development. ATs most commonly reported using state high school athletic association guidelines (n=74/87; 85%) and state health departments (n=74/87; 85%) as resources for sport-related policy development. ATs reported implementing an average of 15 mitigation strategies (±4) from a possible 25; common strategies included athletes bringing their own water bottle (n=86/87; 99%), facility and equipment cleaning (n=83/87; 95% and n=81/87; 93%, respectively) and frequent handwashing (n=80/87; 92%). **Conclusions:** COVID-19 infection among SS athletes denotes a health event substantiating the need for infection control strategies. Asymptomatic cases represented approximately one-third of infections. Among athletes with symptomatic infections, a minority endorsed complications following recovery. ATs were commonly involved in sports-related policy development, implementation, and management of COVID-19 cases for athletes in SS schools, and most utilized state-level resources to do so.

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Impact of COVID-19 on Incidence of Sport-Related Concussion in High School Athletes From the State of Michigan

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Context: Identification of sport-related concussion (SRC) incidence is crucial for clinicians to understand which athletes are at greatest risk for injury and to implement targeted prevention strategies. However, the COVID-19 pandemic has dramatically altered sport participation, including in sports from the Michigan High School Athletic Association (MHSAA). The MHSAA made multiple changes to their high school sports seasons, such as delays, full suspensions, and intermittent play. Therefore, it is important to examine how SRC incidence and risk by sport has changed before and during the COVID-19 pandemic. The purpose of this study was to determine the clinical incidence of SRCs and risk by sport in Michigan high school athletes before and during the COVID-19 pandemic. **Methods:** An epidemiological study of athletes diagnosed with SRC participating in 18 MHSAA sports from 2018-2019 and 2020-2021 academic years was performed. All SRCs were recorded in the MHSAA Head Injury Reporting System by certified athletic trainers, administrators, or coaches. Clinical incidence proportions were calculated by dividing the number of SRCs in each sport by the number of participants in each sport per 100 student-athletes and are presented with 95% confidence intervals (CI). Risk ratios were calculated by dividing the incidence proportion of 2020-2021 academic year by the incidence proportion of 2018-2019 academic year. **Results:** Across the 18 MHSAA sports, there were 281,992 participants in 2018-2019 and 243,912 participants in 2020-2021 academic year. Overall, 3,751 SRCs were reported in 2018-2019 and 1,704 SRCs in 2020-2021, resulting in incidences of 1.3 per 100 players (95% CI, 1.28-1.37) and 0.70 per 100 players (95% CI, 0.67-0.73), respectively. Across all sports, athletes from the 2020-2021 year were approximately half as likely [R=0.53 (95% CI, 0.50-0.56)] to sustain an SRC compared to athletes from 2018-2019 year (Table 1). Of the sports with the most SRCs—football, soccer, basketball, baseball/softball — athletes from the 2020-2021 year had 0.50 (95% CI, 0.46-0.55), 0.53 (95% CI, 0.46-0.62), 0.60 (95% CI, 0.51-0.70), and 0.51 (95% CI, 0.41-0.65) times the risk of sustaining an SRC, respectively. **Conclusions:** During the COVID-19 pandemic, the risk of athletes sustaining an SRC was approximately half as likely compared to before COVID-19. Risk persisted across sports with the most SRCs, which could be due to shortened seasons for certain sports. Importantly, Certified Athletic Trainers in the State of Michigan should be aware of underreporting of SRCs due to the focus around COVID-19 safety. Future research should be conducted to better understand the impact of the COVID-19 pandemic on SRC, along with reasons for decreased risk and incidence.

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Table 1. Clinical Incidence Proportions per 100 student-athletes and Risk Ratios for Student-Athletes Sustaining a Sport-Related Concussion during the 2018-2019 vs. 2020-2021 Academic Years

Sport	2018-2019 Year	2020-2021 Year	Risk Ratio
Baseball/Softball	0.7 (0.62-0.80)	0.36 (0.29-0.43)	0.51 (0.41-0.65)
Basketball	1.21 (1.1-1.32)	0.72 (0.63-0.82)	0.60 (0.51-0.70)
Cross Country	0.05 (0.02-0.09)	0.01 (-0.004-0.03)	0.23 (0.05-1.04)
Football	4.45 (4.23-4.67)	2.22 (2.06-2.39)	0.50 (0.46-0.55)
Gymnastics	1 (0.26-1.75)	0.48 (-0.06-1.04)	0.49 (0.13-1.87)
Ice Hockey	3.49 (2.86-4.11)	0.92 (0.59-1.25)	0.27 (0.18-0.40)
Lacrosse	1.77 (1.49-2.05)	1.24 (0.99-1.5)	0.70 (0.54-0.91)
Skiing	0.41 (0.1-0.72)	0.31 (0.03-0.58)	0.76 (0.24-2.37)
Soccer	1.92 (1.75-2.08)	1.02 (0.89-1.15)	0.53 (0.46-0.62)
Swimming & Diving	0.41 (0.29-0.53)	0.18 (0.09-0.27)	0.44 (0.25-0.77)
Tennis	0.06 (0.02-0.10)	0.03 (0.0006-0.06)	0.48 (0.15-1.52)
Track & Field	0.07 (0.04-0.09)	0.04 (0.02-0.07)	0.63 (0.34-1.20)
Wrestling	2.21 (1.91-2.5)	0.94 (0.73-1.16)	0.43 (0.33-0.56)
All Sports	1.3 (1.28-1.37)	0.70 (0.67-0.73)	0.53 (0.50-0.56)

Clinical incidence proportions and risk ratios are presented with 95% confidence intervals (95% CI).

Middle School Wrestling Concussion Rates and Mechanisms

Ferranti SA, Kelshaw PM, Hacherl SL, Erdman NK, Caswell AM, Lincoln AE, Dunn RE, Caswell SV: Sports Medicine Assessment, Research & Testing Laboratory, ACHIEVES Project, George Mason University, Manassas, VA; Athletic Training Program, Department of Kinesiology, University of New Hampshire, Durham, NH; Orthopedics & Sports Medicine Research, MedStar Health Research Institute, Baltimore, MD

Context: Wrestling, has among the highest concussion incidence in all collegiate and high contact sport. For many children, middle school (MS) is the first opportunity to participate in wrestling, however, research describing incidence of concussion in MS wrestling remains limited. Therefore, we sought to describe the incidence of concussion and subsequent time loss (TL) sustained by MS wrestlers. **Methods:** A retrospective descriptive epidemiology study of concussions sustained during MS wrestling. Data was examined from competitive wrestling seasons at 9 (2015 / 16 to 2018 / 19) and 16 (2019 / 20) middle schools, respectively. Certified athletic trainers recorded athlete exposure (AE) and injury data during all practices and matches as part of the Advancing Healthcare Initiatives for Underserved Students (ACHIEVES) project. An AE was defined as one athlete participating in one school-sponsored practice or competition. Concussion frequencies and injury rates (IRs) per 1000 AEs were calculated. Time-loss (TL) was defined as the number of days from the date of concussion diagnosis to unrestricted return to sport. Concussion injury rate ratios (IRR) with 95% confidence intervals (CI) compared IRs between practice and matches. IRRs with 95% CIs excluding 1.0 were considered statistically significant. **Results:** A total of 38,297 AEs (practice=29,655 AEs, competition=8,642 AEs) and 43 concussions (IR=1.12 / 1000 AEs, 95% CI=0.79-1.46) were reported. Concussion rates during practices (n=33 [76.7%], IR=1.16 / 1000 AEs, 95% CI=0.44-1.87) and matches (n=10 [23.3%], IR=1.11 / 1000 AEs, 95% CI=0.73-1.49) were comparable (IRR=1.04, 95% CI=0.51-2.11). The most common concussion mechanisms overall were surface contact (n=27 [62.8%], IR=0.71 / 1000 AEs, 95% CI=0.44-0.97) followed by contact with an opponent (n=12 [27.9%], IR=0.31, 95% CI=0.14-0.49). Surface contact also resulted in the highest IR during practices (n=20 [46.5%], IR=0.67, 95% CI=0.38-0.97) and matches (n=7 [16.2%], IR=0.81, 95% CI=0.21-1.41). Mean TL following concussion was 18.4±8.25 days (Median=15.0 days, Interquartile Range =13.0-18.8 days) although seven (16.3%) concussions resulted in TL greater than 28 days. **Conclusions:** Overall, the concussion rate observed in our sample of MS wrestlers was higher than previously reported at the high school and collegiate levels. This was likely attributable to the practice concussion rate in MS wrestlers being considerably higher than previously reported in high school and collegiate wrestling. The rate of concussion associated with surface contact was also higher than reported among high school and collegiate wrestlers. Our study reported a longer time loss than prior research on high school and collegiate sports. Altogether, our findings suggest a need to investigate strategies to improve skill acquisition or coaching techniques to reduce the risk of concussion caused by surface contact in practice among MS wrestlers.

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Epidemiology of Injuries in Middle School Boys Basketball

Washington EM, Kelshaw PM, Hacherl SL, Martin JM, Erdman NK, Caswell SV: Sports Medicine Assessment, Research & Testing Laboratory, ACHIEVES Project, George Mason University, Manassas, VA, and Department of Kinesiology, University of New Hampshire, Durham, NH

Context: Basketball is a highly popular contact sport with more than 4 million United States children participating annually. Despite its popularity, limited evidence exists related to the epidemiology of injuries in middle school (MS) boys basketball. Therefore, our purpose was to describe the epidemiology of injuries in MS boys basketball. **Methods:** Certified athletic trainers collected injury and athlete exposure (AE) data for practices and competitions for boys' basketball teams from 9 middle schools during the 2015/16 and 16 in 2019/20 academic years. An AE was defined as one athlete participating in one school-sponsored practice or competition. Injury frequencies and rates (IRs) per 1000 AEs were calculated by event type (practice, competition), diagnosis, severity, and mechanism. Injuries were classified as non-time loss (NTL; < 24 hours participation restriction) or time loss (TL; ≥ 24 hours participation restriction). Injury severity was categorized as mild (1-6 days), moderate (7-21 days), or severe (> 21 days) dependent on the number of days of participation restriction. Injury rate ratios (IRR) with 95% confidence intervals (CIs) compared IRs between practice and competition. IRRs with 95% CIs excluding 1.0 were considered statistically significant. **Results:** Overall, 715 injuries were reported (IR=17.10; 95% CI:15.85-18.36) across 41,801 AE (practices:31,057 AE; competitions:10,744 AE). Most injuries occurred during practice (n=510 [71.3%], IR=16.42, 95% CI=15.00-17.85) as compared with competition (n=205 [28.7%], IR=19.08, 95% CI=16.47-27.69). The majority of injuries resulted in NTL (n=538 [75.2%]). Among TL injuries, most were classified as mild (n=151 [86.8%]) followed by moderate (n=18 [10.3%]) and severe (n=5 [2.9%]). The rate of NTL injury was not significantly different (IRR=0.97; 95% CI: 0.00-2.14) between practice (n=403, IR=12.97) and competition (n=135, IR=12.57). The rate of TL injury was significantly higher (IRR =1.85; 95% CI: 0.68-3.03) in competition (n=68, IR=6.33) than practice (n=106, IR=3.41). The most common mechanisms for TL injuries were non-contact (n=50 [28.7%], IR=1.20; 95% CI=0.86-1.53), surface contact (n=29 [16.7%], IR=0.69; 95% CI=0.44-0.95), and player contact (n=27 [15.5%], IR=0.65; 95% CI=0.40-0.89). **Conclusions:** We observed that most MS boys' basketball injuries to be minor resulting in NTL or fewer than 7 days of participation restriction. Although the overall IRs were similar in competition and practice, the rate of TL injuries was significantly higher during competition with the majority caused by non-contact mechanisms. Compared to prior findings among high school and collegiate levels, we observed a lower incidence of TL injuries, suggesting that participation in MS boys' basketball is relatively safe. Our findings bolster the value of access to onsite athletic training services for injury surveillance as well as managing injuries for middle school athletes.

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Free Communications, Oral Presentations: Prevention and Treatment of Upper Extremity Injury

Moderator: Stephen Thomas, PhD, ATC

Thursday, June 30, 2022; 11:45 AM-12:40 PM; Room 201BC

Specialization, Pitch Smart Compliance, and Long-Term Throwing Arm Health in College Baseball Players

Wilkins SJ, Bell DR, Kahanov L, Martin M, Post EG: Rocky Mountain University of Health Professions, Provo, UT; University of Nebraska at Omaha, Omaha, NE; University of Wisconsin-Madison, Madison, WI; Stockton University, Galloway, NJ; Indiana State University, Terre Haute, IN

Context: Early sport specialization is associated with increased risk of overuse injuries in several sports, including baseball. USA Baseball's Pitch Smart (PS) guidelines were developed as age-specific recommendations to increase safe participation in baseball and reduce injury risk. The purpose of this study was to determine whether differences exist in Kerlan-Jobe Orthopedic Clinic (KJOC) Shoulder and Elbow Scores in college baseball players based on a player's compliance with PS guidelines as a youth player. Additionally, our study examined the association of youth PS compliance and specialization status. **Methods:** A total of 752 college baseball players from Midwest institutions were contacted through the institution's athletic trainer to complete a cross-sectional online survey via Qualtrics. A total of 294 baseball players completed the survey (response rate: 39.1%). We measured sport specialization, KJOC scores, and PS guideline compliance using the Baseball and Sport Experience (BASE) survey. The survey was validated through an a priori study of 120 participants who met the inclusion criteria. Content validity and internal consistency were established using an expert panel, and by calculating Cronbach's Alpha values and internal index values for all survey items. Participants self-reported compliance with nine PS guidelines using a 5-point sliding Likert scale (1=Never-5=Always) or by reporting a specific numeric value. The KJOC is a validated quantitative instrument used to measure functional status of the upper extremity. Compliance was determined by comparing individual responses with various PS guidelines for 15-18-year-old pitchers. Data were summarized using means (SD), medians [IQR], and frequencies and percentages. A Mann-Whitney U test was used to determine differences in median KJOC total scores based on compliance with PS guidelines. A Chi-Square test was used to assess associations between level of specialization prior to high school and compliance with individual PS guidelines. **Results:** Of the 294 participants, a total of 217 (mean age: 19.85 ± 1.52 years, height: 183.88 ± 7.27 cm, mass: 87.67 ± 11.68 kg) pitched in high school and completed the KJOC scale questions (median: (90.80 [74.9-97.3). Pitchers who reported pitching with arm fatigue had lower KJOC overall scores compared to pitchers who never pitched with arm fatigue ($p<0.001$). Low-level specialists were more likely non-compliant in completing a warm-up prior to pitching ($p=0.006$) and throwing an age-appropriate maximum number of pitches ($p=0.035$). High-level specialists were more likely non-compliant throwing breaking pitches before age 13 ($p=0.02$). **Conclusions:** Players who reported pitching with arm fatigue in high school had lower KJOC scores in college, indicating poorer throwing arm health. Players who were highly specialized in baseball prior to high school also began throwing breaking pitches at an earlier age. Athletic trainers should be aware of the PS guidelines for baseball pitchers and educate stakeholders about potential long-term health risks involved with non-compliance.

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A Comparison of Electromyography (EMG) Activity During Exercises Targeting Scapulothoracic Muscles

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Context: Contemporary literature discusses the concept of the kinetic chain of the upper extremity, and the importance of a stable scapula for the glenohumeral joint to move against. Exercises that activate the upper trapezius (UT), middle trapezius (MT), lower trapezius (LT), serratus anterior (SA), and latissimus dorsi (LD) muscles sequentially help create a scapular stability. Strengthening exercises of these scapular stabilizing muscles are commonly prescribed for treatment of various shoulder pathologies. The purpose of this study was to evaluate differences in EMG activity of 5 scapular stabilizing muscles during 8 different exercises, thus guiding clinical practice. **Methods:** This crossover study was performed with sixteen healthy college volunteers (age = 25.63 ± 2.52 yrs) in a biomechanics lab. Participants had no history of injury to the upper extremity and did not participate in an overhead sport at the collegiate level. Skin was prepped with rubbing alcohol. Delsys Trigno surface EMG sensors were placed on the 5 muscles being tested: UT, MT, LT, SA, LD parallel to the muscle fibers, on the dominant side only. First subjects performed 3 repetitions of maximal voluntary contractions (MVC) for 3s for each of the muscles separately. Then subjects performed 5 repetitions of each of the 8 exercises [beast scapular (BS), crab scapular (CS), incline push-up (IP), incline push-up with contralateral leg lift (IPCL), prone row (PR), prone Y (PY), prone T (PT), prone arrow (PA)] in randomized order. The independent variable was the different exercises. The dependent variable was the muscle activity (%MVC). A metronome set at 60bpm was used to synchronize the phases of the exercises. All data were collected at a sampling rate of 2000hz. Raw EMG data were full wave rectified and low pass filtered (single pass, Butterworth, 6Hz low pass filter of the 6th order). Data from exercises were normalized to %MVC. Peak activity for each repetition was recorded and averaged. We used separate One-way ANOVAs with Tukey Post Hoc to evaluate differences in EMG activity between the 8 exercises for each of the 5 muscles. **Results:** There were significant differences between the exercises for UT ($F(7,120) = [15.21]$, $p=0.001$), MT ($F(7,120) = [8.65]$, $p=0.001$), LT ($F(7,120) = [17.63]$, $p=0.001$), SA ($F(7,120) = [30.63]$, $p=0.001$), & LD ($F(7,120) = [9.11]$, $p=.001$). Descriptive statistics are provided in Table 1. **Conclusions:** Activity level of each muscle differs by exercise. The PY exercise stimulated UT the most while CS recruited UT the least. MT was activated the most by PY and the least by the IP. LT was most active during the PY exercise while it was least active during the IP. SA was active most during BS and least active during the PT exercise. The CS exercise activated the LD most while PT was the least active.

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A Descriptive EMG Study of Two Novel Ground-Based Exercises Used for Scapular Stability

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Context: Recently, ground-based training techniques have gained popularity in rehabilitation. Ground-based training exercises are performed in a suspended quadruped position, thereby making them closed kinetic chain. Two exercises, beast scapular and crab scapular have yet to be studied. Beast scapular features protraction and retraction of the scapula while crab scapular features scapular elevation and depression. Previous EMG research of scapular stability exercises only focused on local scapular muscles and did not include study of the myofascial kinetic chains that make up the arm. Knowing muscle activity levels during the exercises will help inform clinical practice. **Methods:** This descriptive study was performed with sixteen healthy college volunteers (age = 25.63±2.52 yrs) in a biomechanics lab. Skin was prepped with rubbing alcohol. Delsys Trigno surface EMG sensors were placed on the 9 muscles being tested: upper trapezius, middle trapezius, lower trapezius, serratus anterior, latissimus dorsi, biceps brachii, triceps brachii, flexor carpi ulnaris, extensor carpi radialis parallel to the muscle fibers, on the dominant side. Subjects performed 3 repetitions of maximal voluntary contractions (MVC) for 3s for each of the muscles separately. Then subjects performed 5 repetitions of each of the 2 exercises [beast scapular (BS), crab scapular (CS)], in randomized order. We measured peak muscle activity (%MVC). A metronome set at 60bpm was used to synchronize the phases of the exercises. All data were collected at a sampling rate of 2000hz. Raw EMG data were full wave rectified and low pass filtered (single pass, Butterworth, 6Hz low pass filter of the 6th order). All data from exercises were normalized to %MVC. Peak activity for each repetition was recorded and averaged. Descriptive data (mean and SD) were calculated for each of the muscles. We operationally defined muscle activities as: low (0%–15% MVC), low to moderate (16%–20% MVC), moderate (21%–40% MVC), high (41%–60% MVC), and very high (greater than 60% MVC). **Results:** Upper trapezius activities were low for CS and low to moderate for BS. Middle trapezius activities were high for both BS and CS. Lower trapezius activities were high for BS and moderate for CS. Serratus anterior activities were very high for BS but only low to moderate for CS. Latissimus dorsi activities were moderate for BS and high for CS. Triceps activity was high for BS but low to moderate for CS. Flexor carpi ulnaris activity was moderate for both BS and CS. Biceps brachii and extensor carpi radialis activities were low for both BS and CS. See Table 1 for descriptives. **Conclusions:** Beast scapular and crab scapular are useful scapular stabilization exercises. If high activation of serratus anterior and triceps brachii are desired use BS. If high activation of latissimus dorsi is desired use CS. Both exercises highly activate middle trapezius while limiting upper trapezius activity.

None of the authors have any financial disclosures.

Table 1. Peak muscle activity (%MVC) during the beast scapular and crab scapular exercises.

Muscle	Beast Scapular Mean ± SD)	Crab Scapular Mean ± SD
Upper Trapezius	20.07 ± 18.67	11.00 ± 12.35
Middle Trapezius	45.92 ± 22.22	49.62 ± 24.61
Lower Trapezius	43.9 ± 17.82	37.27 ± 13.95
Serratus Anterior	60.75 ± 9.74	18.19 ± 12.43
Latissimus Dorsi	28.17 ± 17.22	53.82 ± 22.47
Biceps Brachii	8.12 ± 6.14	6.83 ± 5.87
Triceps Brachii	51.46 ± 21.52	16.44 ± 12.12
Flexor Carpi Ulnaris	27.71 ± 16.09	25.57 ± 20.49
Extensor Carpi Radialis	7.19 ± 5.06	5.38 ± 2.52

Lower Trunk Rotation Strength Is Associated With Early Trunk Rotation in High School and Collegiate Baseball Pitchers

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Context: Higher shoulder and elbow joint moments incurred during baseball pitching are theorized to increase the risk of throwing-related upper extremity injuries. Early initiation of trunk rotation and excessive lateral trunk flexion has been linked to higher joint moments. While these kinematic patterns may be attributed to poor trunk control by the abdominal muscles, research examining the relationship between abdominal muscle strength and pitching mechanics is limited. The purpose of the study was to investigate the relationship between trunk rotation strength and pitching biomechanics in amateur baseball pitchers. **Methods:** Sixty-eight high school and collegiate pitchers (age: 16.7±2.3 years, height: 1.78±0.10m, mass: 76.7 ±13.0kg, dominance: 54 right/14 left) participated. The isometric trunk rotation strength was measured using a portable dynamometer as the participants attempted to rotate the torso in a hook-line position (intra-session ICC=.978). The test was performed in both directions (rotation towards dominant and non-dominant limb). The strength normalized to body weight was used to categorize participants into low, moderate, and high tertiles. Pitching kinematics was captured with an optical motion capture system (600Hz) using an established marker set. The marker coordinates and estimated segment mass were used to calculate trunk kinematic variables (timing of initiation of trunk rotation, maximum pelvis-trunk separation angle, and peak lateral trunk flexion angle) and peak elbow varus and shoulder internal rotation moments. The joint moments were normalized to body weight and height. The variables were compared between groups using one-way ANOVAs followed by Bonferroni post-hoc tests (α=0.05). **Results:** Trunk rotation strength in both directions was associated with the timing of trunk rotation ($p<0.05$) (Table). The pitchers with low trunk rotation strength towards the dominant limb initiated trunk rotation earlier than the pitchers in the highest tertile (mean difference=11.4±4.1%, p=.02). The pitchers with low trunk rotation strength towards the non-dominant limb initiated trunk rotation earlier than the pitchers in the middle tertile (mean difference=10.2±4.1%, p=.048). No other variables were different between groups. **Conclusions:** Weak trunk rotation strength was associated with earlier initiation of trunk rotation. During the stride and arm-cocking phases of pitching, creating a lag between the pelvis and upper torso is considered to facilitate the transfer of momentum to the throwing arm, increase ball velocity, and decrease joint kinetics by decreasing the reliance on the arm to generate ball velocity. Our study demonstrated that the inability to delay the trunk rotation to create the temporal lag can be attributed to weak abdominal muscles and suggests that strengthening the abdominal muscles may allow pitchers to delay the trunk rotation. The trunk rotation weakness, however, was not associated with ball speed, lateral trunk flexion, maximum separation angle, or joint moments in our study. Further study is needed to examine the effects of strengthening the abdominal muscles on pitching biomechanics.

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Table: Means and standard deviation of demographics and dependent variables by tertile groups

	Trunk rotation strength towards dominant limb				Trunk rotation strength towards non-dominant limb			
	Low (n=23)	Middle (n=22)	High (n=23)	p-values	Low (n=23)	Middle (n=22)	High (n=23)	p-values
Age (years)	16.6 ± 2.5	16.9 ± 2.5	16.9 ±2.0	.833	16.9 ± 2.8	16.9 ± 1.8	16.6 ± 2.2	.848
Height (m)	1.77 ± .13	1.79 ± .08	1.79 ± .09	.844	1.77 ± .12	1.81 ± .09	1.78 ± .07	.417
Body mass (kg)	80.0 ± 12.5	75.4 ± 14.1	74.8 ± 12.3	.353	80.0 ± 15.1	76.9 ± 12.6	73.1 ± 10.5	.196
Ball speed (m/s)	32.9 ± 3.0	34.0 ± 3.6	33.6 ± 2.3	.492	33.4 ± 3.6	34.1 ± 3.1	33.1 ± 2.3	.533
Timing of trunk rotation (% pitch cycle)	11.9 ± 9.0	20.4 ± 15.7	23.3 ± 14.6	**.018***	12.9 ± 9.1	23.1 ± 17.7	19.6 ± 12.7	**.049***
Max pelvis-trunk separation angle (°)	33.4 ± 14.2	32.2 ± 14.5	33.9 ±13.0	.916	32.5 ± 13.3	31.9 ± 14.7	35.1 ± 13.5	.725
Peak lateral trunk tilt angle (°)	31.3 ± 13.8	30.8 ± 11.2	31.1 ± 8.8	.990	32.4 ± 14.0	30.5 ± 10.5	30.2 ± 9.2	.790
Elbow varus moment (Nm/BW/Height)	4.02 ± .69	4.40 ± 1.03	4.15 ± .89	.638	4.44 ± .88	4.01 ± .90	4.31 ± .82	.262
Shoulder internal rotation moment (Nm/BW/Height)	4.04 ± .67	4.28 ± 1.06	4.07 ± .79	.597	4.32 ± .93	3.94 ± .82	4.13 ± .78	.330

* Statistically significant at alpha level of 0.05

Geographical Differences in Sport Specialization Rates of High School Baseball Players

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Context: Overuse injuries are common in baseball players and have been associated with specializing in one sport. Baseball athletes from warm-weather climates are more susceptible to certain overuse injuries than baseball athletes from cold-weather climates. Sport specialization in baseball may be more prevalent in warm-weather climates because the weather allows athletes to play year-round. However, previous research on sport specialization often overlooks baseball players and has not compared athletes from different climates. The purpose of this study was to compare sports specialization rates and months played per year among high school baseball players who reside in different geographical locations. We hypothesized that baseball athletes from cold-weather areas would be less likely to be specialized in baseball and would play fewer months per year than athletes from warm-weather areas. **Methods:** This cross-sectional study was completed at 15 high schools in 3 different geographic locations. Selected schools were matched based on student population and socioeconomic status. Overall, 623 athletes (Western Alabama: N=225; Southern California: N=206; Southeast Michigan: N=192) participated in this investigation. Participants completed questionnaires consisting of information about demographics, baseball participation, and other sport participation. Completed surveys were electronically entered by the research team, and participants were classified into geographic locations based on the state in which they lived. Sport specialization was classified based on answers to the questions of whether baseball was the athlete's primary sport, whether an athlete had quit other sports to focus on baseball, and whether the athlete played baseball for more than 8 months per year. One point was added for every "yes" response (Low specialization = 0-1, Moderate specialization = 2, High specialization = 3). Associations between geographic location and sports specialization were analyzed via Chi-square. Months played was compared between geographic locations via one-way ANOVA. **Results:** Results: Of the 623 baseball players who participated, 324 (52.0%) were classified as highly specialized in baseball, with 196 (31.5%) classified as moderately specialized, and 103 (16.5%) classified into the low specialization group. A significant relationship existed between geographic location and degree of specialization [$\chi 2=19.09$, $p=.001$]. High school baseball players from Michigan were less likely to be highly specialized (40.6%) than athletes from Alabama (56.0%) and California (58.3%). Baseball players from Michigan played significantly fewer ($p < .001$) months per year (8.5±3.1) than athletes from Alabama (9.9±2.5) and California (10.1±2.9). **Conclusions:** The majority of our sample of high school baseball athletes were classified as highly specialized. Baseball specialization rates were higher in warm-weather states compared to cold-weather states. Our results indicate that intervention and counseling programs may be needed to address sports specialization in the baseball community. The focus of these programs should be on warm-weather states, where specialization is more prevalent.

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Determining the Effects of Pitching Volume and Fatigue on Self-Reported Pain and Injury in High School Softball Pitchers

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Context: Softball pitchers often throw many more pitches and participate in more games than their baseball counterparts. Although the effects of fatigue and pitching volume are often studied with baseball pitchers, little research has been found on the effect that this volume has on adolescent softball players. The purpose of this study was to determine and quantify the prevalence of pain in high school softball pitchers and to examine the relationship of pain to pitching volume and subjective and objective measures of fatigue. **Methods:** This was a prospective, repeated-measures quantitative study of high school female softball pitchers. Sixteen uninjured female softball pitchers (14-19 yo) participated in this study during their pre-season and competitive softball seasons. During the 18-week duration of the study, weekly pain levels using the Numeric Pain Rating Scale (NPRS), reported pitch counts, and vertical jump height measurements were tracked for each pitcher. Additionally, athletes reported fatigue using the Hecimoviche Peiffere Harbough Exercise Exhaustion Scale (HPHEES), and the Perceived Recovery Status Scale (PRS). Due to limited sample size, non-parametric tests were used to detect correlations between pitching volume, pain, fatigue scales, and vertical jump height using Spearman's Rho rank correlation coefficient tests. The significance level was set at $p<0.05$ for all analyses. **Results:** Results of the study demonstrated that increased softball pitching volume was associated with lower reported recovery scores on the PRS at the beginning (week 2 r=-0.784 p=0.04), and at the end (week 16 r=-0.689 p=0.03) of the season. Increased volume was also associated with greater fatigue as demonstrated with lower vertical jump scores at the middle (week 8 r=-0.693 p=0.01) and end of the season (week 16 r=-0.641 p=0.05). Results also showed that self-reported pain on the NPRS was associated with fatigue. Lower PRS scores were reported at the beginning (week 2 r=-0.905 p=0.01), middle (week 8 r=-0.887 $p<0.001$) and end (week 16 r=-0.689 p=0.03) of the season. Pain was also associated with higher HPHEES scores throughout the season (week 2 r=0.764 p=0.05, week 8 r=0.832 $p<0.001$, week 16 r=0.779 p=0.001). Finally, increased pitching volume was also closely associated with increased pain during the final weeks of the season (weeks 14-17 r=0.752 to r=0.892 p=0.01 to 0.05). **Conclusions:** Increased softball pitching volume and pain are associated with increased patient-reported fatigue. Increased pitching volumes were also associated with lower vertical jump measurements as an objective sign of fatigue. Further research is needed to determine if these correlations are significant to injury risk in these athletes so that intervention strategies may be employed.

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The Chronic Adaptation of the Coracohumeral Space in Baseball Pitchers

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Context: Shoulder injuries account for 17% of injuries on the Major League Baseball injured list and anterior shoulder injuries occur frequently. Due to the high forces created during the late cocking phase of pitching, structural adaptations may occur in the anterior shoulder, however, very limited research has focused on anterior shoulder structures. The purpose of this study was two-fold: 1) to determine the chronic adaptations to the coracohumeral distance (CHD) and subscapularis tendon organization due to pitching, 2) to determine if posterior capsule thickness (PCT), scapular protraction (SP), and humeral retroversion (HR) predict CHD and subscapularis tendon organization. **Methods:** A cross sectional study design was utilized to compare dominant and non-dominant CHD and subscapularis tendon organization in professional pitchers. Additionally, HR, PCT, and SP were measured to determine the relationship to CHD and subscapularis tendon organization. The independent variables were SP, PCT, and HR; the dependent variables were CHD and the peak spatial frequency (PSF) of the subscapularis tendon. Data was collected from 52 professional baseball players between 18 and 34 years old with a minimum of 5 years of experience. Diagnostic ultrasound was used to capture images of the CHD and subscapularis tendon with the shoulder in 30° of external rotation, neutral rotation, and internal rotation (hand on the opposite shoulder). The ultrasound probe was applied to the anterior shoulder, the coracoid process and subscapularis tendon were identified, and the images were then captured and saved for further analysis (Figure 1). ImageJ was used following data collection to measure CHD and MATLAB software was used to determine PSF. Reliability test was performed for all measures and shown to have ICCs above 0.98. Paired t-tests were used to compare CHD and PSF bilaterally, and a stepwise linear regression was used to examine the relationship between the independent and dependent variables. **Results:** The dominant arm of pitchers demonstrated a significantly narrower CHD in external rotation (p=0.002, MD=0.86mm), neutral rotation (p=0.005, MD=0.73mm), and internal rotation (p=0.0001, MD=1.36mm), and higher PSF (p=0.0001m, MD=0.12 peaks/mm). Additionally, HR predicted CHD in 30˚ of external rotation (p=0.0001, R2=0.123), neutral rotation (p=0.001, R2=0.11), and hand on opposite shoulder (p=0.0001, R2=0.275). PCT predicted CHD in 30˚ of external rotation (p=0.048, R2=0.157). PSF was predicted by HR (p=0.016, R2=0.062) and the CHD in 30˚ of external rotation (p=0.030, R2=0.109). **Conclusions:** The stress of throwing resulted in a less organized subscapularis tendon and smaller CHD in each arm position. HR retroversion predicted both adaptations to the CHD and subscapularis tendon. Increased HR approximates the less tubercle of the humerus closer to the coracoid process, narrowing the CHD and creating compressive forces on the insertion of the subscapularis tendon. Adaptations to the CHD and subscapularis tendon may place pitchers at risk for injury.

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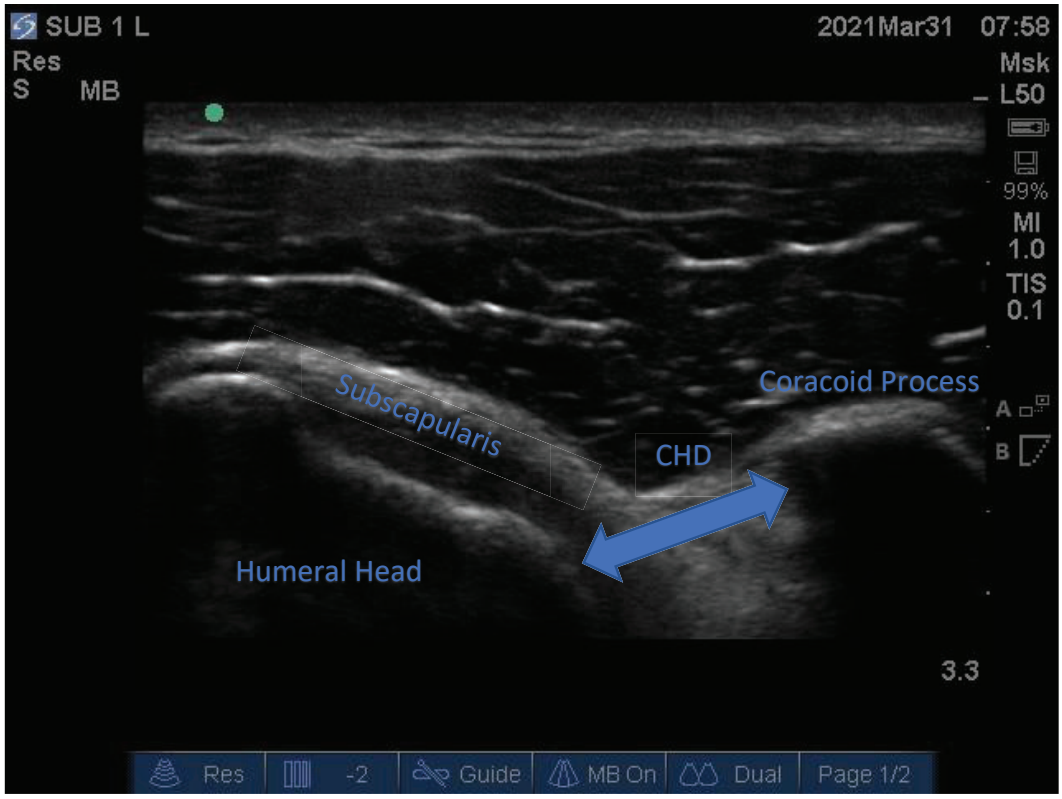
Ultrasonographic Measurement of CHD



Baseball Pitching: Effects on the Ulnar Collateral Ligament and Ulno-Humeral Joint

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Context: In baseball pitchers, the ulnar collateral ligament (UCL) is at risk for injury as it stabilizes the medial elbow against a large valgus stress during pitching. Increased ulnohumeral (UH) joint gap distance, UCL thickness and presence of hypoechoic foci and calcifications have been observed in the dominant compared to non-dominant elbow in professional, but not high school pitchers. It is unclear when these morphological changes start to occur in pitchers. Characterize the UCL characteristics and UH-joint laxity in collegiate pitchers, to define when UCL morphology and the impact on UH-joint laxity occur. **Methods:** NCAA Division I collegiate pitchers (N=41; 19.9 ± 1.2 yrs) were recruited for this cohort study. Bilateral ultrasound (US) images were collected of the medial elbow at 90° elbow flexion at rest and with a 2.5kg valgus-stressed position. US-based calipers measured the UH-joint between the medial humeral trochlea and ulnar coronoid process. UCL thickness was measured at the proximal and distal UCL attachments. The UCL was rated on characteristics of degeneration (0=normal, 1=hypoechogenic foci, 2=anechoic foci, 3=full thickness fiber discontinuity) and presence of calcifications, enthesopathy, and joint effusion. Reliability was established prior to data collection for all measures [ICC (2,k) > 0.83 for all measures]. Bilateral differences were assessed using independent t-tests for quantitative measures, and Wilcoxon ranked-sum and Chi-square tests for qualitative appearance. Linear regression analyses assessed the relationship between qualitative and quantitative measures. **Results:** The dominant arm had a greater prevalence of enthesopathy (24.3% vs 7.3%, p=0.03), degenerative rating (0.49 vs 0.15; p=0.03) and a thicker distal UCL [MD=0.19mm (95%CI=0.05,0.32), p<0.01] versus the non-dominant. There were no significant differences in proximal UCL thickness or UH-joint gap at rest or with applied force. The presence of enthesopathy (B= 0.20, p=0.04) and calcifications (B= 0.31, p=0.02) significantly predicted distal UCL thickness (R2=0.21, p<0.01). Degenerative score (B= 0.28, p<0.01) predicted UH-joint gap (R2=0.14, p<0.01). **Conclusions:** Healthy collegiate pitchers had thicker UCL at the distal attachment, and greater degenerative changes and enthesopathy of the UCL on the dominant arm. But, there was no difference in UH-joint gap. The presence of enthesopathy and calcification predicted a thicker distal UCL, indicating that a UCL dimensional increase was related to pathological changes. Degenerative findings were associated with greater medial joint gapping. Degeneration of the UCL may be a precursor to medial elbow instability and, ultimately, ligament failure. These findings suggest the UCL is thicker distally, with associated qualitative changes in the ligament. Considering greater UH-joint gapping has been previously associated with UCL injury, the lack of gapping in this study indicates that collegiate pitchers may have a lower risk for UCL injury compared to professional pitchers.

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Non-Contact Midshaft Femur Fracture in a Healthy College Athlete: A Level 3 CASE Study

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Background: In the United States approximately 60,000 people sustain midshaft femur fractures per year, typically as the result of high-energy mechanisms such as motor vehicle accidents, falls from a height, or industrial accidents. Due to the mechanism required to fracture this large bone, surgical intervention is typically required. The purpose of this Level 3 case study is to present the case of a noncontact femur fracture in a healthy college athlete. **Patient:** Patient is a Caucasian, 18 year-old freshman linebacker at a Division 1 college. The injury occurred during practice at fall camp. Patient was making a play at practice, he planted his left foot and as he was pushing off to change direction to run after the ball carrier, a loud pop was heard and the patient went to ground. Initial evaluation indicated the patient was conscious and alert, knee ligaments were stable, but presented with significant fluid within the thigh; it was initially unclear if fluid was swelling or blood. Varus/valgus testing showed stable medial and lateral collateral ligaments but movement was felt proximal to the knee at mid-thigh. At this time a femoral fracture was suspected. A vacuum splint was applied on field, EMS and campus safety were called, and an additional call was placed to the attending ED physician at Trauma 1 hospital. Dorsal pedal pulse, distal sensation, and distal motion were assessed prior to splinting, after splinting, and every 5 minutes until EMS arrived; all were intact. A closed, minimally comminuted, complete fracture of mid-femoral diaphysis with anterior displacement of proximal fracture fragment and 6 cm of shortening was noted on x-ray. The patient had no predisposing factors for acute femur fracture and had no history of femoral stress fracture. **Intervention & Treatment:** Patient was treated with a closed reduction and internal fixation/cephalomedullary reconstruction nailing of the left femoral shaft fracture. Nails were inserted laterally. **Outcomes or Other Comparisons:** The comparative outcome for this athlete will be return to Division 1 football. To our knowledge there have been no previous papers written about the return to Division 1 football following a mid-shaft femur fracture. Compared to the protocol used for a professional football player with a contact fracture, this athlete is progressing more quickly than previous literature's timeline. Our patient was completing exercises at weeks 5-7, such as glute bridges, squats, lunges and calf raises, that were completed by the professional football player during weeks 8-12. Based on rate progression, the goal for this athlete is to return by fall camp next year. **Conclusions:** This case presents the case of a healthy, young athlete who sustained a mid-shaft femur fracture without contact or any predisposing factors. The noncontact mechanism of injury distinguishes this case from the tens of thousands of femur fractures that occur annually. Previous studies have looked at athletes who have had an outside force, such as other players, making contact with the thigh. Treatment of previous cases included anterograde versus retrograde intramedullary nailing, whereas this case has lateral nail placements. Rehabilitation of a femur fracture for return to play has not been standardized and no protocol looks at returning to high impact sports, therefore many of the exercises implemented in this case are based on the patient's limitations. **Clinical Bottom Line:** Although an uncommon occurrence, mid-shaft femur fractures can occur in healthy young athletes. Knowledge of appropriate stabilization factors and how the surgical intervention impacts the rehabilitation protocol for the athlete are important take-home points for clinicians.

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Non-Contact Acute Cervical Radiculopathy and Rapid Progressive Weakness in a Recreational Golfer: Type 4 CASE Study

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Background: A 66-year-old male from California presented to the emergency department for acute, progressing neck pain after a golf swing ten days prior. He reported immediate neck, shoulder, and back pain. The days following, he noted progressively decreased right arm strength, mobility, and tingling sensation down his right upper arm that radiated into his thumb and index finger. The patient was unable to actively abduct or forward flex his arm past 90 degrees. Manual muscle testing showed 3/5 right deltoid and 4/5 right bicep. Bicep and brachioradialis reflexes were absent. Special tests showed (+) spurling sign and (+) nerve tension test on the right side. **Differential Diagnosis:** Acute neck pain results from numerous pathologies including brachial plexus injury, cervical facet syndrome, cervical spinal stenosis, cervical disc injury, cervical spine fracture, muscle strain, or contusion.1,2 **Intervention & Treatment:** Anteroposterior, lateral, flexion, and extension cervical radiographs showed decreased disc height with osteophytes at C5-C7. The MRI showed central and right disc herniation at C4-C5 and chronic degenerative changes. The CT scan showed disc herniation to the right filling the entire foramen on side at C4-C5 and facet joint hypertrophy. Due to the patient's rapid and acute progression of decreased sensory and motor function, and to prevent permanent loss of neve function, surgical intervention was discussed with the patient. The patient consented to undergo an anterior cervical discectomy and fusion (ACDF) at C4-C5, which was performed the next day. The patient was discharged 24 hours after surgery. Three days post-op his neck and arm pain had completely resolved and 6 days post-op his arm strength and ROM was back to normal. **Uniqueness:** The mechanism of injury for this patient was non-contact and caused a rapid acute progression of decreased sensory and motor function. If surgical intervention was not chosen as the first line of treatment, it is possible that the nerve could have been permanently damaged. Transforaminal epidural steroid injections can allow the patient relief temporarily, and in some cases eliminate it all together. However, with definitive clinic exam cues, most importantly significant weakness, in conjunction with imaging the cervical nerve roots that were injured were evident and needed quick intervention. **Conclusions:** Cervical radiculopathy is a common cause of neck and arm pain that can be associated with weakness and disability due to compression on nerve roots or spinal cord.4 The incidence rate among the general population is 85 per 100,000 people and studies have shown relationship between physical activity increasing mechanical load on the neck causing higher prevalence of neck pain.4-8 The mechanism of cervical radiculopathy can be chronic degenerative spinal changes or acute trauma to the spine. The C7 root is the most commonly affected nerve within the cervical spine.4-5 Most acute cervical radiculopathy cases will resolve within 8-12 weeks with non-operative treatment.5 Severe weakness is a red flag that requires prompt treatment to prevent irreversible nerve damage and disability. NCAA injury surveillance analysis showed that contact sports put athletes at the highest risk.1,2 Neck injuries among contact collegiate football players showed low rates of cervical disc injuries(1.8%) over a 4 year injury surveillance period.2 This case is unique because the mechanism was non-contact, lower impact, and severe. Neck pain accounts for 40% of work absenteeism and among athletics accounts for 15% of all injuries.5 To prevent financial burden on individuals, acute herniation with loss of motor function and sensation requires prompt surgical treatment, with ACDF being the gold standard of care.7 It is important for the clinician to document noted weakness on exam to bypass conservative treatment and provide swift surgical treatment to protect nerve function.

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Treating Bilateral Osteochondritis Dissecans in the Adolescent Athlete's Knee: Type 1 CASE Study

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Background: Juvenile osteochondritis dissecans(JOCD) is a condition occurring in adolescents that causes breakdown of subchondral bone and articular cartilage.1-3 The majority of cases occur in the medial femoral condyle of the knee.1,2,4,5 The exact cause is still unknown, however a commonly thought factor is overuse.4-7 Early recognition is key for optimal prognosis.2,4 This Level 1 CASE Study was compared to the systematic literature review by Abouassaly et al. which states that stable osteochondritis dissecans(OCD) lesions in the pediatric population are best treated with transarticular drilling if conservative management fails.8 **Patient:** The patient is a 15-year-old male football and baseball athlete, positioned as a cornerback and kicker, and outfielder, respectively. He is 5'9'' and weighs 140lbs. He presented with an insidious onset of medial-sided left knee pain that had been present for over a year and was described as achy and unstable. He had tenderness with palpation over the left medial femoral condyle. Ligamentous and meniscal special tests were negative. The right knee remained asymptomatic. Radiographs and MRI showed bilateral OCD lesions of the medial femoral condyles. The right lesion was measured as 12x15mm and noted as stable, while the left lesion was measured as 26x20mm and its stability was unclear. **Intervention & Treatment:** The patient failed conservative treatment, including physical therapy and rest for several weeks. Based on the MRI, the left lesion did not appear it would heal with nonoperative management due to the size and cystic bony change. Consent was obtained to arthroscopically assess and drill the right knee to prevent progression since he would already be actively rehabilitating the left side. Arthroscopy found both lesions to be stable and transarticular drilling was performed bilaterally. The patient was NWB for 2-weeks, partial weight bearing for the next 4-weeks then full weight bearing by 6-weeks. Two weeks after surgery the patient regained full ROM. Repeat radiographs and MRIs performed 4-months post-op after surgery showed complete healing of the right lesion, with significant healing of the left lesion. He was cleared to start sport-specific activities using a medial unloader brace on the left knee. **Outcomes or Other Comparisons:** The patient made excellent progress with surgical treatment. The right OCD lesion is fully healed. The left lesion demonstrates significant healing. The edema in the medial femoral condyle has decreased, the sclerosis at the base of the lesion has significantly reduced, and the high signal intensity at the base of the lesion is less discrete. Transarticular drilling after failed conservative management, as in this case, is the most common treatment for unstable lesions in pediatric patients as stated by Abouassaly et al. **Conclusions:** The age of the patient and stability of the lesion are important factors in determining course of treatment.2,4,7,9 This patient had bilateral lesions, however, only one side was symptomatic. With the patient being a young, healthy individual who had failed conservative treatment, bilateral transarticular drilling was ultimately the best course of treatment. This prevented further exacerbations and encouraged optimal healing of the asymptomatic right knee by undergoing surgery and rehabilitation of both knees simultaneously. **Clinical Bottom Line:** Early diagnosis is crucial for the best prognosis of JOCD2,4. If insidious knee pain is found without definitive diagnosis, JOCD should be considered. It is crucial to evaluate the knees bilaterally, even if only one knee is symptomatic5. Arthroscopy is the gold standard for diagnosis of JOCD rather than MRI alone due to a false positive rate of about 50% in determining stability of the lesion.9 When addressing JOCD of the knee, stable lesions should first be treated conservatively.3, 8 If this fails, transarticular drilling is necessary.3, 8 If the lesion is unstable, bioabsorbable pin fixation should be used.9

None of the authors have any financial disclosures.

A Great Toe Injury Is a High School Girls' Soccer Player

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Background: A 15-year-old female, African American soccer player reported to the athletic trainer during a soccer game complaining of right great toe pain after being stepped on while kicking the ball. On evaluation she reported an 8/10 pain with activity, pain with palpation over the lateral, dorsal and plantar surfaces of the MTP joint of the great toe. Dorsal swelling and bruising of the foot was observed. No laxity with stress of the first MTP joint. Her mid-foot and ankle where pain free on exam. She denied any neurological symptoms. The athlete stated that she had a history of turf toe. Turf toe taping was applied, but she was unable to return to the game. The patient was referred to the clinic for exam and X-rays. X-rays were negative for fracture. She was placed in a boot for comfort when ambulating. One-week post-injury, she stopped wearing the boot since her pain level was 2/10 with activity, palpation and stress of the MTP joint. She returned to full soccer activity with turf toe taping the great toe. At 8-months post-injury, she returned to the sports medicine clinic after re-injuring her toe playing club soccer the prior week. She reported constant pain, which increased with weight bearing activity. Pain with palpation on lateral, dorsal and plantar surface of the great toe. She denied any neurological symptoms. X-rays were negative. The patient was placed in a boot, removed from all activity, and an MRI was ordered. **Differential Diagnosis:** 1) Turf toe 2) tear of plantar plate ligament 3) Sesamoiditis 4) Avascular Necrosis (AVN). **Intervention & Treatment:** The MRI revealed right first metatarsal AVN. There was no evidence of sesamoid fracture or plantar plate tear. She was put in a short leg cast, provided crutches and instructed to be non-weight bearing. Different treatments were discussed if the bone did not heal. At her one-month follow-up, the patient stated she had not been using the crutches and was pain free with weight bearing and with activity. The cast was removed and erythema, ecchymosis, or swelling were not present. She had mild tenderness to palpation over the plantar and medial aspect of the first MTP joint, and no tenderness to palpation over the remaining tarsals, metatarsals, or phalanges. Her ankle range of motion was 0-15 degrees dorsiflexion, 0-40 degrees plantarflexion, 0-20 degrees inversion, 0-15 degrees eversion. She had 5/5 strength and no pain with dorsiflexion, plantarflexion, inversion, and eversion. Her sensation was intact to light touch and all pulses were normal. Additional functional findings included normal gait, and no pain with one-legged jump. The patient was released to the athletic trainer to start return to play exercises. These exercises included balancing on one-leg, toe intrinsic exercises, ankle range of motion, strengthening, and stretching. She started a gradual progression of running, and two-weeks later was released to full activity. **Uniqueness:** AVN of the head of the first metatarsal is a rare injury. The patient in this case developed AVN after repeated trauma to her first MTP joint. AVN may occur after surgery to correct hallux valgus or has been reported to occur with patients who have a history of taking corticosteroids or alcohol abuse. In this case, prompt conservative care was required to improve outcomes for this patient. **Conclusions:** While AVN is a rare condition, it may occur after bone or joint injury. It is important to rule out AVN if the injured area is not healing. This patient completed one-month of conservative care followed by a gradual return to sport progression and had a positive outcome.

None of the authors have any financial disclosures.

Prospective Validation for Risk Factors of Medial Tibial Stress Syndrome in Active Adolescents: A Type 1 Validation CASE Series

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Background: Medial tibial stress syndrome (MTSS) generally affects those who are physically active and can lead to severe pain along the distal posteromedial tibia. Current literature reports that an increased BMI, greater hip external rotation (ER) ROM, greater ankle plantarflexion (PF) ROM, and increased navicular drop are key modifiable risk factors in the development of MTSS in physically active adults. For reference, a BMI representing a healthy height-to-weight ratio is 18.5-24.9, the normative active ROM for hip ER is 45° and ankle PF is 50°, and a navicular drop ≥ 10 mm represents an overly pronated foot. The purpose of this Type 1 validation CASE series was to prospectively validate these four anthropometric measures as risk factors of MTSS in adolescent athletes. **Patient:** This series used cross country and volleyball athletes at three secondary schools in rural Indiana. In total, 66 athletes (46 cross country, 20 volleyball, age = 15.79, 65% assigned female at birth) were included. The athletic trainer(s) at each school assessed BMI, active hip ER ROM, active ankle PF ROM, and navicular drop for each athlete at the beginning of the sports season. **Intervention & Treatment:** The competitive sports season was the intervention in this CASE series. Both sports teams had a 3-4 week preseason followed by approximately 8 weeks of in-season and post-season competition. Cross country athletes averaged 5 practices and 1 meet per week while the volleyball athletes averaged 4 practices and 2 matches per week. Although the number of practices and games varied each week, all athletes experienced 6 athlete-exposures per week. **Outcomes or Other Comparisons:** 21.21% (n = 14/ 66) of participants developed MTSS during their respective sports season. That finding is consistent with the literature with 13-20% of runners developing the condition. Participants were divided into two groups, MTSS and non-MTSS, and descriptive statistics were completed for both groups. Kruskal-Wallis one-way analysis of variance was used to determine differences because the groups were not normally distributed. Participants who developed MTSS had the following: BMI = 20.84±2.21 (95% CI 19.68-22.00), active hip ER ROM = 33.46±6.20° (95% CI 30.21-36.71°), active ankle PF ROM = 52.89±10.19° (95% CI 47.56-58.22°), and navicular drop = 8.25±2.96mm (95% CI 6.70-9.80mm). Participants who did not develop MTSS had the following: BMI = 21.83±3.18 (95% CI 18.65-25.01), active hip ER ROM = 32.96±8.99° (95% CI 30.52-35.40°), active ankle PF ROM = 57.54±11.81° (95% CI 54.33-60.75°), and navicular drop = 7.70±3.69mm (95% CI 6.69-8.70mm). The mean difference (MD) between groups was calculated by subtracting the mean of those who did not develop MTSS from those that did. The MD of each of the measures were as follows: BMI = -0.99, active hip ER ROM = 0.50°, active ankle PF ROM = -4.65°, and navicular drop = 0.55mm. There were no significant differences in BMI ($p > 0.16$), hip ER ROM ($p > 0.50$), ankle PF ROM ($p > 0.22$), or navicular drop ($p > 0.64$) between participants who did and did not develop MTSS. **Conclusions:** These results do not prospectively confirm those who develop MTSS have a significant increase in the risk factors described in the literature. This may be a result of the participants being adolescents or a sample size too small to ensure adequate statistical power. Additionally, information related to training load and intensity should be considered in future research. **Clinical Bottom Line:** Adolescents with significantly greater BMI, active hip ER ROM, active ankle PF ROM, and/or navicular drop may or may not be more likely to develop MTSS. Therefore, more research should be performed to determine if the risk factors for MTSS between adults and adolescents differ.

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A Case of a Salter Harris IV Knee Injury in a High School Basketball Player: A Type 4 Rare Events Case Study

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Background: This 16-year-old male athlete presented with left knee pain (10 / 10) during a high school varsity basketball game. He stated he felt a sharp pain while trying to jump up to rebound a ball. He denied any sensations of a "pop" or giving way. His relevant medical history includes an acute episode of anterior knee pain from Osgood-Schlatter disease, which was being managed with modalities and activity modification with his athletic trainer. The patient's history was void of any significant injuries to the affected lower extremity. There was no discoloration or ecchymosis noted on examination. A prominent tibial tuberosity compared to the uninvolved side was seen on exam that was thought to be related to his Osgood Schlatter disease. Focal swelling of the left anterior knee was increasing during the sideline examination. Skin turgor was normal. Distal pulses were strong and the patient was neurovascular intact. He denied numbness and tingling of the lower leg and foot during examination. The distal tibia, foot and ankle complex, hip, and thigh were non-tender and had full active range of motion. The medial proximal tibia and medial tibial plateau were painful to palpation (10 / 10). Ligament testing was not performed due to the patient's pain level and probability of fracture. The patient was placed in a knee immobilizer, fitted for crutches, and referred to his preferred provider. **Differential Diagnosis:** Meniscus injury, patella tendon tear, contusion, anterior cruciate ligament injury, medial collateral ligament injury, compartment syndrome, tibia fracture, dislocation. **Intervention & Treatment:** Radiographs confirmed the patient sustained a Salter Harris IV displaced fracture of the left tibia tuberosity, which is a pediatric fracture that extends through the metaphysis, physis, and epiphysis. The patient underwent open reduction and internal fixation surgery of the tibia tuberosity. The patellar tendon was also repaired during surgery. Following surgery, the patient was placed in a wheelchair due to his partial weightbearing limitations for 2 weeks. He was allowed to be toe touch weightbearing for no greater than 25 feet during that time. The patient was prescribed physical therapy and was placed in a knee immobilizer to limit motion. The patient's brace was locked in 0-45 degrees of knee flexion for the first 2 weeks, the third week unlocked to 60 degrees of flexion, and then allowed to increase flexion by 10 degrees per week until he achieved 90 degrees of flexion. Following 2 months of physical therapy, the patient was allowed to begin a return to sport progression with his athletic trainer. Radiographs were taken 6 months after surgery and the tibial growth plate was closing, which is common with this significant injury. Due to this patient's potential for continued growth based on his bone age, it is expected he will experience a total leg length discrepancy of 15 to 18mm. **Uniqueness:** Tibial tubercle fractures constitute less than 1% of all physeal fractures and less than 3% of proximal tibial fractures, making this case very rare. Further, 10-12% of all physeal fractures will be classified as Salter Harris type IV fractures. This patient underwent open reduction and external fixation surgery, which the research reports as the intervention of choice for displaced tibial tubercle fractures. **Conclusions:** : Athletic trainers should be aware of the risk of growth plate fractures in adolescent athletes, particularly those with symptomatic Osgood Schlatter disease. Salter Harris IV fractures are a potentially debilitating injury and prevention strategies should be employed to mitigate the risk to pediatric athletes.

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Taking Care of Knee'ds: A Level 3 Case Study on Whole Patient Care

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Background: Meniscal tears are commonly reported injuries in football and can be the end to an athlete's season. The most common treatment in symptomatic, acute meniscal tears is surgery for a repair, if possible, or a meniscectomy. The menisci play a huge role in the knees' ability to absorb shock, joint stability, joint motion, and joint proprioception. Early treatment after injury is recommended to increase feasibility of repair and prevent additional damage. However, not all patients have the same resources to obtain timely and appropriate surgical care. Access to care can be particularly challenging to those who are underinsured and/or reside in medically underserved areas. **Patient:** An uninsured high school football player residing in a federally classified medically underserved area presented with signs and symptoms consistent with a meniscus tear at a practice during spring of his junior year. The student-athlete was referred for physician evaluation and subsequent MRI which revealed a complex tear in his lateral meniscus with a displaced flap. Surgical treatment was recommended. **Intervention & Treatment:** Surgery was scheduled through a local hospital but as the surgery date got closer, it was postponed due to the patient's insurance and financial status. The cost of the procedure for the uninsured student-athlete was estimated as $30,000 with pre-payment required. The combination of the student-athlete's financial and uninsured status resulted in the surgery being postponed indefinitely. To optimize care, the athletic trainer explored alternative sources of care and medical coverage. The athletic trainer contacted the school's secondary insurance policy for athletics in attempts to help the athlete with the cost of the procedure. The secondary insurance would only be able to cover a very small percentage which was not enough for the student-athlete to afford the procedure. The athletic trainer then began to look into Shriners Hospitals for Children in hopes to find the student-athlete access to the care he needed at a cost he could afford. Following contact with a Shriners Hospital three hours away from the student-athletes' place of residence, the athletic trainer was able to facilitate an evaluation of need followed by a surgical consultation. The patient was approved for surgery at no cost to him or his family 5 months after his initial injury. **Outcomes or Other Comparisons:** The surgery was successfully performed 6 months following the initial injury; however, a meniscectomy was required due to the amount of damage to the structure which may have been exacerbated due to delayed care. Access to a full-time athletic trainer at his high school is allowing the athlete to complete rehabilitation and avoid the cost of out-patient physical therapy. The athlete is expected to make a full return by the spring season allowing him to compete in his final season of track and field with improved knee function and reduced pain. **Conclusions:** The acute meniscus tear was damaged beyond repair causing the surgery to consist of meniscectomy. The surgery was completely covered by Shriners Hospital and saved the athlete not only the cost of the procedure but also addressed the pain the student-athlete was experiencing in his daily life activities. The athletic trainer was determined to help this athlete and was able to care for his patient by practicing whole patient care. **Clinical Bottom Line:** This common case was made difficult by the patient's socioeconomic status which resulted in him facing an indefinite and painful future in addition to delayed treatment. However, the athletic trainers' ability and willingness to advocate for his patient and identify resources resulted in successful whole patient care. Health disparities significantly impacted this patient's course of care; however, the presence of an athletic trainer in a rural secondary school improved the patient's health equity.

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Efficacy of Instrument-Assisted Soft Tissue Mobilization for the Treatment of Ankle Pathology: A Systematic Review With Meta-Analysis

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Context: Instrument-assisted soft tissue mobilization (IASTM) has gained popularity as an adjunct to treatment for a variety of musculoskeletal pathologies. IASTM is a myofascial intervention which uses specially designed instruments to apply forces to soft tissues, eliciting a therapeutic effect. Literature regarding the efficacy of IASTM to improve dorsiflexion range of motion (DFROM), pain, balance, and patient-reported outcomes measures (PROMs) is mixed. Therefore, the purpose of this study was to systematically review the literature regarding the efficacy of IASTM in individuals with ankle pathology for improving clinical or patient-reported outcomes. **Methods:** A systematic literature review was performed in August 2021 using PubMed and Nursing and Allied Health databases. Key words included ankle, calf or lower leg and IASTM, Graston, ASTYM, soft tissue mobilization, soft tissue mobilisation, or myofascial release. Studies were included if they were original research involving an IASTM intervention to treat ankle pathology, reported clinical or patient-oriented outcomes comparing pre- to post-intervention or between groups, and were in English. Data were extracted for study methods and outcomes including DFROM, pain, balance, and PROMs. Statistical analysis was completed using Cochrane's Review Manager software. Variables reported by <3 studies were reported descriptively without meta-analysis. For variables reported by at least 3 studies, we performed 2 meta-analyses each: pre-IASTM compared to post-IASTM intervention, and IASTM compared to another intervention. We calculated the standardized difference of the means (SMD) using the pooled standard deviation for each study. A random effects model was used if heterogeneity was found in the data (I2>0.3), elsewise a fixed effect model was utilized. The Z-statistic and associated p-value for between-group effects were derived and reported from the fixed- or random-effects models. Alpha was set a priori at 0.05. **Results:** Database search resulted in 349 results, of which 4 studies met all inclusion criteria (Table 1). Meta-analysis demonstrated IASTM resulted in significant improvements from pre- to post-intervention for DFROM (SMD=1.72, 95% CI=1.14-2.30, P<0.001), PROMs (SMD=1.91, 95% CI=1.47-2.35, P<0.001) and pain (SMD=1.89, 95% CI=1.30-2.47, P<0.001). IASTM was more effective than an alternate intervention (e.g. stretching, balance training, exercise) at improving DFROM (SMD=0.80, 95% CI=0.43, P<0.001), and PROMs (SMD=0.44, 95% CI=0.02-0.86, P<0.001) but not pain (SMD=-0.01, 95% CI=-0.65-0.67, P=0.98). Balance was only reported in 2 studies, both of which found improvement from pre- to post-intervention but no benefit to IASTM compared to an alternate intervention. **Conclusions:** IASTM is an effective intervention for increasing ankle DFROM and PROMs in individuals with ankle pathology. There is limited evidence that IASTM at the ankle improves pain, and insufficient evidence to support the use of IASTM to improve balance. Clinicians seeking to increase ankle DFROM should consider IASTM as a treatment modality, either in isolation or combined with other treatments.

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Synchronized Core Muscle Thickness and Activation Changes During the Prone Bridge Plank: Agreement Between M-Mode Ultrasound and Electromyography

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Context: The prone bridge plank (plank) exercise is commonly prescribed because of the patterns of muscle activation it elicits that in turn enhance core and low back stabilization. The rectus abdominis plays an important role in providing stabilization throughout a plank and its activation is commonly assessed with surface electromyography (sEMG). sEMG and ultrasound have been used in conjuncture with one another, but evidence is lacking regarding the use of both instruments during core exercises performed to failure. As the plank is often assessed in the literature with specific time durations, such as 30- or 60-second holds, the purpose of this study was to measure the agreement between rectus abdominis muscle thickness and sEMG muscle activity during the first and last 5-seconds of the plank performed to failure on a treatment table. **Methods:** Forty-four participants (22 male, 22 female, age=23.3±4.8years, height=170.3±7.7cm, weight=68.9±10.9kg, IPAQ=5697.2±3647.5mets) with no previous year history of low back, hip, or core injury completed the plank to failure on a treatment table. An ultrasound transducer in a foam block secured with an elastic belt, and sEMG electrode were placed on the right rectus abdominis lateral to the umbilicus prior to exercise initiation. The participant was instructed to hold the plank on the treatment table for as long as possible while M-mode ultrasound and sEMG data were captured. Muscle thickness change was measured in centimeters and sEMG was filtered and all data was normalized. Data was analyzed throughout the first and last 5-seconds as a percentage to the participant's concentric RA contraction thickness (%-thickness change) and to their maximum voluntary isometric contraction (%-MVIC). A Bland-Altman plot was created with the mean difference between the two measures and 95% limits of agreement (LOA). **Results:** Bland-Altman analysis of the first 5-seconds revealed half of the sample above the mean difference and half the sample below (48.76±34.07, LOA: -66.77, 66.77). There were 14 outliers above the upper LOA for the first 5-seconds. The plot analysis overestimated %-MVIC and %-thickness change for the last 5-seconds of the exercise (7.36±58.67, LOA: -115.01, -115.01), resulting in 4 outliers below the lower LOA and clustering around the mean (Figure). **Conclusions:** The first 5-seconds of the plank showed greater heterogeneity compared to the last 5-seconds although there was a higher number of outliers observed. The outliers may be explained by increased RA %-MVIC variance as the participant adjusted their body to achieve proper form upon initiation of the plank. Measurements of muscle thickness and muscle activity during endurance-based exercises may be influenced by the timing of measurement. Holding the plank until failure was important to allow the assessment of these measurement methods during the last 5-seconds prior to discontinuation of the exercise.

None of the authors have any financial disclosures.

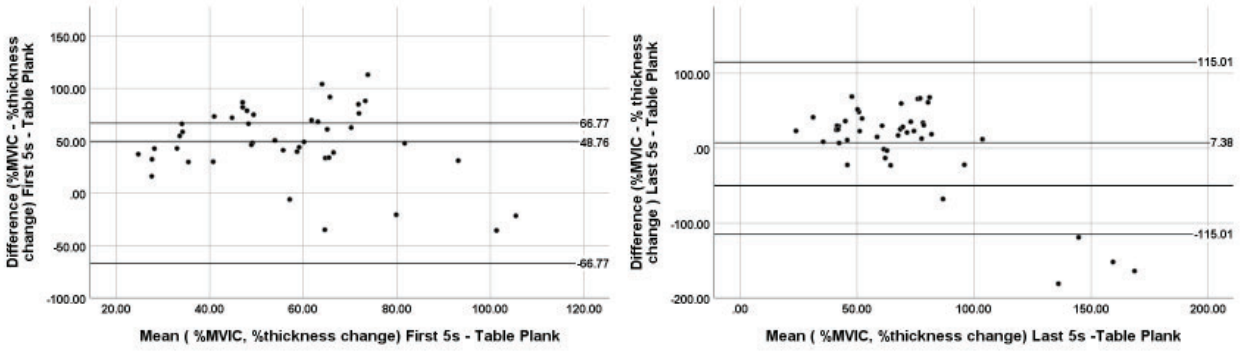

Figure. Bland-Altman plots of agreement for %-MVIC and %-thickness change of rectus abdominis in first 5-seconds and last 5-seconds of prone bridge plank.

Experiences and Outcomes of Complementary and Integrative Health Use by Athletic Trainers in the United States

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Context: Complementary and integrative health (CIH) is common among patients in the U.S. and is a useful tool for athletic trainers to provide holistic treatment. Among U.S. adults, the most common CIH modalities used are yoga, meditation, and chiropractic care. However, there is currently no literature regarding athletic trainers' experiences and outcomes of using CIH modalities as treatment methods for the patients they serve. This study aims to explore the experiences of collegiate athletic trainers using CIH modalities. **Methods:** We used a phenomenological approach to explore the lived experiences of 14 collegiate athletic trainers (7 females, 7 males, age=38±12 years, years of experience=15±12 years). A consensual qualitative research (CQR) design was used for this study. Criterion sampling was used where participants who identified as working in the collegiate setting from the National Athletic Trainers Association and currently using CIH modalities were recruited. Recruitment and data collection were continued until saturation occurred through repeated core ideas. Participants engaged in an online, semi-structured interview (Zoom, San Jose, CA). All interviews were audio-recorded and transcribed. A data analysis team of 3 individuals used a multi-phase process to create a consensual codebook that identified domains and core ideas among the participants' responses. Trustworthiness and credibility of the consensus codebook were established by member checking, multi-analyst triangulation, and auditing. **Results:** Four domains, as can be shown in the figure, emerged regarding the experiences and outcomes of CIH use by athletic trainers: 1) education, 2) motives, 3) clinical application, and 4) barriers. Participants described a wide range of education of CIH including: formal/organized education, informal education/learning on the job from preceptors or mentors, self-directed learning, familial exposure where participants grew up using CIH, and social media exposure where they were introduced to CIH through athletics in the media. The motives and clinical reasoning behind using CIH were to treat the whole patient in both mind and body and to use CIH as an additional modality for treatment rather than a standalone option. Participants mentioned stakeholder acceptance and previous positive experience with CIH as important motivators in implementing the approaches into their care and gave athletic trainers confidence in establishing CIH as an integral part of patient care. The most common types/modalities of CIH applied by the participants were cupping, IASTM, essential oils, breathwork, and yoga. All participants indicated their clinical application was guided by patient preference and improved subjective outcomes, but there was limited use of measures to quantify clinician and patient outcomes relative to the intervention. In those that did use outcome measures, they were limited to pain scales and goniometry. Barriers to implementing CIH techniques were due to lack of formal research or research in English, resources (physical, human, or otherwise), and lack of stakeholder buy-in, including the patient. **Conclusions:** CIH provides athletic trainers with additional modalities to provide holistic and patient-centered care. However, the introduction and education on CIH varies widely across athletic trainers. Because of its usefulness in clinical practice, specifically to address the mental and physical aspects of a patient's primary concern, and reported patient preference, CIH should be incorporated into professional preparation of athletic trainers as well as a part of continuing professional development opportunities. Education surrounding interventions in athletic training, regardless of the level of learning, should focus on quantifiable and meaningful clinical and patient-rated outcomes, which should include CIH approaches. Moreover, additional objective research regarding the outcomes of using CIH as a treatment modality are needed among athletic populations to increase stakeholder buy-in.

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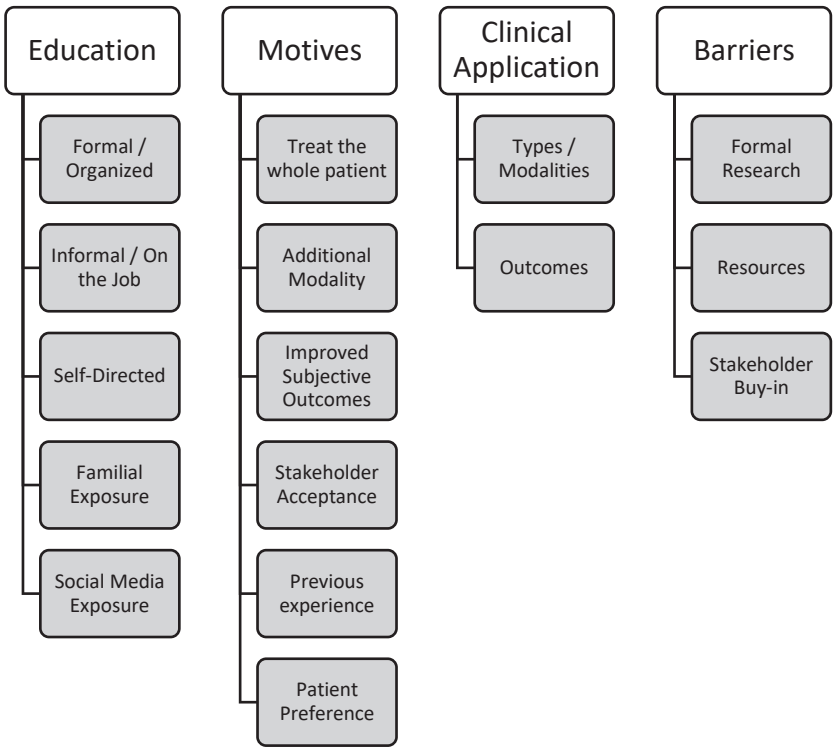

Cupping Therapy: Clinical Usage, Application Procedures, and Perceived Effectiveness by Healthcare Professionals

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Context: Despite its growing popularity since the mid-1900s, the application procedures and factors influencing the usage of cupping therapy (CT) among healthcare professionals (HCPs) in the United States (US) remains unclear. Therefore, the purpose of this study was to investigate the clinical usage, application procedures, and perceived effectiveness of CT among HCPs in the US. **Methods:** One hundred and fifty-eight HCPs (age:29.36±7.42years) with experience utilizing CT in their professional practice participated in this cross-sectional study (completion rate=86.15%;n=158/195). A custom web-based survey designed to assess respondents' clinical incorporation of CT, was disseminated through snowball sampling using an anonymous link on various social media platforms. A content expert reviewed the survey for face validity. It was then piloted on a focus group of 14 athletic trainers with experience and knowledge of CT. The number of survey questions ranged from 1-133, 49 of which included display logic. Questions were categorized into five sections: demographics, clinical usage of CT, CT application procedures, perceived effectiveness of CT, and condition-specific examples. Survey responses were exported, and responses with <80% completion were removed from analyses. Descriptive statistics including means, standard deviations, and frequencies were calculated per survey item. Independent samples t-tests were conducted to compare cup application time between static and moving styles of CT. Chi-squared tests and Fisher's exact tests were used to compare differences in the distribution of categorical variables including air extraction, cup type, and suction mechanism between static and moving cupping. Alpha was set a priori to 0.05. **Results:** Participants reported 6.63±6.46 years of experience working as a HCP and 3.56±2.42 years of experience implementing CT. Ninety-one percent of respondents worked as an athletic trainer (n=144) in either a secondary school (30%;n=47) or collegiate setting (48%;n=77). Dry cupping was the most commonly reported type of CT (99%;n=156), and 75% (n=118) of respondents reported using both static and moving cupping techniques. Respondents indicated significantly shorter cup application times for moving cupping compared to static cupping in terms of both the shortest reported cup application time (Mean-Difference=-0.73min,p=0.004) and the longest reported cup application time (Mean-Difference=-2.01min,p<0.001). Respondents reported extracting less air from the cup when performing moving compared to static cupping, $\chi^2(4,276)=31.49$,p<0.001. On a scale from 1 (not effective at all) to 5 (extremely effective), participants viewed cupping as most effective for treating muscle tightness (4.22±0.77), myofascial trigger points (4.15±0.77), and musculoskeletal pain (3.94±0.74;Figure). The most commonly reported benefits of CT were increased blood flow (90%), improved range of motion (85%), and reduced adhesions in connective tissues (79%). **Conclusions:** While the usage and application of CT varied based on the type and style of CT as well as the patient's condition and tolerance, our findings supported that HCPs found CT to be an effective method for treating various musculoskeletal conditions.

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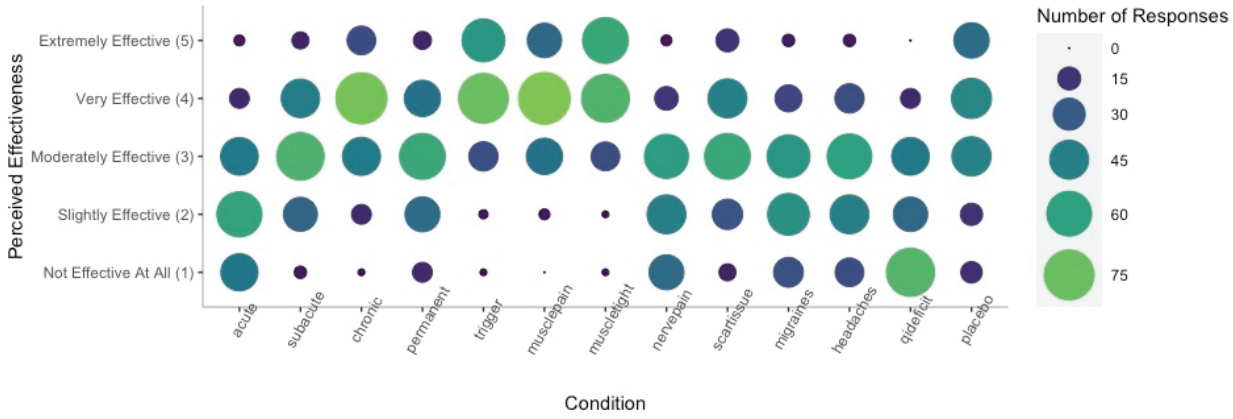
Figure. Clinician perceived effectiveness of cupping therapy by condition



Caption: Using a 1 (not effective at all) to 5 (extremely effective) scale, healthcare professionals reported cupping therapy as most effective for treating muscle tightness (4.22±0.77), myofascial trigger points (4.15±0.77), and musculoskeletal pain (3.94±0.74). Conversely, cupping therapy was reported as least effective for treating qi deficiency (1.96±1.00), acute injuries and conditions (2.20±0.97), and nerve pain (2.40±1.01).

Abbreviations: *acute*, acute injuries/conditions; *subacute*, sub-acute injuries/conditions; *chronic*, chronic injuries/conditions; *permanent*, permanent injuries/conditions; *trigger*, myofascial trigger points; *musclepain*, musculoskeletal pain; *muscletight*, muscle tightness; *nervepain*, nerve pain; *scartissue*, scar tissue; *qideficit*, qi deficiency

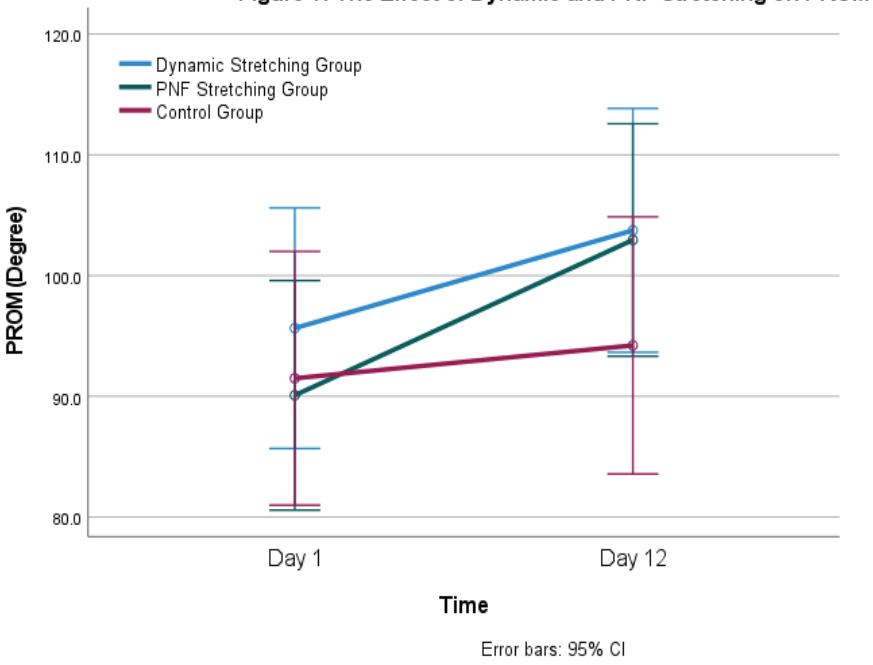
The Effect of Proprioceptive Neuromuscular Facilitation and Dynamic Stretching on Range of Motion, Vertical Jump Performance, and Dynamic Balance

Ozawa Y, Fujii N, Herzog VW, Hanaki S: Weber State University, Ogden, UT

Context: Dynamic stretching and Proprioceptive Neuromuscular Facilitation (PNF) stretching are often used by athletic trainers to increase flexibility, joint range of motion (ROM), muscle temperature, and prevent injury as part of a warm-up. The purpose of this study was to investigate the effect of PNF stretching and dynamic stretching on ROM, vertical jump performance, and dynamic balance. **Methods:** This study was a randomized 3-group pretest-posttest. Thirty active, healthy subjects (14 male and 16 female, age=23.50±2.46 years old, mass=79.65±19.78 kg, height=169.83±8.96 cm, and leg length=88.13±5.64 cm) were randomly assigned to the PNF stretching group (5 male, 6 female), the dynamic stretching group (5 male, 5 female), or the control group (4 male, 5 female). Our independent variables were the type of stretching protocol (PNF stretching, dynamic stretching, and control) and time (pre, post). The dependent variables were active knee extension range of motion (AROM), passive hip flexion range of motion (PROM), vertical jump height, ground reaction force during the vertical jump take-off, and dynamic balance using the Star Excursion Balance Test (SEBT) in lateral, anterior, and posterior directions. We measured all dependent variables on the first day of visit (Day1) and 12 days after (Day12). We stretched participants in the stretching groups on the first day after the baseline measurements (Day1), Day2-5, Day8-11, and the last day before the final measurements (Day12). Data were analyzed using a two-way mixed ANOVA (α=.05). **Results:** There was a statistically significant interaction between the intervention and time on PROM, $F(2,27)=4.98$, $p<.05$, partial $\eta 2=.27$. Both stretching groups increased PROM over time ($F(1,27)=36.30$, $p<.05$, partial $\eta 2=.57$) (Figure 1). Subjects increased their PROM in the dynamic stretching group by 8.10+16.20° (P=.001) and in the PNF stretching group by 12.86+13.66° (P<.001), but there was no difference between the two groups (P=0.89). There were no statistically significant differences between the groups over time for AROM (P=.59), vertical jump height (P=.08), ground reaction force (P=.16), SEBT Lateral (P=.70), SEBT Anterior (P=.08), or SEBT Posterior (P=.13). **Conclusions:** Ten stretching sessions over two weeks of PNF and dynamic stretching increased PROM, but there was no difference between the two stretching protocols. Neither protocol affected AROM, vertical jump height, ground reaction force, or dynamic balance. PNF and dynamic stretching can be used to increase PROM without negative effects on vertical jump height, ground reaction force, or dynamic balance. Future research should measure the effect of various stretching protocols for longer durations on muscle activation, strength, and performance.

None of the authors have any financial disclosures.

Figure 1: The Effect of Dynamic and PNF Stretching on PROM



Photobiomodulation Therapy for Thigh Contusion and Soft Tissue Injury: A Randomized Controlled Trial

Wells AM, Rigby J, Castel C, Castel D: Brigham Young University, Provo, UT

Context: Contusions and soft tissue injury are common muscle injuries in sport, make up approximately 12.1% of all lower extremity injuries. Contusions are documented to comprise 14.2% of all thigh injuries in high school sports. Thigh contusions can take multiple weeks to resolve and limit sport participation during recovery from muscle and capillary tissue damage. The common course of acute treatment for thigh contusions are cryotherapy and non-steroid anti-inflammatory drugs. Additional bleeding, edema, and ischemia are a potential barrier for healing leading to increased scar formation and a prolonged healing process. Immediate care using cryotherapy may lower the tissue metabolic rate protecting from further secondary injury but may negatively impact circulation and clearance through the lymphatic and vascular system. NSAID's may aid pain management, but there are mixed theories about their effects on the healing process following muscle injury. Recently a new therapeutic modality, photobiomodulation has had positive outcomes in healing tissue and improving function. Photobiomodulation in the near infrared and red wavelength spectrum has been effective at reducing markers of muscle damage and improving function after eccentric muscle damage. The purpose of this study was to determine the effects of a photobiomodulation light patch on accelerated muscle recovery following a human thigh contusion using an experimental injury model. **Methods:** Using a single-blinded randomized control trial design, we enrolled 66 healthy participants (M=23, F=23). Participants complete five visits to the research lab on consecutive days. On the first visit, participants completed a baseline isokinetic quadriceps strength testing protocol at 60 and 180°/s. On the second visit, participants were struck in the anterior thigh with a tennis ball from a serving machine placed 12 inches away at a speed of approximately 70 mph. Immediately following the injury, participants were treated for 30 minutes with an active or placebo photobiomodulation patch (Carewear light patch system, Carewear Corp, Reno, NV). Following the treatment, participants completed the same isokinetic quadriceps strength testing protocol. Participants returned to the lab each day were the treatment and isokinetic quadriceps strength test was completed. We normalized the data by calculating the percent change from baseline. We used a mixed model ANCOVA to determine the difference between treatment groups throughout the acute healing process. **Results:** We found the active photobiomodulation treatment significantly aided in the functional recovery of quadriceps peak torque during the 180°/s test ($P=0.030$) and average power during both the 60 ($P=0.041$) and 180°/s ($P\leq0.001$) assessments. At Day 4, the mean peak torque and average power of 180°/s exceeded the baseline levels by 8.9 and 16.8%, respectively. **Conclusions:** The red and blue photobiomodulation light patch aided in quicker recovery during the acute phase of a human thigh contusion injury model, allowing for faster increases in functional quadriceps strength and power.

None of the authors have any financial disclosures.

****Post-Professional Advanced Clinical Track Student Award Winner****

Transverse Abdominis Activity in Healthy Active Adults During Therapeutic Exercises

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Context: Low back pain (LBP) is a leading cause of activity limitation in athletics.1 LBP therapies often focus on spinal stabilization exercises targeting the transverse abdominis (TrA). Common exercises include the abdominal draw-in maneuver (ADIM), side bridging variations, and quadruped however, there is little evidence in rotation-based exercises and TrA activation. When training the TrA, clinicians often instruct the patient to consciously activate the TrA prior to performing the task. Understanding TrA activation in a rotation-based exercise that does not include cueing TrA activation may provide insight into developing functional exercise progressions. The purpose of this study was to compare TrA activity during a rotation-based task without cueing to TrA activity in other exercises that utilize cueing. **Methods:** This descriptive laboratory study included 19 healthy participants (15 female; age: 22.9±1.6 years, BMI: 24.6+3.4kg·m-2). We used musculoskeletal ultrasound (MSK-US) to measure TrA activity in 4 tasks: ADIM, quadruped ADIM (Q-ADIM), bird-dog, and standing resisted rotation. We secured the MSK-US transducer on the abdomen half the distance between the umbilicus and lateral midline of the trunk. We used B-mode to take a resting TrA thickness image related to each task. For ADIM and Q-ADIM, we instructed participants to exhale and bring their belly button to their spine in hook-lying and quadruped positions respectively. For bird-dog, participants performed a Q-ADIM followed by contralateral shoulder flexion and hip extension. For the rotation, participants performed ipsilateral trunk rotation on a cable machine with a 2.3kg weight. We measured TrA thickness during each task. We calculated the TrA activation ratio (ARTrA) using the formula: TrA active thickness / TrA resting thickness.2 ARTrA > 1.0 indicates an active TrA. Repeated measures ANOVA evaluated differences in resting measures and ARTrA for each task, $p < .05$. Pairwise comparisons with Bonferonni adjustment identified differences between tasks. We calculated the percentage of individuals achieving ARTrA > 1.0 for each task and the Cochran's Q test evaluated for differences. **Results:** Resting TrA thickness differed depending on resting position, with resting ADIM being less than resting quadruped and resting standing (Table 1). We found ARTrA to be different between tasks (p=.002), with pairwise comparisons presented in Table 1. Many participants achieved an ARTrA > 1.0 in each task, with no significant differences (ADIM=94.7%, Q-ADIM=84.2%, bird-dog=94.7%, rotation= 89.5%, p=0.532). **Conclusions:** This is the first known study to explore the TrA's activity during a rotation-based task using MSK-US. Although the bird-dog task produced the greatest ARTrA of the two dynamic tasks, 90% of participants were able to achieve an ARTrA > 1.0 in the standing resisted rotation task without cueing TrA activation. These findings indicate there may be functional options to exercise the TrA without requiring cueing. Further research can be done specifically in the LBP population.

None of the authors have any financial disclosures.

The Usage of Active Video Games as a Therapeutic Rehabilitation Tool, Part 2: Athletic Trainers' Perspective

Deans SM, Martin M, Cappaert T: Rocky Mountain University, Provo, UT, and Sierra College, Rocklin, CA

Context: The perceptions of active video games (AVGs) such as the Nintendo Wii, Xbox Kinect, and PlayStation Move usage as a mode of therapy in physical and occupational therapy has been well documented.1 However, exploration of the same AVG usage within the athletic training profession is limited. The objective of the study was to investigate perceptions regarding the usage of AVGs as a therapeutic intervention tool among athletic trainers (ATs). **Methods:** The study followed a phenomenological approach to better understand phenomena of active video games (AVG) application for therapeutic rehabilitation among ATs. After completing Part 1 of the study via an online survey, participants were invited to participate in a voluntary follow-up semi-structured interview. A field-tested peer reviewed interview guide was used for data collection. Purposeful sampling was used to recruit participants. Interviews were conducted via Zoom and were recorded and transcribed by the principal investigator. After transcription, the data was assigned labels (i.e., coded) to capture meanings to information which addressed the research questions. Data was organized into categories that share common concepts and synthesized into themes. Following the interpretation of the data, trustworthiness and credibility of the data were established through methodological triangulation (member checking and peer debriefing) to decrease any threats of validity (external and internal), and further reduce researcher bias. **Results:** Sixteen ATs volunteered to participate in a semi-structured interview (men = 6, women = 8). The participants were employed in the following settings: secondary/high school (n = 5), intercollegiate athletics (n = 6), professional (n = 1), outpatient orthopedic-rehabilitation clinic (n = 2). Four main themes were identified: 1) AVGs can be used as an accessory tool which compliments the tech-savvy generation of athletes, 2) AVG usage is on the onus of the clinician, 3) the concept of AVGs must overcome professional barriers that define the AT profession, and 4) AVG usage is a professional adaptation to the social construct of society technology. The findings from the study indicate emergent themes share common factors (i.e., subthemes) that influence one another; thus, the themes are interchangeable, Figure 1. For example, setting dependency is a first-order subtheme for the theme of professional barriers. Subsequently, it can also explain the external factor that influences the onus of a clinician. This unique concept indicates that implementing a new technique into the AT profession is a multi-faceted approach. **Conclusions:** ATs are open to AVG usage in the clinical setting and see it as an alternative mode of therapy. However, the lack of research on feasibility and setting practicality limits implementation. Future research should focus on developing integration strategies conducive to the dynamic environment of the profession.

None of the authors have any financial disclosures.

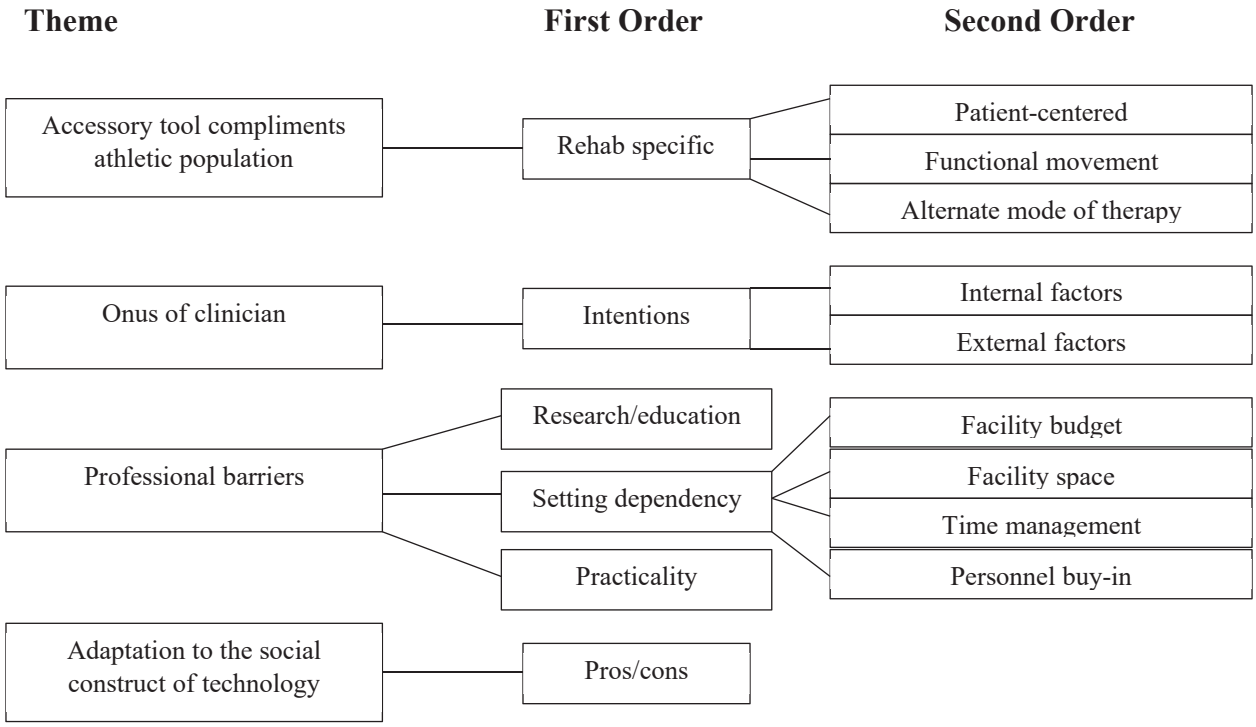


Figure 1. Emergent Themes.

****Early-Career Award Winner****

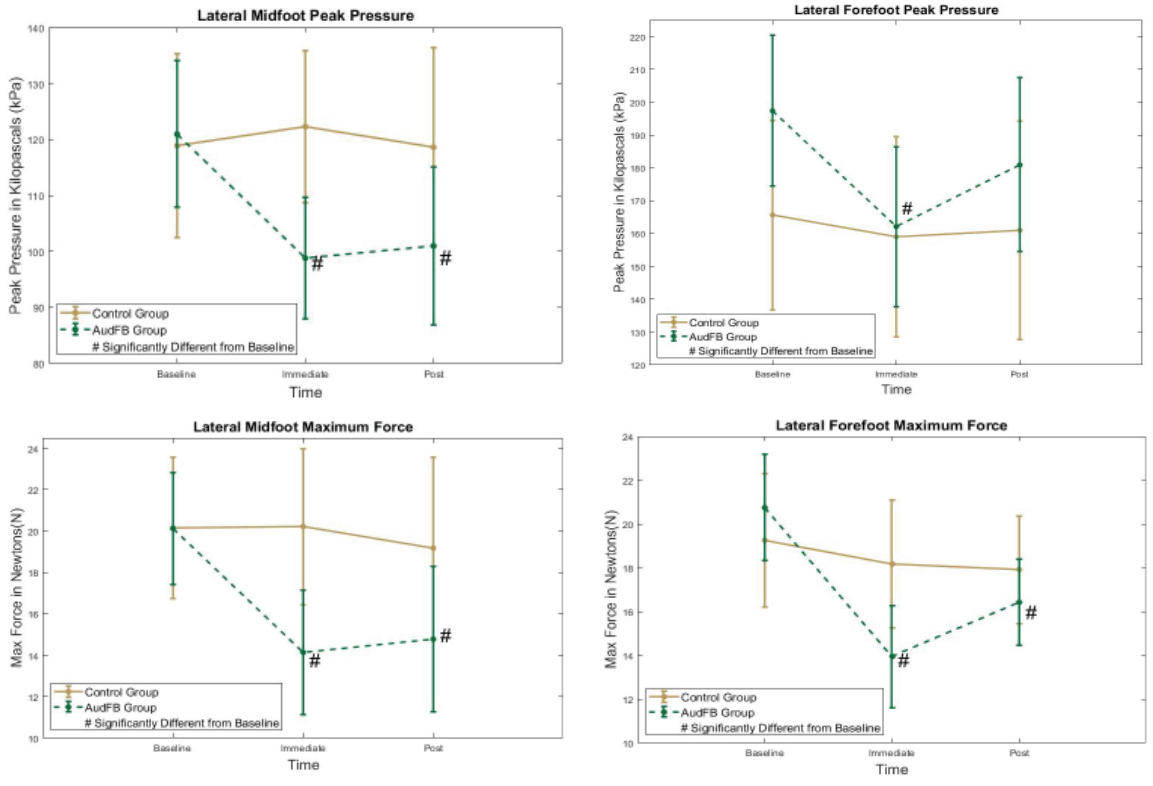
Immediate and Retention Effects of Auditory Biofeedback Gait Training on Biomechanics and Talar Cartilage Characteristics in Chronic Ankle Instability

Torp DM, Thomas AC, Hubbard-Turner T, Donovan L: University of Kentucky, Lexington, KY, and University of North Carolina at Charlotte, Charlotte, NC

Context: Individuals with CAI often demonstrate increased pressure and forces over the lateral foot, which may promote osteoarthritis through altered cartilage deformation. Unfortunately, interventions capable of changing these destructive gait patterns are lacking. The use of external biofeedback during walking improves real-time biomechanics; however, the retention of these changes is unknown. Ultrasonography is a pioneering technology capable of assessing cartilage deformation and may give insight into the effectiveness of gait training in CAI. The purpose of this randomized-controlled trial was to assess the immediate and 1-week retention effects after 2-weeks gait training with auditory biofeedback (AudFB) compared to a control (NoFB) on plantar pressure and talar cartilage deformation patterns in CAI. **Methods:** Eighteen of 26 CAI participants completed all testing sessions. AudFB (n=11, 23.82±3.31 years; 26.49±5.08 kg/m2) and NoFB (n=7, 22.25±3.33 years; 27.89±4.35 kg/m2) were fitted with athletic shoes and plantar pressure insoles at Baseline, Immediate and 1-Week post-intervention to assess walking biomechanics. Ultrasound was captured at rest and after 30-minutes of walking at each testing session. AudFB was administered via a thin pressure sensor that was placed on the insole underneath the fifth metatarsal head of the involved limb. The sensor was connected to a potentiometer and set to elicit noise when the sensor experienced excessive pressure. AudFB participants were instructed to walk without causing noise during the entire 30-minute gait intervention. NoFB participants were never introduced to the AudFB and instructed to walk comfortably. Insoles recorded peak pressure and max force during treadmill walking. Regions of interest included the lateral midfoot and forefoot. Ultrasound deformation was assessed as a percent change in normalized thickness in the total, medial, and lateral regions measured via ImageJ. Within and between group differences were analyzed with repeated-measures analysis of variance with pairwise comparisons. Differences were considered significant if $p<0.05$ with associated moderate-to-large effect sizes that did not cross 0. **Results:** AudFB reduced peak pressure in the lateral midfoot (Mean Difference [MD]: 22.21kPa, $p<0.001$) and forefoot (MD: 35.58kPa, $p=0.002$) at Immediate. Reduced peak pressure was retained at 1-Week in the lateral midfoot (MD: 19.97kPa, $p<0.001$). Max force in the lateral midfoot (MD: 6.0N, $p<0.001$) and forefoot (MD: 6.8N, $p<0.001$) declined at Immediate and was retained at 1-Week in both regions (MD: 5.4N, $p<0.001$; 4.3, $p=0.001$, respectively) in AudFB. No gait changes were observed in the NoFB group (Figure 1). No significant changes in talar cartilage characteristics were observed in either group at any time point. **Conclusions:** Two-week gait training with auditory biofeedback improved gait immediately and up to 1 week following intervention in CAI patients. These findings were not coupled with changes in cartilage deformation patterns. Clinicians should employ auditory biofeedback during gait training after ankle sprains and monitor long-term joint health.

None of the authors have any financial disclosures.

Figure 1. Means and 95% Confidence Intervals of the Lateral Column Within Groups and Across Time



Two-Week Plantar Massage but Not Ankle Joint Mobilization Intervention Reduces Visual Reliance in Those With Chronic Ankle Instability

Wikstrom EA, Cain MS, Song K, Migel K, Jang J, Lin FC, Pietrosimone BG, Blackburn JT, Franz JR: University of North Carolina at Chapel Hill, Chapel Hill, NC; University of Texas Permian Basin, Odessa, TX; University of Kentucky, Lexington, KY; North Carolina State University, Raleigh, NC

Context: Lateral ankle sprains are highly prevalent musculoskeletal injuries that often result in chronic ankle instability (CAI). Compared to those without CAI, those with CAI rely more on visual information to maintain both static and dynamic balance. Manual therapies like plantar massage and ankle joint mobilization improve various CAI-associated impairments including balance. The underlying mechanism for balance improvements remains unclear but reducing an individual's reliance on visual information has been hypothesized. Traditional balance training does not reduce visual reliance in those with CAI. The purpose of this investigation was to evaluate the effects of separate 2-week plantar massage and ankle joint mobilization interventions on visual reliance during single-limb stance in those with CAI. **Methods:** Sixty participants (age: 21±3 years, number of ankle sprains: 5±3, Giving way episodes within 6 months: 9±11, Ankle Instability Instrument: 7.3±1.3) were equally randomized into plantar massage, ankle joint mobilization, and control (no intervention) groups. All participants had CAI as defined by the International Ankle Consortium. The manual therapy groups received 6, 5-minute treatments of their respective interventions over a 2-week period. The control group continued normal daily activities. Three 10-second trials of single leg stance with eyes open and eyes closed were captured before (Baseline) and within 72 hours of completing the assigned intervention (Post). Time-to-boundary (TTB) minima means and center of pressure velocity (COPV) in the mediolateral (ML) and anteroposterior (AP) directions were calculated and used to generate '% modulation' scores for each outcome which quantifies the loss of postural control when vision is removed using the following formula: [(eyes closed - eye open) / eyes open] * 100. Larger positive COPV and larger negative TTB scores represent greater postural declines and thus greater reliance on visual information during the eyes open condition. Group × Time mixed model ANOVAs with an alpha level of 0.05 were used to determine the effect of each manual therapy intervention relative to the control group. **Results:** Four participants were lost to follow-up. The % modulation means and standard deviations for all three groups are listed in the Table. Plantar massage resulted in significant visual reliance reductions ($p \leq 0.046$) in sagittal (i.e., TTB-AP and COPV-AP) but not frontal plane outcomes ($p \geq 0.069$) relative to the control group. Joint mobilization did not alter visual reliance in any outcome relative to the control group ($p \geq 0.413$). **Conclusions:** A 2-week plantar massage but not an ankle joint mobilization intervention reduces visual reliance during single limb stance in those with CAI. The results suggest that plantar massage, if integrated with balance training interventions, could help improve postural control and alter the sensory organization strategies of those with CAI.

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Fellow sponsored by Erik A. Wikstrom, PhD, ATC, LAT.

Table: The % Modulation means and standard deviations for each group from before and after the 2-week intervention.

	Control (n=18)		Plantar Massage (n=19)		Ankle Joint Mobilization (n=19)	
	Baseline	Post-Test	Baseline	Post-Test	Baseline	Post-Test
TTB-AP (%)	-52.5±9.7	-53.0±7.3	-57.5±8.2	-48.8±8.7*	-54.6±8.8	-54.4±11.0
TTB- ML (%)	-50.8±13.4	-56.0±7.1	-55.4±10.8	-55.4±10.8	-54.9±9.0	-56.6±10.4
COPV-AP (%)	117.4±31.7	120.9±33.7	126.5±37.9	100.9±38.5*	115.8±47.3	122.5±39.1
COPV-ML (%)	119.9±47.4	117.0±36.2	121.5±44.5	121.2±42.8	118.3±42.5	128.2±40.1

* Indicates a statistically significant pre-to-post improvement in the manually therapy group relative to the control group ($p \leq 0.046$).

Sensory Reweighting System Differences on Vestibular Feedback With Increased Task Complexity in Individuals With Chronic Ankle Instability Compared to Healthy Controls

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Context: Chronic ankle instability (CAI) is associated with a less flexibly adaptable sensorimotor system, which may alter the ability to reweight sensory reliance during complex tasks. Compensatory reliance on visual feedback in CAI individuals may be a result of inadequate multisensory integration and reweighting of other sensory systems. The objective of this study was to determine CAI-related differences in sensory reweighting when maintaining postural control with increasing task complexity. **Methods:** Forty-four physically active individuals with and without CAI (CAI: age: 26.09±5.8yr; height: 172.35±9.8cm; mass: 76.2±14.9kg; Controls: age: 25.4±5.9yr; height: 169.7±9.3cm; mass: 72.0±14.8kg) participated in a laboratory case-control study. The involved limb for CAI was identified as the limb with a history of ankle sprains. Healthy control limbs were matched to the involved and uninvolved limbs of the CAI group. Postural control for each participant was evaluated using the Sensory Organization Test (SOT) in double- and single-limb stance on the involved and uninvolved limbs. The SOT challenges somatosensory, visual, and vestibular feedback in a combination of the sway-referenced support surface and visual surroundings with and without vision to examine sensory system reliance during postural control. A 2×3×3 repeated measures ANOVA and Tukey's LSD post-hoc analyses were used to analyze interactions between group, sensory system reliance (Somatosensory, Visual, Vestibular), and task (stance: DLS, SLS-IL, SLS-UL) (alpha=0.05). **Results:** There were significant interactions between group, sensory system reliance, and task ($F_{4,168}=3.219$, P=0.014). Tukey's LSD post-hoc comparisons revealed healthy controls (63.15±2.09%) significantly down-weighted vestibular reliance compared to CAI (69.91±2.08%, P=0.027) while controlling posture in SLS-IL. Pairwise comparisons displayed healthy controls significantly down-weighted vestibular reliance transitioning from DLS (73.31±1.98%) to SLS-UL (65.01±1.90%, P=0.001) and SLS-IL (63.15±2.08%; P=0.001), respectively. No significant differences in vestibular reliance between individual tasks (DLS: 81.82±1.39%, SLS-UL: 70.13±1.90%, SLS-IL: 94.41±0.92%, P>0.05) were noted in CAI. Both groups significantly up-weighted somatosensory reliance in DLS (CAI:97.22±0.54%; Controls:97.36±0.54%) compared to SLS-UL (CAI: 81.82±1.39%, P=0.001; Controls: 80.26±1.39%, P=0.001) and SLS-IL (CAI: 81.78±1.39%, P=0.001; Controls:78.88±1.39%, P=0.000), respectively. There were no significant differences in visual reliance between individual tasks for CAI (DLS: 93.21±0.96%, SLS-UL: 94.41±0.92%, SLS-IL: 94.83±0.93%, P>0.05) and healthy controls (DLS: 92.87±0.96%, SLS-UL: 94.04±0.92%, SLS-IL: 94.95±0.93%, P>0.05). Pairwise comparisons also revealed significant differences in sensory reweighting between somatosensory, visual, and vestibular in DLS, SLS-UL, and SLS-IL, respectively, for both CAI and healthy controls (DLS: P<0.001; SLS-UL: P<0.001; SLS-IL: P<0.001). **Conclusions:** CAI and healthy individuals demonstrated similar up-weighting patterns of somatosensory and vision when transitioning from double to single limb stance. However, CAI failed to down-weight vestibular reliance during SLS-IL compared to healthy controls. The failure to down-weight vestibular reliance while transitioning from simple to more complex tasks may be an important CAI-related factor to consider. Future studies should investigate the regulation of vestibular reliance in those with CAI.

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Fellow sponsored by Scott E. Ross, PhD, ATC.

Within-Session and Between-Session Effects of Auditory Biofeedback Gait Training on Biomechanics in Patients With Chronic Ankle Instability

Donovan L, Thomas AC, Torp DM: University of North Carolina at Charlotte, Charlotte, NC, and University of Kentucky, Lexington, KY

Context: Auditory biofeedback has been shown to medially shift center-of-pressure (COP) location during walking among patients with CAI; therefore, it has the potential to improve ankle stability. However, prior to clinical implementation, more evidence on dosage parameters is warranted. The purpose of this randomized-controlled trial was to determine the minimum session duration and number of sessions of auditory biofeedback necessary for patients with CAI to adopt a lateral-to-medial shift in COP during walking. **Methods:** Nineteen patients with CAI were randomized into an auditory biofeedback group (AudFB: (n=11; sex=F:7; BMI=26.5kg/m2; age = 23.8 years)) or a no feedback group (NoFB: (n=8; sex=F:5; BMI=27.9kg/m2; age=22.3 years)). All participants completed eight, 30-minute treadmill-walking sessions, over a 2-week period. At the start of each session, participants were fitted with footwear and in-shoe plantar pressure-recording insoles. Participants in the NoFB group walked at a self-selected pace on a treadmill for 30-minutes where COP was measured for 30-seconds within the first minute (0-minute) and at every 5-minute interval thereafter (7 time-intervals total). The AudFB group had their COP recorded during the same time-intervals; however, after the first COP recording (0-minute) a custom-assembled auditory tool was fixed to the participant's involved limb in a manner that would cause the tool to elicit a noise if their COP was excessively lateral. For the remainder of the session, the AudFB group was instructed to walk so that the tool would not elicit a noise. The COP location was extracted from 10-steps within each 30-second trial. Steps were condensed into 10% increments across the entire stance phase (5%-95%) so that 10-individual data points were created to form a COP gait line for each trial. For both groups, means and associated 95% confidence intervals (CIs) were calculated for each COP gait line and compared within each session (0-minute time-interval compared to each subsequent time-interval) and between sessions (session-1 0-minute time-interval compared to each subsequent session's 0-minute time-interval). Data points where 95% CIs did not overlap represented a significant difference in COP location. **Results:** The AudFB group had significant within-session lateral-to-medial shifts in COP location during session-1 at the 15 (45% of stance; peak mean difference ± standard deviation=4.6±4.1mm) and 20-minute time-intervals (35% and 45%; 4.2±4.8mm) (Figure 1). Significant lateral-to-medial shifts in COP location were observed between session-1 and sessions 5 (35-55%; 4.2±4.7mm), 7 (35%-95%; 6.7±4.1mm), and 8 (35%-95%; 7.7±4.8mm) (Figure 1). There were no significant changes for the NoFB group. **Conclusions:** Patients with CAI who received AudFB needed an average of 15-minutes during session-1 to meaningfully shift their COP location medially and 4-sessions before the pattern was retained. Thus, AudFB should be used for at least 15-minutes over 4-sessions to shift COP gait line location.

This study was funded by a University of North Carolina at Charlotte Faculty Research Grant. The authors have no other financial disclosures.

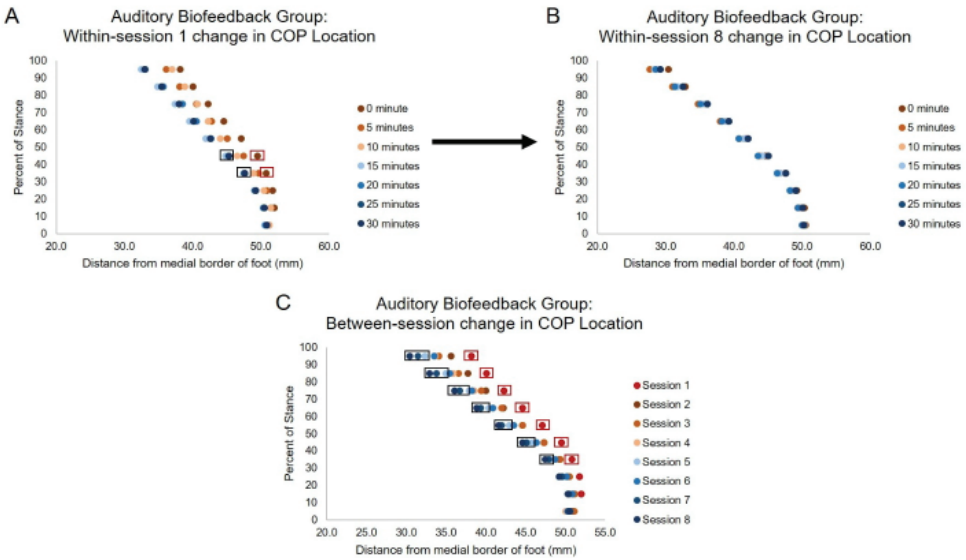

Figure 1. Data points (means) within black boxes represent a significant lateral-to-medial shift in COP location indicated by the associated 95% confidence intervals (CIs) not overlapping with the 95% CIs of the means within the red boxes. While receiving auditory biofeedback, patients with CAI needed 15-minutes during session-1 to meaningfully shift their COP location medially (A). For each subsequent session, the time it took patients to change their gait decreased until session-8, when no observable differences in gait were identified (B). Between sessions, 4-sessions were required before the gait pattern was retained (C).

The Relationship Between Constructs of Health-Related Quality of Life and Lower Extremity Visuomotor Reaction Time in Females With History of Lateral Ankle Sprain

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Context: Many individuals who sustain a lateral ankle sprain (LAS) fail to return to their prior activity because of lingering deficits and residual symptoms associated with their injury. Individuals with a history of LAS report elevated levels of injury-related fear, decreased ankle function, and decreased overall health-related quality of life (HRQOL). Additionally, individuals with history of LAS exhibit deficits in neurocognitive functional measures such as visuomotor reaction time (VMRT), which may be a contributor to worse patient-reported outcome (PRO) scores. The aim of this study was to examine the relationship between constructs of HRQOL, measured using PROs, and lower extremity VMRT in individuals with a history of LAS. **Methods:** A cross-sectional design was used to examine the relationship between constructs of HRQOL and lower extremity VMRT in young adult females with history of LAS (n=19; age= 24±3.5 years; height=163.1±9.8 cm; mass=65.1±11.5 kg; time since last LAS=67.8±50.5 months). Variables of interest included: 1) Tampa Scale of Kinesiophobia (TSK-11), 2) Fear Avoidance Beliefs Questionnaire (FABQ), 3) Penn State Worry Questionnaire (PSWQ), 4) Modified Disablement in the Physically Active Scale (mDPA), 5) Foot and Ankle Disability Index (FADI), and 6) lower extremity VMRT measured using an LED sensor system. Following the completion of PROs, participants completed a lower extremity VMRT task where they responded to a visual stimulus by using their foot to deactivate a series of 5 LED light sensors arranged in a semicircle. The test limb was denoted as the limb deactivating the sensors while the other limb maintained single-limb balance. Participants completed the test bilaterally, completing 3, 30-second practice trials per limb followed by a 1-minute test trial per limb. Separate Spearman's Rho correlations were performed to assess the relationship between PROs assessing constructs of HRQOL and lower extremity VRMT for both limbs. Correlations were interpreted as: 0.00-0.19 = very weak, 0.20-0.39 = weak, 0.40-0.59 = moderate, 0.60-0.79 = strong, and 1.0 = very strong. Significance was set at $p<0.05$. **Results:** Summary data can be found in Table 1.There was a strong, significant negative correlation between FADI-ADL (ρ=-0.68; P=0.002) and FADI-Sport (ρ=-0.76; P=0.001) scores and injured limb VMRT. There were moderate, significant negative correlations between the uninjured limb VMRT and FADI-ADL (ρ=-0.60; P=0.01) and FADI-Sport (ρ=-0.60; P=0.01) scores. There was a moderate, significant positive correlation between the injured limb VMRT and mDPA-PSC(ρ=0.52; P=0.01) and mDPA-Total (ρ=0.54; P=0.02) scores. All other correlations were not statistically significant. **Conclusions:** Young adult females with history of LAS demonstrated an association between self-reported constructs of HRQOL and lower extremity VMRT. As VMRT is a modifiable injury risk factor, future studies should examine the effectiveness of interventions designed to improve lower extremity VMRT in individuals with history of LAS and how they may impact self-reported HRQOL.

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Table 1. Descriptive Statistics of Explanatory and Response Variables

	Median	IQR
Explanatory variables		
Injured FADI-ADL (%)	96.2	7.7
Injured FADI-Sport (%)	90.6	21.9
Injured FADI-Total (%)	94.1	8.8
FABQ-Work	0	4
FABQ-PA	13	8
FABQ-Total	14	11
mDPA-MSC	2	5
mDPA-PSC	5	13
mDPA-Total	7	11
PSWQ	18	6
TSK-11	15	4
Response variables		
Injured Limb VMRT (sec)	.50	.09
Uninjured Limb VMRT (sec)	.49	.09

Abbreviations: ADL, Activities of Daily Living; FABQ, Fear Avoidance Belief Questionnaire; mDPA-MSC, Modified Disablement in Physically Active Mental Summary Component; mDPA-PSC, Modified Disablement in Physically Active Physical Summary Component; PRO, Patient-Reported Outcome; PSWQ, Penn State Worry Questionnaire; sec, seconds; TSK-11, Tampa Scale of Kinesiophobia; VMRT, Visuomotor Reaction Time

Vestibular and Visual Sensory Integration During Static Postural Control in Athletes With and Without Ankle Sprain History

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Context: Individuals with ankle sprains have known balance impairments, which may be due to a reduced ability to appropriately reweigh sensory and/or somatosensory information during postural control. There is little evidence regarding how increased sensory integration demands of vestibular and visual systems influence postural control in athletes with ankle sprains. Therefore, the purpose of this investigation was to compare postural control ability in response to vestibular and visual sensory noise between athletes with and without ankle sprain history. **Methods:** Twenty-four athletes with ankle sprain history (10 males, 14 females; 19.5±1.1yrs; 170.1±15.7cm; 70.2±25.3kg; 2.6±3.9 ankle sprains) and 49 athletes with no ankle sprain history (27 males, 22 females; 19.7±1.6yrs; 176.3±12.7cm; 79.2±23.7kg) were included in this analysis. All subjects completed four conditions of the Concussion Balance Test (COBALT): Condition 3 (eyes closed, feet shoulder-width apart, head oscillations of 60°in yaw plane at 120 BPM, firm surface), Condition 4(eyes open, feet together, torso rotations of 60°at 40 BPM with shoulders 90° flexed and elbows extended, firm surface), Condition 7 (same as Condition 3 but on foam surface), Condition 8 (same as Condition 4 but on foam surface). For each condition, a sway score (degree/sec) was calculated as the mean angular velocity of COP sway with respect to a participant's estimated center of gravity. Greater sway scores indicated worse postural stability. The number of performance errors during the COBALT were also collected. The errors included hands off the hip, opening eyes during an eyes closed trial, moving feet from appropriate positioning, stepping off the force plate, and not keeping head turns or trunk rotation in sync with the metronome for two beats or more. Each of the four COBALT Conditions was completed twice and averaged scores were used for analysis. Separate Mann-Whitney U tests were used to compare sway scores and the number of errors between groups. Effect sizes were also calculated using es=z/√N. Alpha was set at p=0.05. **Results:** The sway scores and the number of errors during each COBALT Condition for each group can be seen in Table. Sway scores for Condition 3 (p=0.035, es=0.25) and 4 (p=0.012, es=0.29) and the number of errors for Condition 7 (p=0.021, es=0.27) were significantly greater in athletes with ankle sprain history compared to athletes with no ankle sprain history. **Conclusions:** Those with a LAS history may have a dismissed ability to compensate in conditions with vestibular/visual noise compared to those without a LAS history. Also, additional demands (i.e. unstable surface) on the vestibular noise increased errors, which may be a compensatory response to maintain balance. Our results provide additional evidence that those with ankle sprains have limited ability to flexibly integrate and reweight sensory information during postural control, which may be targeted during the rehabilitation.

COBALT system was provided to the University of Kentucky on loan from Bertec Corp. Bertec Corp. did not contribute to design analysis or preparation of this submission.

Table. COBALT Sway Scores and Errors for each group.

Condition	Ankle Sprain History (n=24)	No Ankle Sprain History (n=49)	P-values	Effect sizes
Condition 3				
Sway score (deg/s)	0.37±0.09	0.32±0.09	0.04	0.25
# of Errors	0.35±0.58	0.24±0.42	0.51	0.08
Condition 4				
Sway score (deg/s)	0.76±0.17	0.68±0.13	0.01	0.29
# of Errors	0±0	0±0	-	-
Condition 7				
Sway score (deg/s)	1.37±0.42	1.26±0.35	0.31	0.12
# of Errors	2.33±1.67	1.43±1.41	0.02	0.27
Condition 8				
Sway score (deg/s)	0.93±0.20	0.90±0.21	0.57	0.07
# of Errors	0±0	0±0	-	-

No Differences in Lower Extremity Visuomotor Reaction Time Between Patients With Contact and Non-Contact ACL Injuries

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Context: Primary injury risk for ACL injuries is linked to slower reaction time (RT). After ACL reconstruction (ACLR), individuals who sustain a non-contact primary ACL injury are more likely to have a secondary ACL injury when compared to those with contact primary ACL injuries. Slower reaction time may be an underlying reason for the difference in secondary injury risk between contact and non-contact ACLR populations. Therefore, the purpose of this study was to compare lower extremity visuomotor reaction time (LEVMRT) between individuals with contact versus non-contact ACL injuries after ACLR. **Methods:** Forty-six individuals with ACLR (27 Female, age=21.08 ± 8.28 years, 10.17 ± 4.61 months since ACLR) participated in this cross-sectional study. Participants self-reported sustaining a contact or non-contact ACL injury. LEVMRT was assessed using a novel paradigm that used light-emitting wireless sensor discs (Fitlight Trainer™, Fitlight Sports Corp; Figure 1). Participants stood on one limb, while deactivating a series of 5 light-emitting wireless sensor discs that were positioned in front of the moving limb. Participants extinguished the lights using their feet by stepping on a disc as quickly as possible after it illuminated in a random order. Participants completed three 30-second practice trials followed by one 1-minute test trial and the test was completed bilaterally. LEVMRT was calculated as the average time (seconds) it took participants to extinguish a light after it illuminated. Mann Whitney U Tests were used to examine differences in LEVMRT between the contact and non-contact ACL injury groups. A Hedges' g effect size (ES) and 95% confidence interval (CI) were used to determine the magnitude of difference between groups. The ES was interpreted as: small 0.2 ≥, medium 0.5 ≥, and large 0.8 ≥. Alpha was set a priori to $p < 0.05$. **Results:** Fifteen participants (33%) sustained a non-contact ACL injury and 31 participants sustained a contact ACL injury. The contact group involved limb LEVMRT (mean = 0.542 ± .112) did not significantly differ from the non-contact involved limb LEVMRT (mean=.498± .904; $p = 0.14$). Additionally, the contact group uninvolved limb LEVMRT (mean=0.525 ± .11) did not significantly differ from the non-contact group uninvolved limb LEVMRT (mean=0.480± .076; $p = 0.13$). A small effect size was observed between groups for the involved limb LEVMRT (ES=0.1074, 95% CI [-0.219 – 1.004]) and uninvolved limb LEVMRT (ES=0.1013, 95% CI [-0.170 – 1.055]). **Conclusions:** No difference in LEVMRT were observed between participants with ACLR who experienced a contact or non-contact ACL injury. The LEVMRT in both groups was impaired when compared to normative RT data from athletic populations. This impairment may be an underlying mechanism in the primary risk for both contact and non-contact ACL injuries. Future research should further consider neuro- and psycho-physiological differences between patients prior to ACL injury.

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Figure 1. Set Up for Lower Extremity Visuomotor Reaction Time (LEVMRT) Testing (Fitlight Trainer™, Fitlight Sports Corp)

Isolated Hamstring Fatigue Does Not Improve Quadriceps Activation in Individuals With Anterior Cruciate Ligament Reconstruction

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Context: Quadriceps activation failure is commonly observed following ACL reconstruction (ACLR). Antagonist facilitation is believed to contribute to this, as passive hamstrings fatigue is reported to increase quadriceps strength and activation. However, the sustained effects of actively induced hamstrings fatigue may be more relevant to rehabilitation specialists, yet remain unknown. Therefore, our purpose was to determine the immediate and delayed effects of a single bout of isometric hamstrings fatigue on quadriceps strength and activation among individuals with ACLR and healthy controls. **Methods:** Eleven individuals with primary, unilateral ACLR (7F, 21.9 ± 2.4 years, 49.6 ± 39.1 months from surgery) and 11 matched uninjured controls (7F, 21.7 ± 1.9 years) were cross-sectionally investigated in a research laboratory. Independent variables were group and time. Peak quadriceps torque, early (RTD100) and late (RTD200) rate of torque development, hamstrings-to-quadriceps electromyographic co-activation, and central activation ratio (CAR) were assessed in the involved, or matched control, limb during a series of maximal voluntary isometric contractions (MVICs). During the fatiguing protocol, participants performed repeated 30-second hamstrings MVICs until dropping below a threshold equivalent to 50% of their previously established MVIC for two consecutive trials. Participants were reassessed immediately after and 30 minutes after fatigue. Outcomes were compared using a 2 (group) x 3 (time) repeated measures analysis of variance with post hoc testing as appropriate. Cohen's d effect sizes were calculated with 95% confidence intervals to determine the magnitude of observed differences. **Results:** Individuals with ACLR demonstrated lesser peak torque at baseline (post hoc $t = 2.607$, $p = .017$, $d = -1.11$ [-2.01, -0.21]), and lesser CAR at each time point (post hoc Baseline: $t = 4.190$, $p < .001$, $d = -1.79$ [-2.78, -0.80]; Post-Immediate: $t = 2.854$, $p = .012$, $d = -1.22$ [-2.13, -0.31]; Post-30 minutes: $t = 2.358$, $p = .033$, $d = -1.01$ [-1.89, -0.12]) compared to controls. However, hamstrings-to-quadriceps coactivation and rate of torque development did not differ between groups at any time point (all $p > .05$). CAR decreased from baseline to 30 minutes post-fatigue in the control group only (post hoc $F = 5.226$, $p = .035$, $d = -1.20$ [-2.11, -0.29]). **Conclusions:** A single bout of isolated hamstrings fatigue did not improve quadriceps neuromuscular function in individuals with ACLR. However, despite large magnitude differences in quadriceps strength at baseline, strength fell within normal limits relative to controls up to 30 minutes after fatigue. On the basis of previous research, individuals who experience greater facilitation of the hamstrings (higher hamstrings-to quadriceps coactivation) may be more appropriate candidates for this intervention.

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Quadriceps Motor Unit Behavior After Anterior Cruciate Ligament Reconstruction

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Context: Despite targeted multidisciplinary therapy, quadriceps weakness remains the hallmark clinical impairment following ACL reconstruction (ACLR) and is associated with an early onset of post-traumatic osteoarthritis. Muscle function is dependent on the quality of neural drive to the muscle and the resultant motor unit (MU) behavior, as determined by MU recruitment, recruitment threshold (RT), amplitude (MUAP), and firing frequency (mean firing rate [MFR]). Unfortunately, quadriceps MU inhibition is widely documented after ACLR. Conventional rehabilitation may habituate faster firing of low threshold (smaller) MUs, a strategy that would theoretically increase force output in the absence of high threshold (larger) MU activation. Thus, we aimed to determine if differences in MU firing behavior exist in individuals with ACLR. **Methods:** Seventeen individuals with primary, unilateral ACLR (9 female, age=22.8±4.3 years, time from surgery=30.0±23.3 months) and matched controls (8 female, age=21.5±3.8 years) were cross-sectionally investigated during a single session in a research laboratory. Participants completed three 15-second trapezoidal contractions at 50% maximal voluntary isometric contraction (MVIC). High-density vastus medialis EMG activity and torque were recorded concurrently. The quadriceps Hoffmann reflex (H:M ratio) and central activation ratio (CAR) were acquired bilaterally to detail the proportion of MU pool available and volitionally activated. EMG signals were decomposed into constituent MU action potential trains. We examined the MUAP-RT and MFR-RT relationships with linear regression and extracted the slope and y-intercept for each individual contraction. Separate analyses of covariance were used to analyze the effect of group and limb on the slope of each relationship, while controlling for and the y-intercept, MVIC torque, CAR, and H:M ratio. Post-hoc, we planned to investigate Pearson's r correlations between selected covariates and the slope of each relationship within each group. **Results:** Individuals with ACLR demonstrated lower MVIC torque in the involved limb compared to uninvolved (2.9±0.5 vs. 3.4±0.6 Nm/kg, p=.011), but not to matched controls (3.0±0.6 Nm/kg, p=.896). There were no differences in H:M ratio or CAR between groups or limbs (all p > .05). The slope of the MFR-RT relationship was shallower in the ACLR limb compared to controls (-16.13±2.90 vs. -18.02±2.89; F1,50=6.1, p=.017, d=0.65) (Figure 1). The y-intercept (F1,50=135.2, p<.001) and MVIC torque (F1,50=22.9, p=.039), were identified as statistically significantly covariates. In support of the observed group difference, MVIC torque was moderately and positively associated with MFR-RT slope in the ACLR group (r=0.486, p=.004), but not the control group (r=0.194, p=.323). We observed no group or limb differences in MUAP-RT relationships (all p > .05). **Conclusions:** Our results indicate that individuals with ACLR demonstrate faster MFR at given recruitment thresholds compared to controls, without differences in motor unit size, quadriceps strength or activation. These results may support the use of an adaptive neural strategy to upregulate the force contributions of active motor units.

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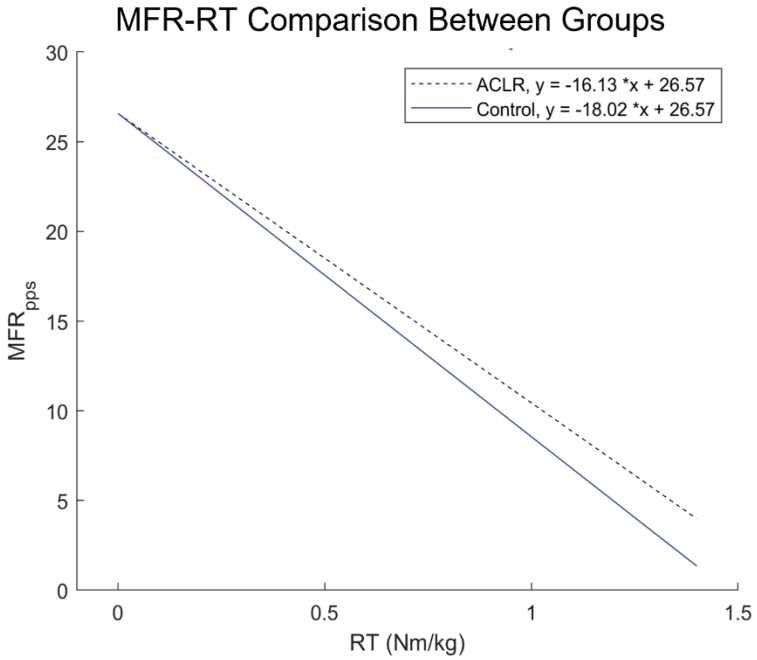

Visualization of MFR-RT relationship between groups, demonstrating faster MFRs at given recruitment thresholds in the ACLR compared to control groups. Covariates appearing in the model are evaluated at the following values: MFR-RT y-intercept = 26.57, H:M Ratio = 0.26, MVIC = 3.24 Nm/kg, CAR = 95.13 %

Upper Extremity Neuromuscular Function Can Discriminate Between Individuals With and Without Glenohumeral Labral Repair

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Context: Neuromuscular assessment of clinical outcomes following glenohumeral labral repair is often complex. It is important to identify the most useful metrics of neuromuscular function about the individual's health status by reducing the data to simple but meaningful forms. This allows clinicians to prioritize important factors to be addressed in rehabilitation and assessment of post-operative recovery while minimizing time and risks. The objectives of this study were to investigate (1) whether commonly described measures of neuromuscular function could discriminate between individuals with glenohumeral labral repair and uninjured controls, (2) how accurately those selected outcome measures could classify individuals' health status, and (3) to compare outcomes between those with and without glenohumeral labral repair. **Methods:** 16 individuals with a primary, unilateral glenohumeral labral repair (13M/3F, age: 24.1 ± 5.0 years, time from surgery: 36.7 ± 33.3 months) and 14 uninjured controls (11M/3F, age: 23.8 ± 2.7 years) participated in this cross-sectional study. Mass-normalized shoulder abduction and wrist flexion maximal voluntary isometric contraction (MVIC) torque (Nm/kg), motoneuron pool excitability of the flexor carpi radialis (Hoffmann reflex [H:M ratio]), corticospinal excitability of the upper trapezius, middle deltoid and flexor carpi radialis (active motor threshold [AMT, %]) were measured bilaterally during two study visits. Receiver operator characteristic (ROC) curve analyses were used to determine the extent to which the measured outcomes could discriminate between individuals with and without a history of glenohumeral labral repair. Multiple logistic regression was used to determine the accuracy of classification for each outcome measure that demonstrated acceptable discrimination (area under the curve [AUC] ≥ 0.7). Independent t-tests were used for between-group comparisons. **Results:** Shoulder abduction torque symmetry ≤ 95.5% (AUC = .938, $p < .001$) and AMT of the upper trapezius ≥ 41.0% (AUC = .804, $p = .005$) demonstrated excellent diagnostic utility. Unilateral shoulder abduction torque ≤ 0.71 Nm/kg (AUC = .795, $p = .006$) and H:M ratio of the flexor carpi radialis ≤ 0.23 (AUC = .799, $p = .005$) demonstrated acceptable diagnostic utility. Shoulder abduction torque symmetry alone was the strongest indicator, and classified health status with 90.0% accuracy ($\chi2(1) = 24.9$, $R2 = .753$, $p < .001$). Injured participants demonstrated lower shoulder abduction torque ($p < .001$) and symmetry ($p < .001$), higher AMT of the upper trapezius ($p < .001$), and lower H:M ratio of the flexor carpi radialis ($p = .010$), supporting the ROC findings. **Conclusions:** Shoulder abduction torque symmetry was the most accurate diagnostic and predictive metric to discriminate between individuals with and without glenohumeral labral repair, suggesting the utility of bilateral strength assessment in clinical settings. Corticospinal excitability of the shoulder stabilizer and motoneuron pool excitability of the forearm muscle may also offer clinically relevant insights on presence of injury in this population.

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Factors Influencing a Clinically Feasible, Functional Reaction Time Battery: The Standardized Assessment of Reaction (START)

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Context: Reaction time is often measured using computerized neurocognitive assessments when examining concussion. However, computerized measures do not correlate with whole-body functional movement reaction time, suggesting minimal sport-related applicability in concussion management. We developed the Standardized Assessment of Reaction Time (START) to emulate the rapid, concurrent cognitive and whole-body movement needed in sport. Reaction time can be affected by demographic or pre-existing factors that must be accounted for when implementing START clinically. Our study purpose was to 1) compare START movement and cognitive conditions and 2) assess factors associated with START performance among healthy collegiate student-athletes. We hypothesized all START conditions would differ, and sex and sport type would be associated with START performance. **Methods:** We conducted a cross-sectional study among 63 healthy collegiate student-athletes (58.7% male, age:19.3±0.9yrs [range=18.0-23.4], mass:79.6±29.0kg, height:173.8±33.4cm, 25.4% concussion history) who completed health-history questionnaires (age, sex, limb dominance, sport, concussion history, height, mass, sleep night before, caffeine intake) and START during pre-season testing. START consisted of 3 movements (standing, single-leg balance, cutting) under 2 cognitive states (single-task, dual-task [subtracting by 6's or 7's]) for 3 trials each condition (6 conditions total). Trials were video recorded with a mobile device (240 frames-per-second). All START positions required hands on hips. START initial stances required feet together for standing trials, non-dominant leg balancing for single-leg balance trials, and an athletic stance for cutting trials. Participants were told "get set", and then a video-synchronized penlight was randomly illuminated after 2-10s. Participants moved their hands off their hips to an outstretched "T" position immediately following penlight illumination for standing and single-leg balance trials. Cutting trials required participants perform a 45° cut-sprint to left- or right-side targets 3.05m away. All START trials were calculated as time (ms) between penlight illumination and initial movement. We used a 3x2 repeated-measures ANOVA with post-hoc t-tests to assess START movement and cognitive differences, and univariable linear regressions with 95% confidence intervals (95%CI) to examine START performance and health-history factor associations. **Results:** The ANOVA interaction ($p<0.001$) demonstrated all START conditions differed from each other (Figure; post-hoc p's$\leq$0.001), except single-task standing versus single-task single-leg balance ($p=0.70$). Age was associated with single-task cutting, with every 1-year increase increasing reaction time by 18.4ms ($p=0.003$; 95%CI:6.6-30.2ms). Age was not associated with any other START conditions ($p\geq0.15$). Sex ($p\geq0.12$), hand dominance ($p\geq0.17$), leg dominance ($p\geq0.13$), height ($p\geq0.18$), mass ($p\geq0.06$), concussion history ($p\geq0.06$), sport type ($p\geq0.06$), sleep night before ($p\geq0.22$), and caffeine intake ($p\geq0.18$) were not associated with any START condition. **Conclusions:** Most START outcomes resulted in different reaction time performance, confirming conditions produced unique measures. Age was the only significant factor, but other factors may still meaningfully alter START. A larger study is needed to comprehensively determine all meaningful associations between pre-existing factors and START.

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Publicly Available Return to Learn Protocols Among National Collegiate Athletic Association Division I Universities

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Context: Return to learn (RTL) protocols are designed to protect an athlete and gradually return to the classroom. The purpose of this study was to explore RTL protocols within the National Collegiate Athletic Association (NCAA) division I university setting. Publicly available documents found on the internet for 351 division I universities were reviewed to assess the inclusion of NCAA RTL policy. **Methods:** A cross-sectional review of publicly available information was conducted. A listing of each division I university was obtained from the NCAA website. An internet keyword search was performed with each university name and the following terms; concussion protocol/policy, sports medicine manual, sports medicine policies and procedures. Policies were reviewed using the NCAA Concussion Safety Checklist. An answer of either a "yes" or "no" was assigned for each component of the checklist. Descriptive statistics were calculated. **Results:** Of the 351 universities, 192 had a publicly available concussion policy, and 154 (80%) of those policies included an RTL protocol. Identification of a multidisciplinary team was the most common component included, while re-evaluation by a team physician or multidisciplinary team if symptoms last longer than 2 weeks was the least common component. 79% of the policies assessed included each individual component of the NCAA's RTL checklist. Out of the 154 universities, 111 (72%) included the year that their protocol was updated. **Conclusions:** As required by the NCAA, an RTL protocol must be included in a university's concussion policy. According to these findings, of the publicly available data, it appears that 20% of division I universities are missing a RTL protocol as a part of their concussion policy. The athletic community has become very aware of return to play (RTP) protocols as it impacts participation on the field/court, the same cannot be said for RTL as it impacts participation in the classroom. RTL is recommended to occur before an athlete completes a RTP protocol. It is important that athlete's all-around well-being is addressed, and that includes support on and off the field.

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Evaluating the Implementation of the Concussion Awareness Training Tool for High Performance Athletes Using the RE-AIM Framework

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Context: Approximately 20,000 varsity student-athletes participate at 56 Canadian U Sports institutions. Despite a national call for mandatory annual athlete concussion education, education received by Canadian university athletes in 2019 was inconsistent. U Sports (national university sports-governing body) and researchers partnered to develop the Concussion Awareness Training Tool for high-performance athletes (CATT-HPA) using an integrated knowledge translation approach involving program administrators, university athletic/physiotherapists, and athletes. The RE-AIM (reach, effectiveness, adoption, implementation and maintenance) framework is a comprehensive, systematic model for examining research translation and dissemination. The objective is to evaluate implementation of the CATT-HPA at varsity institutions in Canada using the RE-AIM framework. **Methods:** This concurrent parallel mixed methods evaluation was conducted as part of a pre-experimental study examining the effectiveness of the CATT-HPA. University administrators and athletic therapists/physiotherapists at all 56 U Sports affiliated institutions were provided a link to the CATT-HPA to share with their athletes including a pre and post course assessment. A convenience sample of athletes assessed the course on 6 domains using a 5-point Likert scale (i.e. overall assessment, learned something new, usefulness, engagement, recommendation for other athletes, and likelihood of returning). Development of the CATT-HPA utilized several strategies to assist with implementation including identifying needs and barriers, development of a certificate tracking system, and incorporating stakeholder input. After the season, all university administrators were provided a subsequent face-validated uptake survey evaluating adoption of the CATT-HPA. We observed certificate completions and requests for mandatory tracking throughout the evaluation period. To examine programme implementation, we used the 5 dimensions of the RE-AIM framework. Quantitative data from surveys and observations were analyzed using frequency and proportions, and open-ended responses explaining non-implementation were analyzed using qualitative content analysis. Following collection, all data were integrated to provide a comprehensive evaluation within the RE-AIM framework. **Results:** A total of 24/56 (42.9%) universities from all 4 sport conferences within U Sports participated in the study and mandated or shared the tool during the 2020-2021 season. In terms of reach, of the approximately 5555 athletes provided the link to the education, 1292 completed the certificate and 347 (39.2% male, 59.7% females, 1.2% undisclosed; median (range) age: 19 (17-33)) completed the course assessment during the evaluation period from September 2020 to March 2021. Reasons for schools not implementing included 1) late access to the course, 2) COVID-19 (no athletic seasons, reduced resources), 3) athlete burden, and 4) pre-existing concussion education. The majority of athletes rated the course as good or excellent (296/347, 85.30%). In total, 283/347 (81.56%) athletes felt they learned something new, 305/347 (87.90%) felt the course was useful, 226/347 (65.13%) agreed the course was engaging, 258/347 (74.35%) agreed they would recommend the course to other varsity athletes, and 211/347 (60.81%) planned on returning to access content if needed. In terms of maintenance, 36/47 respondent universities suggested they would make it mandatory for all or some of their athletes in the 2021-2022 season, 5/47 suggested they would recommend to all or some of their athletes, 5/47 were unsure and 1/47 did not share. The 2021-2022 season is ongoing. To date, 21 U Sports universities have implemented the mandatory institution email certificate tracking system for certificates and there have been over 10,562 certificate completions from 47/56 (84%; median (range): 153 (1-898)) universities. **Conclusions:** The CATT-HPA's integrated knowledge translation approach and implementation strategies were effective. The majority of U Sports institutions implemented the tool despite challenges resulting from COVID-19. Timing of implementation affected adoption in the first year of development and is an important consideration for future work. Athletes responded positively to the content of the CATT-HPA. Evaluation of athlete changes to knowledge, beliefs and behaviours is underway.

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Greater Mild Traumatic Brain Injury Lifetime Incidence Is Associated With Lower Brain Network Resilience but Not Efficiency in Special Operations Forces Combat Soldiers

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Context: Special Operations Forces (SOF) combat Soldiers sustain frequent blast and blunt neurotrauma, most often classified as mild traumatic brain injury (mTBI). Exposure to repetitive mTBI has been associated with persistent behavioral, cognitive, emotional, and neurological symptoms later in life. Identifying neurophysiological changes associated with mTBI exposure, in the absence of present-day symptoms, is necessary for detecting future neurological risk. Advancements in graph theory and functional magnetic resonance imaging (fMRI) have offered novel ways to analyze complex whole-brain network connectivity. Healthy brain networks demonstrate "small-world" topology, characterized by high-degree cortical hubs and short path lengths between nodes. Global efficiency (GE) is a network measure quantifying information exchange over paths. The assortativity coefficient (AC) measures a network's resilience to failures in its main components. Our purpose was to determine how mTBI lifetime incidence affected whole-brain network measures (GE, AC) in SOF combat Soldiers. **Methods:** Healthy SOF combat Soldiers (n=146 males, age=32.9±4.3yrs) underwent multimodal neuroimaging at a biomedical research imaging center using 3 Tesla Siemens Prisma or Biograph MRI scanners in this cross-sectional study. Anatomical and functional scans were preprocessed using the fMRIPrep pipeline. The blood-oxygen-level-dependent (BOLD) signal was extracted from each fMRI time-series using the Big Brain 300 atlas. Correlations between atlas regions were calculated and Fisher z-transformed to generate subject-level correlation matrices. The Brain Connectivity Toolbox was used to obtain undirected, weighted, functional network measures for GE (the average inverse shortest path length) and AC (the correlation coefficient between the degrees of all nodes on two opposite ends of a link). A linear regression was fit to model the relationship between continuous mTBI incidence and AC. Due to non-normal outcome distribution, Kruskal-Wallis one-way ANOVA was employed to compare GE between ordinal mTBI incidence groups (0,1-2,3+). **Results:** Among combat Soldiers reporting mTBI exposure (n=76; 52.05%), 37 reported 1-2 mTBI and 39 reported 3+ mTBI. No significant differences in GE were observed between mTBI incidence groups ($\chi2(2)=0.11$, P=.946). Continuous mTBI lifetime incidence significantly predicted AC while controlling for age (F1,144=6.51, P=.012). As shown in the Figure, a negative linear relationship was observed between greater mTBI incidence and lower AC (B-unstandardized=-.00359, β-standardized=-.20792, R^2=.0432). **Conclusions:** No group differences in GE were observed between mTBI groups; however, greater mTBI lifetime incidence predicted lower AC. Brain networks with greater AC have more resilient, interconnected hubs while lower AC indicates widely distributed vulnerable hubs. We found that efficient brain communication may be maintained following multiple mTBIs despite network resilience being negatively associated with greater mTBI incidence. This may explain why clinical symptoms generally resolve in patients with repetitive mTBI despite increasing risks for subsequent neurocognitive disorders and neurological disease. The assortativity coefficient may be a useful neuroimaging biomarker for tracking prodromal physiological effects linking mTBI to future adverse outcomes.

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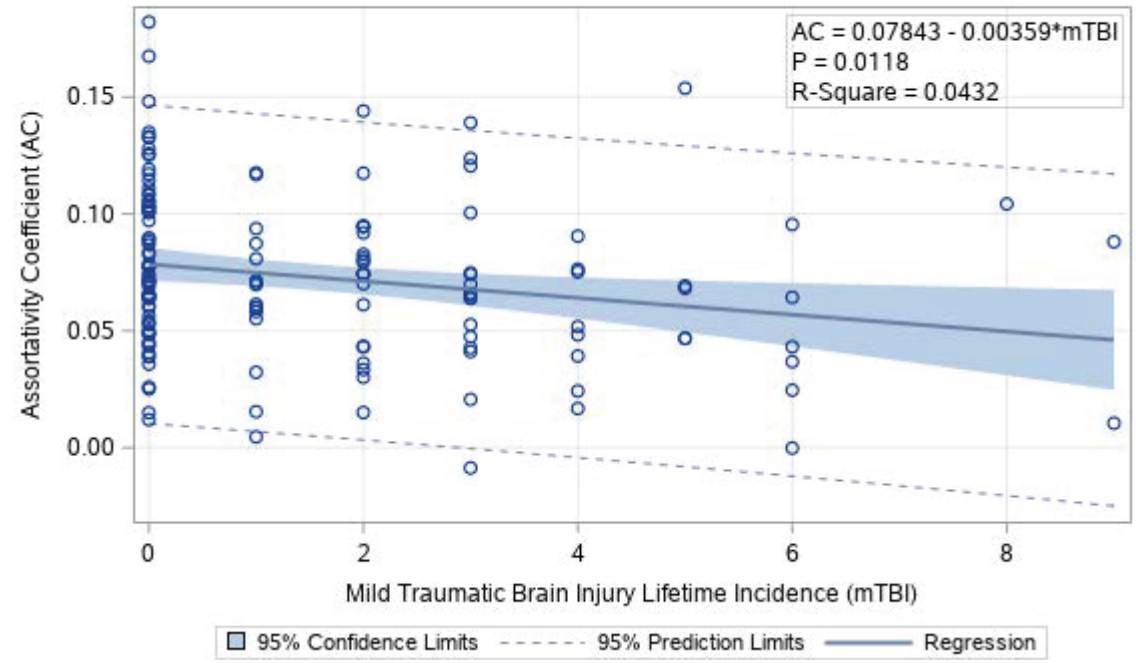
Figure: Linear Regression Between Assortativity Coefficient & mTBI Lifetime Incidence



Reliability of a Novel Concussion Documentation Audit Tool

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Context: Previous research reports deficiencies in documentation of initial concussion evaluations by athletic trainers. We are unaware of a comprehensive tool to audit the completeness of concussion documentation compared to best practice recommendations. Therefore, we developed a tool that assesses evidence-based criteria required for complete documentation of initial concussion evaluations. Face, content and concurrent validity were established; however, establishing reliability of the tool is necessary. The purpose of this study was to assess intra- and interrater reliability of the Concussion Documentation Audit Tool (CDAT) for auditing the completeness of initial concussion evaluation documentation. **Methods:** Three certified athletic trainers (2-35 years' experience) used the CDAT to audit a convenience sample of 53 deidentified initial concussion evaluation notes from 2 clinical sites (1 high school, 1 college) in random order on 2 occasions separated by at least 1 week (Audit 1, Audit 2). The CDAT assesses 36 critical components of initial concussion evaluations on a 3-point scale, where 2 points indicates the criterion was fully met and 1 and 0 points indicate partial or no compliance, respectively. The 36 items of the CDAT were divided into subsections: History (9 items); Presentation (10 items); Physical Exam (10 items); Assessment & Plan (7 items). Two-way random intraclass correlation analyses (ICC2,1, $p<.05$) were used to assess for intra- and interrater reliability of CDAT overall score (maximum=72 points) and subsection scores. ICC values were interpreted conservatively: Poor:<0.6, Fair:0.6-0.7, Acceptable:0.7-0.8, Good:0.8-0.9, Excellent:>0.9. Bland-Altman analyses were used to assess interrater agreement (Rater 1-Rater 2, Rater 2-Rater 3, Rater 1-Rater 3) for individual items from Audit 1. **Results:** Intrarater ICCs for overall CDAT scores demonstrated excellent reliability (Table). Intrarater ICCs for CDAT subsections ranged from good to excellent. Interrater ICCs for overall CDAT scores indicated excellent reliability. Interrater ICCs for CDAT subsections demonstrated acceptable to good agreement indicating moderate reliability. Agreement analyses for 2 of 36 items on the CDAT showed statistically significant differences across all three comparisons, indicating consistently poor agreement for items regarding injury date ($p<0.02$) and neurocognitive assessment ($p<0.04$). For the remaining 34 items, 11 had moderate agreement and 23 had good agreement. **Conclusions:** The CDAT is a reliable instrument to audit the completeness of initial concussion evaluation documentation. Future efforts should aim to further solidify the measurement properties of the CDAT across more raters and specifically for the two items that had poor agreement across raters. The CDAT is a promising tool that may be able to inform targeted interventions to improve initial concussion evaluation documentation for students and clinicians. Additionally, the CDAT inherently provides an outline for complete documentation that clinicians can refer whenever documenting concussions.

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Table. Inter- and intrarater reliability (95% CI*) of CDAT subsection and overall scores.

	History	Presentation	Physical Exam	Assessment & Plan	Overall
Intrarater Reliability (Rater 1)	.79 (.67, .87)	.81 (.70, .89)	.96 (.93, .97)	.93 (.88, .95)	.91 (.85, .95)
Intrarater Reliability (Rater 2)	.85 (.75, .91)	.83 (.72, .90)	.94 (.90, .96)	.86 (.77, .91)	.93 (.89, .96)
Intrarater Reliability (Rater 3)	.82 (.72, .89)	.84 (.74, .90)	.91 (.85, .95)	.89 (.82, .93)	.95 (.92, .97)
Interrater Reliability	.77 (.67, .85)	.76 (.66, .84)	.88 (.82, .92)	.70 (.57, .80)	.90 (.85, .94)

*Confidence Interval

A Summary Representation of Baseline Sensory Organization Test Measures in Healthy Elite Athletes

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Context: Following concussion, the sensory organization test (SOT) is often used to determine readiness for return-to-play (RTP). The SOT contains 3 domains of sensory organization including reliance on visual, somatosensory, and vestibular information. At times, an individual's baseline SOT values are unknown to assist with RTP decisions. As a result of extensive training, elite athletes may have enhanced balance and coordination capability, rendering general population normative values for the SOT as inappropriate for comparison. In elite, highly trained and highly physically active individuals[P], what are representative baseline values[O] for the SOT[E]? **Methods:** PubMed and EBSCOHost (Academic Premier, CINAHL, Medline, SportDiscus) were searched through September 2021. Search terms included iterations of "athlete", "concussion", "healthy, "normal", "test", and "vestibular". The search was limited to studies on humans, in English, and published in the past 5 years. Selection criteria required that studies investigated 1) highly trained and physically active individuals [collegiate athletes or military], 2) participants were healthy at the time of testing, and 3) used the SOT to determine balance and postural control. Additionally, outcomes for each sensory domain of the SOT (visual, somatosensory, and vestibular) needed to be reported. Extracted data included participant ages, sample sizes, means±SD of scores for the composite SOT, and somatosensory, vestibular, and visual domains. The modified Joanna Briggs Institute scale (mJBI) for Cross-Sectional Studies was used to critique the internal validity of included studies. The mJBI is scored out of 6; higher scores indicate fewer threats to validity. A sample-size adjusted weighted mean (wtSOT), weighted SD (wtSD), and weighted 95%CI (wt95%CI) around the wtSOT was calculated for each domain. Weighted mean age (wtAge) ± SD for all participants was also calculated. **Results:** Six studies met selection criteria. mJBI scores ranged from 4 to 6. The most commonly missed criteria were 1) not identifying confounding factors, such as previous history of concussion or balance problem and 2) not adjusting for those confounding factors in the analysis. The age of participants ranged from 18-29 (wtAge = 23.1 ± 4.3 years). Calculated weighted scores are reported as the n, wtSOT ± wtSD, [wt95%CI]. For the composite SOT (n = 967, 79.2 ± 5.8, [78.8, 79.5]); somatosensory (n = 777, 92.2 ± 2.46, [92.1, 92.4]); vestibular (n=777, 89.0 ± 7.4, [88.5, 89.5]); visual (n=777, 77.7 ± 9.6, [77.0, 78.4]). **Conclusions:** These results describe a synthesized and weighted set of representative SOT scores. The weighted 95% CI provides the credible variability of young, healthy, highly trained, and highly physically active individuals. When baseline SOT data for a particular athlete is unknown, these composite and domain ranges can be used as a surrogate baseline for comparison. Studies generally had limited risk of bias; however most did not account for previous concussion, potentially affecting SOT scores.

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Anxiety Influences Concussion Assessment Scores at Baseline in Division-I Collegiate Athletes

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Context: Anxiety has been cited in the literature as both a risk-factor and consequence of sports-related concussions. It has been suggested that patients who have a medical history of anxiety are at risk for a prolonged recovery following injury. Current concussion management guidelines suggest a multifaceted approach to evaluation which include a variety of assessments to measure various domains following injury. Thus, it is important to understand the influence of anxiety on these assessments at baseline. Therefore, the purpose of this study was to investigate the effect of self-reported levels of anxiety on performance on baseline assessments. **Methods:** A total of 158 Division-I collegiate athletes (94 male, 64 females; 19.72±1.39 yrs.; 164.74±13.60cm; 79.39±24.27kgs) from two University athletic departments participated in the study. Participants completed the Beck Anxiety Inventory, a self-report questionnaire measuring the severity of anxiety symptoms. Participants were divided into three groups: minimal, mild, and moderate anxiety. Participants also completed baseline assessments including the Post-Concussion Symptom Scale (PCSS), a reaction time assessment, Concussion Balance Test (COBALT), Gaze Stabilization Test (GST), and neurocognitive assessments from the NIH Toolbox®. Kruskal-Wallis tests were used to compare baseline assessment scores between groups. When indicated, Mann-Whitney U tests were used to investigate pairwise differences between groups. Alpha was set a-priori at $p=0.05$. **Results:** Significant main effects for anxiety were identified for average reaction time ($p=0.015$), the Flanker Inhibitory Control and Attention Test (Flanker) ($p=0.011$), and the symptom scores ($p<0.001$). The group that reported minimal anxiety had significantly better reaction time (0.47±0.04secs) than both the groups reporting mild (0.50±0.04secs; $p=0.010$) and moderate anxiety (0.50±0.05secs; $p=0.041$). There were no significant differences between the mild and minimal groups ($p=0.44$). The group with minimal anxiety performed significantly better on the Flanker (50.25±10.52) than the mild (44.89±10.67$p=0.047$) and moderate (40.00±9.83; $p=0.01$) groups. There were no significant differences in performance on the Flanker between the mild and minimal groups ($p=0.29$). Finally, the group with moderate anxiety reported more symptoms (42±33.17) than the mild (12.39±8.85; $p<0.001$) and minimal (2.94±4.93; $p<0.001$) groups. There were significant differences between the symptoms reported on the PCSS by the mild and moderate groups, with higher symptoms reported by the moderate group ($p=0.005$). There were no significant group differences for any of the other baseline assessments ($p>0.05$). **Conclusions:** Understanding the potential influence that anxiety may have on concussion assessments at baseline is important to informing clinical decision making and interpreting post-injury assessment results in individuals who report with anxiety. These results suggest that individuals with moderate levels of anxiety may score lower at baseline on assessments of cognition and reaction time, as well as report more symptoms than those with mild or minimal anxiety. It is important to know whether an individual experiences anxiety to interpret post-injury results more accurately.

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Functional Reaction Time is Not Different Among Young Adults With a Recent Concussion, Lower Extremity Injury, and No Recent Injury

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Context: Athletes with a concussion history are more susceptible to sustaining lower extremity injuries than their non-concussed counterparts. One hypothesis is that individuals may have slower reaction time (RT) following their concussion that lingers beyond typical return-to-play. Studies have shown that traditional reaction time assessments (computerized neurocognitive testing) are not correlated with functional movement RT, and therefore may not be demanding enough to truly evaluate readiness to safely return-to-play. We hypothesized that participants with a concussion history would have slower functional RT than their healthy peers without a history of concussion, with or without a recent history of lower extremity injury (LEI) during dual-task conditions. **Methods:** This cross-sectional study was conducted in a research laboratory. Forty-one participants (51.2% female; 21.1±2.1yrs; 172.8±11.7cm; 69.8±14.6kg, 85.4% right-leg dominant) were recruited for three different groups (healthy [n=15], history of concussion [n=11], history of lower extremity injury [n=15]). In the past 1-13 months, healthy controls had no injury history, the concussion group had sustained a concussion, but no LEI; and the LEI group had sustained a time-loss LEI, but no lifetime concussions. Participants performed 16 anticipated cutting trials [8 per limb; dominant/non-dominant] with (dual-task) and without (single-task) a cognitive task (subtracting by 6's or 7's). Participants jumped off a 30cm box and performed an anticipated cut at 45 degrees to either their dominant or non-dominant side. RT was calculated as the seconds between visual stimulus and when participants' sacrum moved >3cm in the sagittal or transverse plane, whichever occurred first. Two 3 (group) x 2 (cognitive task) repeated-measures ANOVAs were used to explore RT between groups during single- and dual-task conditions on dominant and non-dominant anticipated cutting (α=0.05). **Results:** There was no significant interaction between group and cognitive condition for dominant (p=0.526) or non-dominant limbs (p=0.775). There were no significant main effects for group ($p \geq 0.973$). There were significant main effects for cognitive task between dominant ($p < 0.001$) and non-dominant ($p < 0.001$) limbs; where participants reacted more slowly during dual-task trials compared to single-task trials in all groups for both dominant and non-dominant directional cutting. Means and standard deviations are presented in the Table. **Conclusions:** Healthy young adults with a history of concussion or LEI in the past 13 months do not present with functional RT differences compared to their healthy counterparts, indicating that if functional RT deficits occur acutely post-injury, they may recover prior to one-month post-injury. There were significant differences in RT for the cognitive condition regardless of group, as is common with dual task paradigms. This RT measure should be explored acutely post-injury to explore the possibility of using a functional RT measure with and without a cognitive task to measure readiness to return to activity.

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Table. Anticipated Cutting Functional Reaction Time for All Groups

		Healthy	Concussion	Lower Extremity Injury
Dominant Direction	Single-Task	0.589 ± 0.134	0.544 ± 0.119	0.599 ± 0.136
	Dual-Task	0.695 ± 0.198	0.687 ± 0.187	0.701 ± 0.129
Non-Dominant Direction	Single-Task	0.554 ± 0.172	0.533 ± 0.138	0.563 ± 0.121
	Dual-Task	0.693 ± 0.185	0.700 ± 0.206	0.697 ± 0.100

[a] All values (mean ± standard deviation) are reported in seconds.
[b] A larger number indicates a worse (slower) reaction time.

Mapping Adolescent Athletes' Perceptions of Activity Limitations Following Sport-Related Concussion to the International Classification of Functioning, Disability, and Health

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Context: Symptoms resulting from concussion and the removal from sports participation following a concussion negatively affects physical and mental aspects of health-related quality of life (HRQOL). As such, there is an increased emphasis on exploring concussion outcomes related to HRQL and patient-centered variables. However, categorizing outcomes to established disability frameworks is limited. Our purpose was to explore patient-perceived activity limitations following concussion mapped to the International Classification of Functioning, Disability, and Health (ICF). Understanding the impact of concussion on disability domains may help align care to aspects of health most affected from the patients' perspective. **Methods:** We conducted a prospective, longitudinal study in secondary schools that included 50 patients (41 males, 5 females, 4 missing, age=14.9?3.5 years) with a medically diagnosed sport-related concussion. The Patient Specific Functional Scale (PSFS) was used to assess self-perceived limitations resulting from concussion on days 3 and 10 post-injury and return-to-play. The PSFS is a self-reported scale that asks patients to identify 3-5 activities that are impacted by the injury and instructs patients to rate the difficulty of performing those tasks on a scale of 0 (unable to perform) to 10 (no difficulty). Activities were first coded into common themes by a three-person research team for subsequent analysis. Activities were then coded and mapped to ICF domains, chapters and categories. The dependent variables were PSFS patient-response categories, ICF domains, chapters, and categories. Descriptive analyses and frequencies were reported. **Results:** Patients listed 157 individual activities that were categorized into 28 patient-response categories. All (100%) responses were mapped to the ICF with most (75%, 21/28) fitting the activities and participation (AP) domain (Table 1). Within the AP domain, most items mapped to community, social, and civic life chapters (48%, 10/21), followed by learning and applying knowledge (14%, 3/21), and mobility (14%, 3/21). The most common categories mapped within the AP chapters were recreation and leisure (48%, 10/21), applying knowledge (14%, 3/21), and school education (9.5%, 2/21). Of the 25% (7/28) fitting body structures and functions, items primarily mapped to mental functions (71.4%, 5/7) and sensory function and pain (28.6%, 2/7) chapters and to specific mental functions (42.9%, 3/7) and sleep (28.6%, 2/7) categories. **Conclusions:** Adolescents self-identified post-concussion activity restrictions that impacted their perceived health, primarily related to functional activities and social roles. These domains should be addressed by treating clinicians to ensure the patient's perspective is considered when managing the concussion. The PSFS may complement traditional impairment assessments to better ascertain what is important to each patient and to manage each injury individually.

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Table 1. Mapping of Patient Responses to the ICF components, chapters, and categories.

ICF Component	Chapters Represented	Categories Represented
Body Structures and Function	Mental functions	Sleep (b134)
	Mental functions	Specific mental functions (b140)
	Sensory functions and pain	Seeing and related functions (b210)
	Sensory functions and pain	Hearing and vestibular functions (b230)
Activities and Participation	Learning and applying knowledge	Applying knowledge (d163)
	General tasks and demands	Undertaking multiple tasks (d220)
	Communication	Using communication devices and techniques (d360)
	Mobility	Walking (d450)
	Mobility	Moving around using transportation (d475)
	Self-care	Washing oneself (d510)
	Major life areas	School education (d820)
	Community, social, and civic life	Recreation and leisure (d920)

Development of the Post-Concussion Collegiate Return-to-Learn Protocol Using a Modified Delphi Approach

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Context: Concussion research largely encompasses management strategies to return athletes to sport-specific activities, with a graduated return-to-sport protocol implemented as clinical best practice. However, there is limited empirical evidence regarding academic supports after concussion. Current return-to-learn (RTL) research primarily highlights classroom management strategies specific to primary and secondary education, which may not be feasible at the post-secondary level. Therefore, the purpose of this study was to develop a university-specific RTL protocol for students recovering from concussion using a modified Delphi approach. **Methods:** Thirty-nine individuals were invited to participate in a modified Delphi study based on the following criteria: licensed healthcare providers within the collegiate setting; academic stakeholders with experience advocating for undergraduate students and their academic support after concussion; or individuals with an established concussion research agenda. The first stage of the Delphi included a literature review that was completed from September 2020-February 2021 to provide the panel with a background on concussion management and identify gaps in the current literature regarding college-specific academic support services after concussion. During the second stage, the panel was asked to answer a series of open-ended questions regarding any modifications they would make regarding the current RTL protocol established by the 2016 Concussion in Sport Group. Qualitative analysis using a constant comparative approach was conducted using Dedoose Software resulting in 42 statements. During stage three, Delphi panelists were asked to rate each statement on a 9-point scale during the second stage of the Delphi process. Measures of central tendency of each rating were individually sent to the panelists adjacent to the group mean. During the final (fourth) stage of the Delphi process, panelists had the opportunity to review the results from stage three and modify their responses based on the group ratings. Statements that achieved a mean score >=7 were considered to have achieved consensus. **Results:** Twenty-two panelists completed the entire Delphi process across 16 institutions and/or healthcare systems (mean age=45.6+/-11.8 years; 54.5% female). The panel was comprised of eight concussion researchers, nine clinicians, and five academic stakeholders. Clinicians and researchers accumulated nearly 800 peer-reviewed, concussion-related publications, with 329 as first or senior author. Only 34 (80.9%) of the original 42 statements achieved a mean score >=7 (i.e., consensus). The final RTL protocol includes six statements in Stage 1, eight statements for Stages 2 and 3, and four statements in Stage 4. The statements developed by the panelists resulted in the Post-Concussion Collegiate RTL Protocol. **Conclusions:** This is the first study to develop consensus guidelines to support students, faculty, and staff in higher education who need additional guidance on appropriate academic supports following concussion. This protocol serves as a framework to improve communication between medical and academic stakeholders within a university infrastructure.

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Factors Associated With Return to Normal Academic Performance Post-Concussion in United States Service Academy Cadets and Midshipmen

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Context: Patterns of clinical recovery and factors that may influence return to activity following concussion have been well studied; however, data regarding time to return to normal academic performance post-concussion and factors that influence this time have not been adequately explored. The purpose of this investigation was to examine the factors associated with time to return to normal academic performance following concussion. **Methods:** A prospective cohort study was conducted with service academy cadets/midshipmen participating in the Concussion Assessment, Research, and Education (CARE) Consortium. All participants completed baseline demographics, including sex (male, female), sport level (varsity, non-varsity), and concussion history (yes, no). Those who sustained a concussion from December 2014-March 2020 underwent standardized post-concussion evaluations at regular time points, including SCAT-Symptom scores within 48-hours of injury. Information regarding participant's self-reported return to academics was collected during the unrestricted return to activity evaluation. Time to normal academic performance was defined as the number of days before the participant returned to normal academic performance. The primary outcome of interest was time to return to normal academic performance. Descriptive statistics were calculated for time to return to normal academic performance by sex. Kaplan-Meier survival estimates were calculated by initial symptom burden at the <48-hour post-injury evaluation (SCAT-Total Symptoms ≤6, 7-15, ≥16). Univariate and multivariable Cox proportional-hazards regression models controlling for site and academic year were used to estimate the association between sex, sport level, concussion history, and initial symptom burden and time to return to normal academic performance ($p<0.05$). Hazard ratios (HR) and 95% confidence intervals (95%CI) were calculated. **Results:** During the study period, 1,509 participants (41% female, 20.2±1.48y, 174.9±10.3cm, 73.8±14.0kg) sustained a concussion. On average, males (8.1±11.2 days) returned to normal academic performance approximately 6 days sooner than females (13.6±20.3 days). Kaplan-Meier survival estimates by initial symptom burden are presented in Figure 1. Univariate models demonstrated that males (HR=0.70, 95%CI=0.62-0.77, p=<0.001) and varsity athletes (HR=0.66, 95%CI=0.59-0.73, p=<0.001) returned to normal academic performance sooner than females and non-varsity athletes. Participants with an initial symptom burden ≤6 returned sooner than those endorsing 7-15 symptoms (HR=0.73, 95%CI=0.64-0.83, p=<0.001) and ≥16 symptoms (HR=0.56, 95%CI=0.48-0.65, p=<0.001). Prior concussion history was not associated with time to return to academics (p=0.934). Similarly, in the multivariable model, participants with an initial symptom burden ≤6 returned 25-41% sooner than those endorsing 7-15 symptoms (HR=0.75, 95%CI=0.65-0.86, p=<0.001) and ≥16 symptoms (HR=0.59, 95%CI=0.51-0.69, p=<0.001). Sex (HR=0.71, 95%CI=0.64-0.80, p=<0.001) and sport level (HR=0.75, 95%CI=0.67-0.85, p<0.001) also contributed to time to return in the multivariable model. **Conclusions:** Males, varsity athletes, and individuals with fewer symptoms post-injury report returning to normal academic performance sooner than females, non-varsity athletes, and individuals with a greater initial symptom burden. These factors should be considered post-concussion to create an individualized approach to return to academics.

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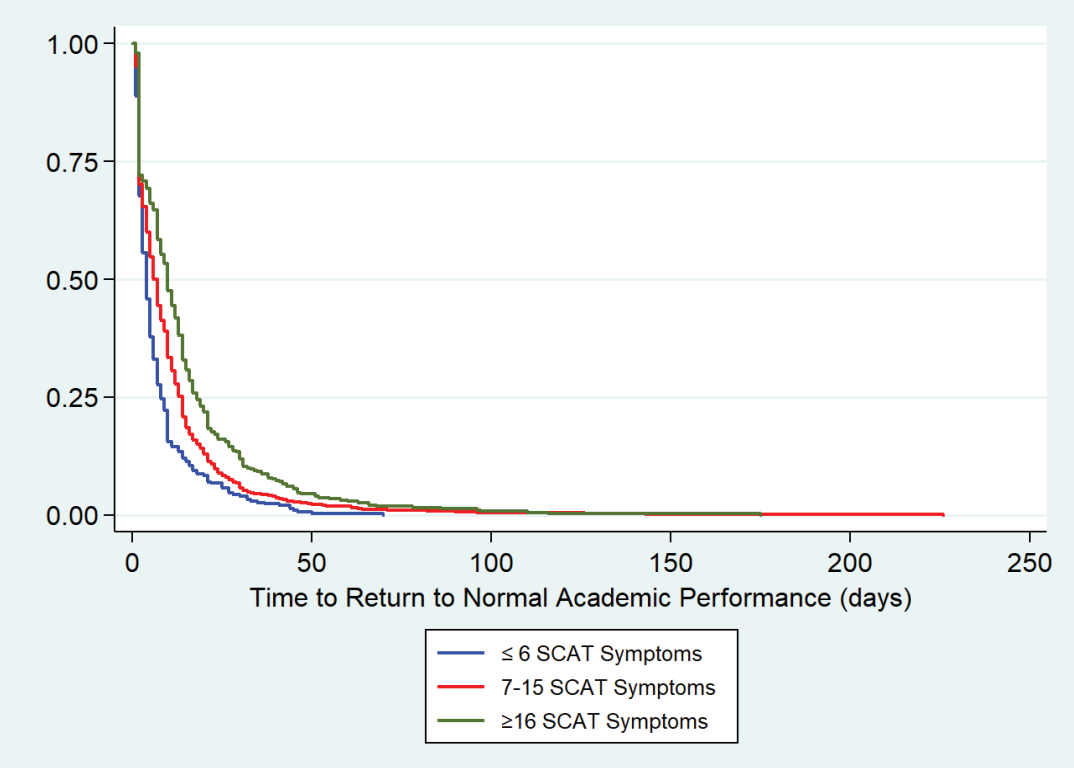
Figure 1. Kaplan-Meier Survival Estimates for return to normal academic performance by initial symptom burden



The Relationship Between Neurocognition and Single- and Dual-Task Tandem Gait Among Collegiate Student-Athletes

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Context: Computerized neurocognitive assessments (e.g., processing speed, reaction time) are associated with jump landing biomechanical outcomes such as knee abduction moments and angles. Specifically, individuals display less high-risk landing biomechanics with better neurocognitive assessments scores. However, it is unknown how neurocognition influences single- and dual-task tandem gait. The purpose of this study was to determine the association between baseline neurocognitive measures and single- and dual-task tandem gait among healthy, collegiate student-athletes. We hypothesized that neurocognitive measures would be highly associated with dual-task tandem gait performance but not with single-task tandem gait. **Methods:** We conducted a prospective cohort study of 186 student-athletes (females=52.7%, age=18.8±1.3 years, height=177.2±12.0 cm, mass=75.8±20.2 kg) during pre-season concussion baseline testing. Neurocognitive testing was completed via CNS Vital Signs with standard neurocognitive domains (composite memory, psychomotor speed, reaction time, complex attention, cognitive flexibility, processing speed, executive function) examined. Participants completed tandem gait on a 3-meter walkway requiring student-athletes to walk to one end, turn around, and walk back (6 meters) as fast as possible without error. Five single-task and five dual-task (e.g., walking while either spelling words backward, subtracting by 6s or 7s, reciting the months backward) tandem gait trials were completed, and gait time in seconds (s) was averaged for analysis. Neurocognitive domains were correlated before analysis, and highly correlated domains ($|r|\geq0.70$) were excluded from statistical models. Multivariable linear regression models ($\alpha=0.05$) were performed with neurocognitive domains as the predictor variables and single- and dual-task tandem gait time as criterion variables. **Results:** Single-task tandem gait time was not significantly associated with any neurocognitive domain ($R^2=5.0\%$, $p=0.155$; Table 1). The dual-task tandem gait time model was significant ($R^2=10.6\%$, $p=0.002$) with every 0.014ms increase in reaction time relating to a 1s increase in dual-task tandem gait time (Table 1). **Conclusions:** Slower reaction time was associated with slower tandem gait time, but only during dual-task tandem gait. Reaction time has been reported to have the predictive and prognostic potential for musculoskeletal injury and concussions, and our findings highlight the subtle connections between separate neurocognitive and motor tasks. Therefore, improving reaction time may decrease dual-task tandem gait time and reduce the risk of musculoskeletal injury. However, future research is warranted to investigate this connection with injury risk further. Additionally, the lack of association indicates dual-task tandem gait and CNS Vital Signs are assessing different facets of cognition and motor capabilities and therefore cannot be used as substitutes for one another.

None of the authors have any financial disclosures.

Table 1. Single- and Dual-Task Tandem Gait Time (s) Multivariable Regression Models

	Unstandardized Beta	95% Confidence Interval	*p-value*
Single-Task			
Composite Memory	-0.115	-0.496 to 0.266	0.552
Psychomotor Speed	-0.063	-0.174 to 0.047	0.260
Reaction Time	0.030	-0.012 to 0.072	0.161
Complex Attention	0.469	-0.193 to 1.131	0.164
Processing Speed	-0.076	-0.384 to 0.233	0.630
Executive Function	0.150	-0.326 to 0.427	0.535
Dual-Task[a]			
Composite Memory	0.102	-0.003 to 0.206	0.057
Psychomotor Speed	-0.024	-0.054 to 0.007	0.129
Reaction Time[a]	0.014[a]	0.002 to 0.025[a]	0.020[a]
Complex Attention	0.123	-0.059 to 0.305	0.185
Processing Speed	-0.076	-0.161 to 0.009	0.078
Executive Function	0.025	-0.106 to 0.156	0.708

[a] significant with $p\leq0.05$.

The Influence of Depression Symptoms on Recovery From Concussion in Collegiate Athletes

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Context: Premorbid symptoms of depression have been associated with a longer recovery time following a sport concussion (SC). Elevated symptoms of depression have also been observed following a diagnosed SC in high school and collegiate athletes. However, limited or no data has addressed symptoms of depression following a medically diagnosed SC as a potential modifier of the number of days until a collegiate athlete reports symptom free (DSF). The purpose of our study was to determine the relationship between symptoms of depression as measured by the 9-item Patient Health Questionnaire (PHQ-9) and DSF following a diagnosed SC in collegiate athletes. We hypothesized that collegiate athletes who did compared to those who did not endorse symptoms of depression would take significantly longer to report symptom free following a diagnosed SC. Additionally, we hypothesized the a moderate to strong correlation (r>0.40) would exist between the PHQ-9 composite score and DSF following their diagnosed SC. **Methods:** Participants in our prospective study consisted of 88 (55 males,33 females) Division 1 collegiate athletes who were diagnosed with a SC, who were on average age of 20.3+1.32 years old. Participants were administered the PHQ-9 within 72 hours of their diagnosed SC in a sports medicine clinic and were then divided into groups based on if they did (n=66[39 males,27 females]) or did not (n=22[16 males,6 females]) endorse symptoms of depression. Participants were then administered a daily symptom inventory (revised Head Injury Scale) until they reported symptom free. Participant age, gender, and sport were compared using independent t-tests and chi squared ($\chi 2$) analyses. Due to non-normally distributed data, a Mann-Whitney U test was used to compare days until symptom free between groups. The relationship between the PHQ-9 total score and DSF following a diagnosed SC was calculated using a spearman correlation coefficient (ρ). All analyses were performed with $\alpha = 0.05$. **Results:** Participants with or without symptoms of depression were similar in age ($t(86)=-0.46$, $p=0.65$). Groups were also similar in terms of gender ($\chi 2(1) =1.31, p=0.25$). On (median [range]), participants who did (7.50[2-176] days) compared to those who did not (4.50[1-22] days) endorse symptoms of depression took significantly longer ($z=-2.23, p=0.03$) to report symptom free following a medically diagnosed SC. A significant correlation was observed between the PHQ-9 total and DSF ($\rho =0.22$, $\rho 2=.05$, $p=.04$). **Conclusions:** The majority (75% [66/88]) of collegiate athletes who participated in our study endorsed symptoms of depression as measured by the PHQ-9 following a diagnosed SC. Our results suggest that the presence of depression-related symptoms can influence DSF from a diagnosed SC in collegiate athletes. Clinicians should consider adding a measure of depression such as the PHQ-9 to their SC assessment as it may help identify individuals at risk for a longer recovery.

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Attention Deficit Hyperactivity Disorder Does Not Influence the Recovery of Collegiate Athletes Diagnosed With a Sport Concussion

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Context: Attention deficit hyperactivity disorder (ADHD) has been identified as a risk factor for sport concussion (SC) as well as a potential modifier of recovery. However, most research related to ADHD and recovery from SC has been performed in high school rather than collegiate athletes. The purpose of our study was to compare the number of days collegiate athletes with and without the medical diagnosis of ADHD took to report symptom free following a diagnosed SC. We hypothesized that collegiate athletes with ADHD would take significantly longer than athletes without ADHD to report symptom free following a diagnosed SC. **Methods:** Our cross-sectional study consisted of 219 (89 females, 130 males) Division I collegiate athletes who were diagnosed with a (SC) by athletic trainer or physician between the 2015 and 2019 sport seasons. Participants were divided into groups based on if they reported (n=34[12 females, 22 males) or did not report (n=185[77 females, 108 males) a medical diagnosis of ADHD. Following the diagnosis of a SC, all participants completed the revised Heading Injury Scale (HIS-r) daily until symptom free. All participants made an unrestricted return-to-play following their diagnosis based on a clinical examination and a multidimensional assessment that consisted of computerized balance and neurocognitive assessments as well as the HIS-r. Independent t-tests and chi squared ($\chi 2$) analyses were used to analyze demographic data. Effect sizes were calculated using Cohen's d. Since the data were non-normally distributed, a Mann-Whitney U test was used to compare groups in terms of days until symptom free. All analyses were performed with $\alpha = 0.05$. **Results:** Groups were similar in terms of age (t(217)=-0.23, p=0.82, d=-0.04[-0.41,0.32]) and gender composition ($\chi 2(1)=0.48$,p=0.49). Athletes with ADHD had significantly (t(217)=3.04, p=0.02, d=0.61[0.24,0.98]) more previously medically diagnosed concussions (1.4+1.50) compared to athletes without ADHD (0.75+1.04). Athletes with ADHD on median took 8.5(1-62) days to report symptom free while athletes without ADHD took 8.0(1-203) days. Days until symptom free for each group are depicted in Figure 1. In terms of days until symptom free, athletes with and without ADHD had a mean rank of 108.46 and 118.37, respectively. A significant difference was not observed (z=-0.84, p=0.401) between groups for days until symptom free following a medically diagnosed SC. **Conclusions:** Our results suggest that ADHD is not a modifier of recovery from a medically diagnosed SC. A limitation of the current study was the inability to control for prior concussion history and ADHD medication due to the use of nonparametric statistics. These findings further support that clinicians should use an individualized approach when treating collegiate athletes diagnosed with a SC regardless of a premorbid diagnosis of ADHD.

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Comparison of Collegiate Athletes With and Without Attention Deficit Hyperactivity Disorder (ADHD) in Terms of Days Until Symptom Free Following a Diagnosed Sport Concussion.

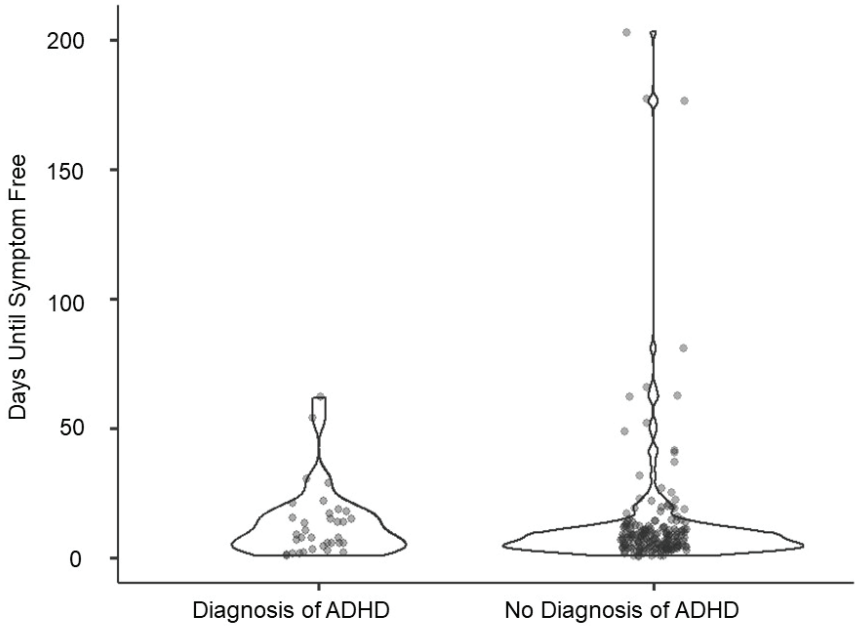

Figure 1. A comparison of days until symptom free for collegiate athletes with and without a diagnosis of ADHD.

Assessing Time To Symptom Resolution Among Collegiate Student-Athletes With Delayed Injury-Reporting Following Concussion

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Context: Evidence suggests athletes with immediate removal from activity after concussion, and those obtaining earlier specialized care demonstrate shorter recovery timelines. However, various factors may influence the immediate recognition of suspected concussion. We aim to describe the time between date of concussion occurrence and date of reported concussion in a cohort of collegiate student-athletes. We explore associations between athlete (sex, class year, contact level, athletic division, concussion history) and injury characteristics (symptoms, sport-related (SRC) vs non-SRC, activity type, season type), and time between concussion occurrence and reported concussion (injury-reporting time). We compare time to symptom resolution between student-athletes with 0 days, ≤1 week, and >1 week/ ≤1 month delays in injury-reporting time. **Methods:** Data is from a prospective cohort study and surveillance system accruing concussion cases in collegiate sports from 2013-14/2020-21. We obtained institutional review board approval and athletes consent prior to data collection. Athletic trainers document athlete and injury characteristics into the study's online database. Activity type includes competition, scrimmage, practice, skills-instruction, strength and conditioning, sport-specific unsupervised activity. Season type includes preseason, in-season, second-season, off-season-academic year, and off-season-summer. Symptom count was divided above/below the group median (10). We describe and test for associations between athlete and injury characteristics, and injury-reporting-delay with chi-square analyses and Fisher's exact tests ($p \leq .05$). We assess time from injury to symptom resolution among injury-reporting-delay groups, examining Kaplan Meier curves with Logrank test ($p \leq .05$). **Results:** The database contains 3,186 concussions to date (missing injury-reporting time: 2.7%, n=87). 64.2% (n=1,990/3,099) demonstrated zero days between injury and report; 33.7% (n=1,004/3,099) had delayed-reporting within 1-week, and 2.1% (n=65/3,099) 1-week to 1-month. There was a significant difference in reporting-time between SRC (0 days: 69.3%, n=1,822/2,630; ≤1 week: 29.1%, 764/2,630; >1 week/ ≤1 month: 1.7%, n=44/2,630) and non-SRC (0 days: 35.8%, n=/469; ≤1 week: 59.7% n=280/469; >1 week/ ≤1 month: 4.5%, 21=/469) injuries ($\chi2(2)=195.3$; $p<0.001$). There was a significant association between reporting-time and symptom count >10 ($\chi2(2)=29.6$; $p<0.001$). Among SRC, there were significant associations between injury-reporting time and athletic Division ($\chi2(2)=44.2$; $p<.001$) and activity type ($\chi2(12)=32.2$; $p<.001$). Among SRC, there was no significant differences in injury-reporting time by sex ($\chi2(2)=1.7$; $p=.426$), class year ($\chi2(8)=7.3$; $p=.507$), concussion history ($\chi2(2)=1.4$; $p=.496$), contact ($\chi2(4)=4.5$; $p=.346$), and season ($\chi2(8)=4.6$; $p=.799$). Cases with longer reporting-delays displayed overall longer time-to-symptom resolution (Figure 1; $p<0.001$). **Conclusions:** Approximately 36% of cases had at least 1 day between date of injury and date they reported their injury highlight a subset of concussions may not be reported on the day of injury in the collegiate setting. Those with reporting within 1 week and within 1 month of injury exhibited longer symptom resolution time, suggesting student-athletes with delayed injury-reporting may take longer for symptom resolution.

The Ivy League-Big Ten Epidemiology of Concussion Study is funded by the Presidents of the Ivy League and Big Ten through the Big Ten Ivy League Traumatic Brain Injury (TBI) Research Collaboration.

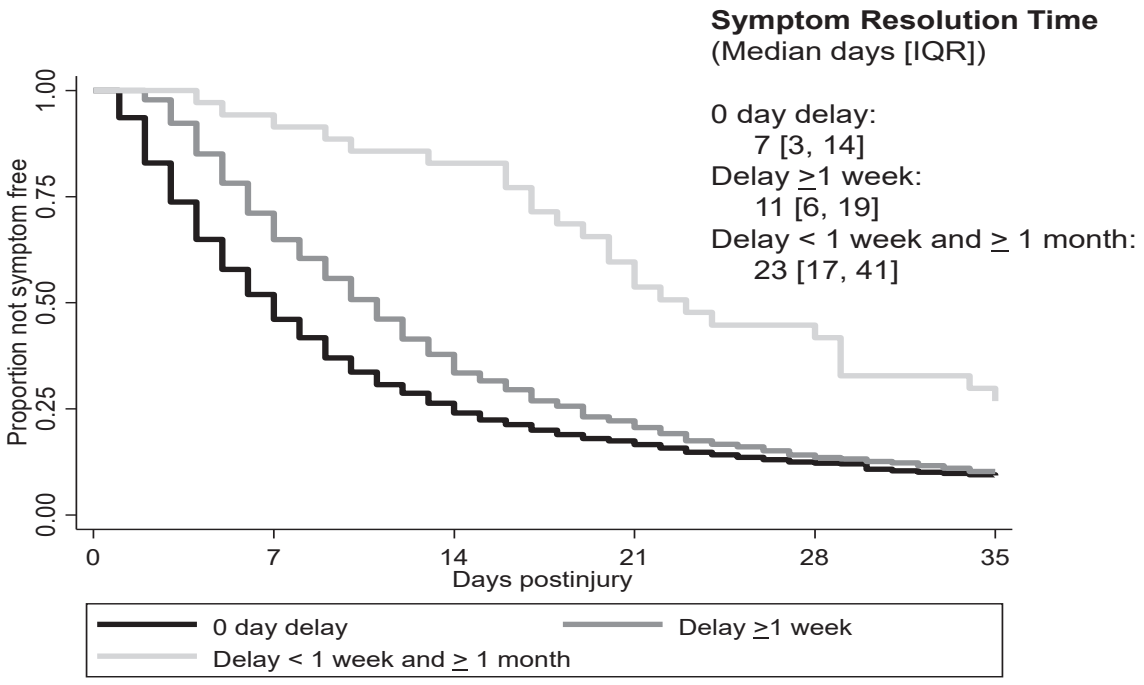

Figure 1. Kaplan Meier curve displays differences (Logrank $p < .001$) in time to symptom resolution for 0 day delay: 7 [3, 14] days, delay ≤1 week: 11 [6, 19] days, delay > 1 week and ≤ 1 month: 23 [17, 41].

Ankle Kinematics During a Drop-Vertical Jump in Patients With Chronic Ankle Instability and Healthy Controls: A Bivariate Confidence Interval Comparison

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Context: Context: Ankle kinematic differences have been identified in patients with chronic ankle instability (CAI). Previously reported findings in this population are focused on single-plane analysis. The complexity of joint-motion is multi-directional and allows for various strategies in order to accomplish movement goals. Single-dimensional analysis may not reflect the three-dimensionality of the ankle complex. A bivariate confidence interval (CI2) comparison allows for the simultaneous statistical analysis of two-dimensions which may better reflect the motions of the ankle-joint complex during a drop-vertical jump (DVJ). The purpose of this study was to assess the frontal and sagittal joint-motion of the ankle during a DVJ in patients with CAI and healthy controls using a CI2 comparison. **Methods:** Methods: This case-control study took place in a motion capture laboratory. Forty-six young active individuals with CAI and healthy controls participated. (CAI: n=23, age: 21.4±3.1, sex: 16 female, 7 male, height (cm): 169.0±8.8, weight (kg): 70.7±3.9, FAAM-ADL: 86.7±7.5, FAAM-Sport: 66.5±15.7, Control: n=23, age: 21.7±2.9, sex: 15 female, 8 male, height (cm): 165.4±12.6, weight (kg): 63.3±13.3, FAAM-ADL: 100±0.0, FAAM-Sport: 100±0.0) Kinematics were captured using a Flock of Birds (Ascension Tech., Inc., Burlington, VT) electromagnetic motion-analysis system using Motion Monitor software (Innovative Sports Training, Inc., Chicago, IL). A forceplate was used to assess ground contact during the DVJ (Bertec Corp., Columbus, OH). Fifteen jumps were performed and researchers monitored jumps for consistency. Ankle kinematics were compared from 100ms pre forceplate contact to 200ms post forceplate contact. Group means and 90% confidence intervals were compared (Herb et al, JAT, 2018). A 90% CI2 of ankle frontal and sagittal motion was then calculated and compared between groups. **Results:** Results: The univariate confidence interval analysis as previously published (Herb et al, JAT, 2018) identified greater inversion from 107ms to 200ms post contact (Mean difference: 4.01±2.55) and greater plantar-flexion from 11ms to 71ms post contact (Mean difference 5.33±2.022) The CI2 analysis identified unique difference from 6ms to 21ms and 36ms to 63ms prior to landing. During this period patients with CAI were more plantar-flexed and everted compared to controls. From 92ms to 101ms and 113ms to 122ms post contact, group differences were identified with patients with CAI having more inversion and plantarflexion. **Conclusions:** Conclusion: The CI2 analysis is a novel technique for evaluating data and may represent a useful analysis for assessing joint-motion. The multi-dimensionality of the ankle allows for various movement strategies in order to position the limb. Future research should consider the CI2 technique when analyzing data to better reflect the higher dimensionality of human movement.

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Between-Limb Differences in Sagittal Plane Gait Biomechanics Are Exacerbated During Treadmill Walking in Individuals With ACL Reconstruction

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Context: Individuals with ACL reconstruction (ACLR) walk with a stiffened gait pattern (e.g. smaller sagittal plane knee moments and angles) which heightens post-traumatic osteoarthritis (PTOA) risk. Gait biomechanics are typically assessed overground using motion capture and in-ground force plates. Instrumented treadmills offer several experimental advantages and are increasingly used to evaluate gait biomechanics. However, smaller sagittal plane knee moments are observed on treadmills compared to overground in healthy individuals, thus potentially masking an important outcome. Therefore, the purpose of this study was to compare overground and treadmill gait in individuals post-ACLR. We hypothesized that between-limb differences in sagittal plane biomechanics would be greater overground than on a treadmill and would be greater in individuals with ACLR than in healthy controls. **Methods:** This laboratory-based, cross-sectional study enrolled 24 individuals 6-12 months post-ACLR (13 women, 11 men) and 24 healthy controls (17 women, 7 men). Participants walked at their self-selected speed for 5 trials overground and for 5 minutes on an instrumented treadmill while 3-dimensional kinematics and kinetics were sampled. Peak internal knee extension moments [KEM] and knee flexion angles were averaged over the 5 overground trials and over the first 5 steps during the final 1.5 minutes on the treadmill during the first half of stance. KEM was normalized to the product of body weight and height. Limb symmetry indices (LSI) were calculated as the contralateral limb minus the ACLR limb, with 0 representing perfect symmetry. The control group's index limb was determined by a random number generator to match the number of right/left index limbs in the ACLR group. Separate Group x Condition repeated measures ANCOVAs controlling for gait speed were conducted for each outcome. Post hoc comparisons were conducted between groups and conditions for any significant interaction effects (Bonferroni-corrected alpha=0.05/4=0.0125). **Results:** There was a significant interaction effect for both peak KEM (P=0.013) and KEM-LSI (P=0.002). Post hoc evaluation revealed less symmetrical KEM-LSI on the treadmill (0.011+/-0.009) compared to overground (0.006 +/- 0.010) in the ACLR group (P=0.005). Similarly, KEM-LSI was significantly less symmetrical in the ACLR group on the treadmill compared to controls (-0.001+/-0.006; P<0.001), but not in the overground condition (0.001+/-0.005; =0.058). Differences in KEM approached significance for being smaller in the ACLR group (0.013+/-0.01) compared to controls in the treadmill condition (0.017+/-0.01; P =0.066), but not in the overground condition (0.021+/- 0.01, 0.021+/-0.01; P=0.738). There were no significant interaction effects for peak knee flexion angle (P=0.558) nor knee flexion angle LSI (P=0.095). **Conclusions:** Contrary to our hypothesis, between-limb differences in sagittal plane knee moments were exacerbated during treadmill gait, suggesting that instrumented treadmills may elucidate aberrant gait biomechanics post-ACLR that are masked overground. Additionally, individuals with ACLR ambulated on the treadmill with a gait biomechanics profile consistent with PTOA development.

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Higher Vertical Impulse Variability During Walking in Those With Chronic Ankle Instability

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Context: Sensorimotor deficits in patients with chronic ankle instability (CAI) are thought to alter the individual's gait biomechanics and subsequently the loading of the talar cartilage, a deleterious cascade of cartilaginous degeneration. Those with CAI exhibit higher vertical ground reaction force (vGRF) loading rates compared to those without CAI. However, the influence of CAI on vGRF variability remains unknown. The purpose of this investigation was to compare the variability of walking vGRF parameters between those with and without CAI. We hypothesized that those with CAI exhibit higher loading variability while walking compared to those without CAI. **Methods:** Ten individuals with CAI (age: 21.7±4.06 years, mass: 66.15±13.54 kg, height: 166.90±6.64 cm, walking speed: 1.39±0.19 m/s) and ten without CAI (age: 20.5±1.65 years, mass: 66.28±15.56 kg, height: 173.77±11.24cm, walking speed: 1.37±0.108m/s) participated. CAI inclusion criteria were in accordance with the International Ankle Consortium guidelines. All participants walked on force-measuring split-belt treadmill at a self-selected speed for two minutes. Ground reaction force data (2000Hz) from the dominant (uninjured) and involved (CAI) limb was collected during the second minute (Range: 53-73 steps). Data was filtered using a 4th order Butterworth filter with a 6Hz cutoff frequency. Time to peak was calculated as the time from initial contact to peak vGRF. Loading rate was calculated by dividing the rise in force from initial contact to the peak vGRF by time to peak. Impulse was defined as the area under the curve. Duty factor was the proportion of the stride for which the limb was in contact with the ground. A coefficient of variation (COV) was then calculated for each dependent variable to measure the relative dispersion of data points within a participant's data series around the mean. An independent t-test or a Wilcoxon signed rank tests was used to compare COV means between the groups based on data normality and an a priori alpha level of 0.05 was used to determine statistical significance. Effect sizes were calculated to confirm the hypothesis testing. **Results:** Impulse COV was significantly different between those with and without CAI (p=.001) with a large effect size of 0.82. Duty factor was also significantly different between groups (p=.03) with a large effect size of 1.05. No other groups differences were noted (p>.05). The COV data and calculated effect sizes for the dependent variables can be seen in the Table. **Conclusions:** Those with CAI exhibit a higher amount of loading variability across the entire stance phase (i.e. higher impulse COV). This higher impulse COV is likely due to higher duty factor COV (i.e. irregular duration of foot contact). Higher loading and duty factor COV suggests that those with CAI have a more unstable loading pattern while walking.

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Table. Descriptive statistics of the vertical ground reaction force variable's coefficient of variation between those with and without chronic ankle instability. CAI: chronic ankle instability, CON: control. *: Statistically significant differences between groups.

	Coefficient of Variation (%)		Analysis	*p*-value	Effect Size
	CAI (n=10)	CON (n=10)			
Peak (N)	3.31±1.09	3.27±0.65	Student's t	0.922	0.04
Time to Peak (s)	8.32±8.90	5.92±2.29	Wilcoxon signed rank	0.218	0.12
Loading Rate (N/s)	8.26±2.18	7.87±2.40	Wilcoxon signed rank	0.257	0.08
Impulse (Ns)*	5.24±5.57	2.70±2.56	Wilcoxon signed rank	0.001	0.82
Duty Factor (%)*	1.50±0.27	1.23±0.24	Student's t	0.030	1.05

Sural Nerve Reflexes During a Drop Landing Task in Subjects With and Without Chronic Ankle Instability

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Context: Chronic ankle instability (CAI) is a multifaceted condition characterized by prolonged feelings of ankle instability and episodes of "giving way" following an acute lateral ankle sprain. Research has shown that individuals with CAI demonstrate a unique modulation pattern of cutaneous reflexes during rhythmic activities like walking, but there is a paucity of research regarding the effects of CAI on cutaneous reflex amplitudes during sport specific activities like jumping. Therefore, the purpose of this study was to investigate cutaneous reflex amplitudes during a single-leg drop landing task in participants with and without CAI. **Methods:** This was a cohort study design and data were collected in a controlled laboratory setting. Sixteen physically active adults volunteered and were placed in a CAI (n=8; 3 males, 5 females, age=22.38±2.77 years, height=174.93±9.77 cm, weight = 77.1±13.32 kg), or control (n=8; 6 males, 2 females, age=19.5±2.45 years, height=174.93±9.77 cm, mean weight = 71.36±8.64 kg) group using inclusion criteria endorsed by the international ankle consortium. Each subject performed 30-40 drop landing trials, which involved planting on their test limb from a platform the height of their tibial tuberosity. The test limb for CAI subjects had the greatest number of ankle sprains and symptoms of instability, while the test limb for control subjects was matched to the CAI group by limb dominance. Muscle activity of the tibialis anterior (TA), peroneus longus (PL), medial gastrocnemius (MG) and lateral gastrocnemius (LG) was collected via surface electromyography. During random trails, subjects' ipsilateral sural nerve was stimulated at one of two different phases; 1) when they stepped off the platform (takeoff), or 2) as they contacted the ground (landing). Data from unstimulated trials were subtracted from stimulated trials to calculate a net middle latency reflex (80-120ms post-stimulation) for each muscle at each phase. Four separate two-way ANOVAs were performed to determine differences in background EMG (using unstimulated trials) between and within groups. One-sample t-tests were performed to determine significant net reflexes for each muscle at each phase. **Results:** There were no group differences in muscle activity during the unstimulated trials, however the main effect of phase showed a significant difference in TA ($p < .001$) and PL ($p < .001$) activity. For net reflex EMG, the control group had significant PL facilitation during takeoff (Mean=4.7±1.12%, p=.005) and PL inhibition during landing (Mean=-4.5±1.6%, p=.034). The CAI group had no significant net reflexes (Fig 1). **Conclusions:** CAI subjects' inability to facilitate or inhibit the PL following sural nerve stimulations during a drop landing task provides further evidence of motor-behavioral impairments in this population. Evaluating cutaneous reflexes may help to identify neural alterations within the corticospinal tract that contribute to an increased risk of recurrent ankle sprains and subjective feelings of instability.

None of the authors have any financial disclosures.

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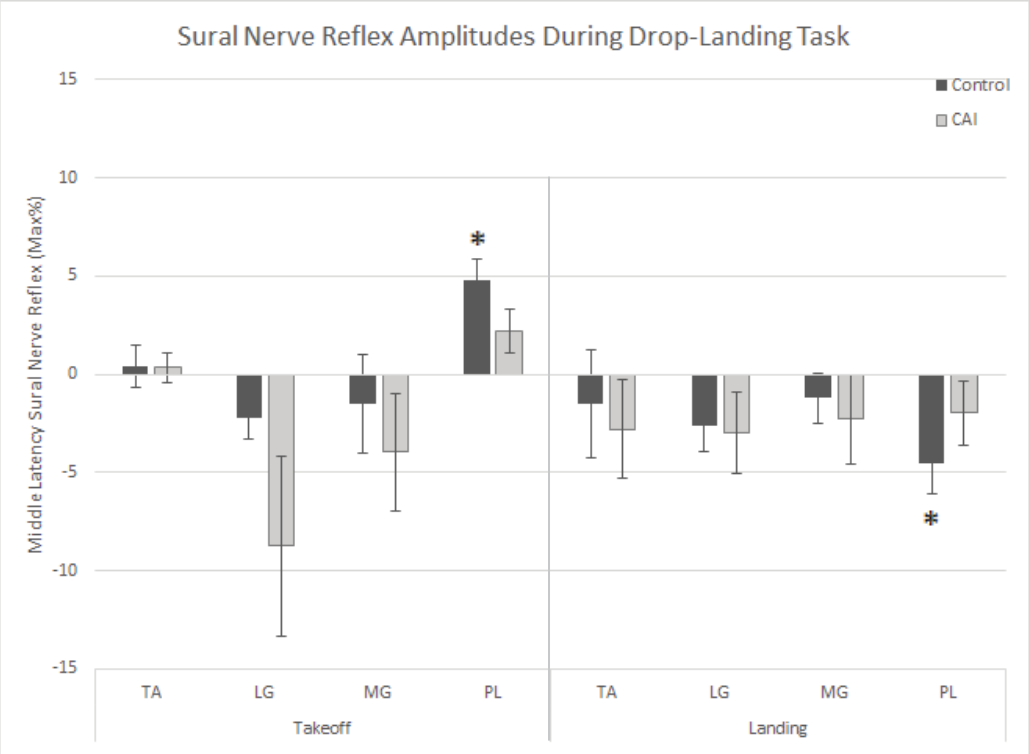

Fig. 1 Net reflex activity (%max) 80-120ms after stimulating the sural nerve at the takeoff and landing phases of a drop-landing task. An (*) above a bar denotes when the control group produced a significant net reflex from 0 ($p<.05$).

Restoration of Pre-Injury Single Leg Hop Performance Improves Patient-Reported Outcomes After Lateral Ankle Sprain

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Context: Lateral ankle sprains (LAS) are a common injury in sport often requiring removal from activity. Single leg hop tests are used to determine return-to-play (RTP) readiness based on limb symmetry, however this may not result in better patient-reported outcomes (PROs) over time relative to restoring function to baseline (pre-injury) levels. The purpose of this study was to determine if individuals who return to baseline function (restorative) have better PROs compared to individuals who return to symmetry in high school athletes who sustained a LAS. **Methods:** Prospectively, 58 high school athletes (37 males and 21 females, 15.84±1.18 years, 174.43±9.69cm, 78.81±15.30kg) who sustained a LAS were enrolled. A LAS was defined as missing at least 24-hours of participation and diagnosed by an athletic trainer. Individuals completed a single leg hop for distance (SLHOP) with three trials on each leg at pre-injury and RTP. Participants completed the Foot and Ankle Ability Measure (FAAM) at time of injury, RTP, and 6-months post RTP. Based on SLHOP data, individuals were classified into two groups, symmetry (SLHOP within 10% of the uninjured leg) or restorative (SLHOP within 10% of pre-injury levels). Athletes who were restorative and also obtained symmetry were defined as restorative. The independent variable was group (restorative and symmetry) and time (time of injury, RTP, and 6-months post RTP). The dependent variables were FAAM-ADL and FAAM-Sport. A repeated measures ANOVA was conducted for each dependent variable with the between-subjects factor group and within-subjects factor time. The interaction of group x time was the primary comparison of interest. Alpha level was set at 0.05. **Results:** Thirty-nine individuals were classified in the symmetry group (days missed 6.94±3.70 days) and 19 in the restorative group (days missed 6.73±3.74 days; p=0.84 between groups). On average, the symmetry group decreased -31.70±10.48cm on the injured limb and -23.85±6.35cm on the uninjured limb with an average limb symmetry of 96.39±4.14% at RTP. However, the restorative group on average degraded -6.51±4.35cm on the injured limb and -4.00±1.76cm on the uninjured limb with an average limb symmetry of 96.01±5.59% at RTP. The FAAM-ADL and Sport were significant for the interaction time x group (p=0.002 and p/<\0.001, respectively). Specifically, at time of injury there was no statistical difference between the two groups for the FAAM-ADL (Table 1; p/>\0.05) and FAAM-Sport (Table 1; p/>\0.05). At RTP and 6-months post RTP individuals in the restorative group scored significantly better on the FAAM-ADL and FAAM-Sport compared to the symmetry group (p/<\0.05) (Table 1). **Conclusions:** Participants who RTP within 10% of their pre-injury SLHOP performance (restorative) had significantly better PROs at RTP and 6-months post RTP when compared to the symmetry group. Clinicians may consider the benefits of restoring individuals to baseline measures, as symmetry may not ensure better outcomes.

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Table 1. Foot and Ankle Ability Measure Descriptive Statistics at Time of Injury, Return-To-Play, and 6-months post Return-to-Play

		Time of Injury	Return-to-Play	6-months post Return-to-Play
FAAM-ADL				
	Symmetry	35.21±14.33	78.44±9.81*	83.54±9.53*
	Restorative	34.16±15.48	87.16±6.34	98.42±3.24
FAAM-Sport				
	Symmetry	22.08±16.75	73.64±14.91*	66.67±6.42*
	Restorative	21.26±12.40	86.05±7.92	96.84±4.77

*Significant difference between groups at the individual time point (p<0.05).

Frontal Plane Landing Strategies Differ Between Limbs During a Cross-Over Triple Hop in ACL Reconstructed Females

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Context: The cross-over triple hop (COTH) is a commonly used functional test because it is a multi-planar task that provides the clinician insight into between-limb function following ACL reconstruction (ACLR). Females post-ACLR may demonstrate unfavorable frontal plane movement strategies during multi-planar tasks despite returning to unrestricted activity. Quantifying initial-impact phase (i.e., initial contact through 100ms) frontal plane energy absorption could help identify potential movement strategies during COTH landing consistent with elevated ACL-injury risk. However, it is unknown whether individuals post-ACLR demonstrate similar frontal plane landing strategies bilaterally during a COTH. Therefore, the purpose of this study was to compare frontal plane energy absorption strategies during the initial-impact phase of COTH landing. **Methods:** Nineteen females (19.2±1.8 years-old, 164.1±7.0 cm, 63.8±7.6 kg, time after ACLR: 20.1±9.5 months) completed three COTHs with both limbs. Kinematics and kinetics were assessed bilaterally during the first COTH landing using an optical motion capture system interfaced with a single force plate. Frontal plane energy absorption at the ankle, knee and hip was quantified by integrating the negative area under the joint power curve during the initial-impact phase of COTH landing. Total frontal plane energy absorption was quantified by summing these values across joints. Average total hop distance and total energy absorption were compared between limbs using dependent t-tests. A 2x3 repeated-measures ANOVA was used to assess potential influences of limb, lower extremity joint, and their interaction on the magnitude of energy absorption in the frontal plane ($\alpha \leq 0.05$). Bonferroni corrections were applied to post-hoc pairwise comparisons where applicable. **Results:** Participants hopped 3.2% farther with their uninvolved limb than their reconstructed limb (ACLR-involved: 1.80±0.40 body-heights, ACLR-uninvolved: 1.86±0.40 body-heights, p=0.044). The reconstructed limb absorbed more total energy in the frontal plane than the uninvolved limb (ACLR-involved: 1.85±0.71% body weight x height, ACLR-uninvolved: 1.50±0.54% body weight x height, p=0.003). We identified a significant interaction between limb and joint (p<0.001). Results from our post-hoc pairwise comparisons are displayed in Figure 1. **Conclusions:** Females post-ACLR exhibited different frontal plane landing strategies during a COTH despite being cleared for unrestricted activity. These differences are driven by the involved hip absorbing ~31% more energy than the uninvolved hip (Figure 1). Even with the uninvolved limb hopping ~3% farther, these biomechanical differences would remain undetected using the 90% limb-symmetry threshold commonly used for return-to-play. While total initial-impact phase energy absorption has been previously associated with ACL injury-related biomechanics, that was in a sagittal plane task where most of the frontal plane energy was absorbed by the knee. It is possible that these results may also impact re-injury risk in females post-ACLR, but further investigation is needed to determine whether increased frontal plane energy absorption at the hip is associated with ACL injury-related biomechanics during multi-planar tasks such as the COTH.

None of the authors have any financial disclosures.

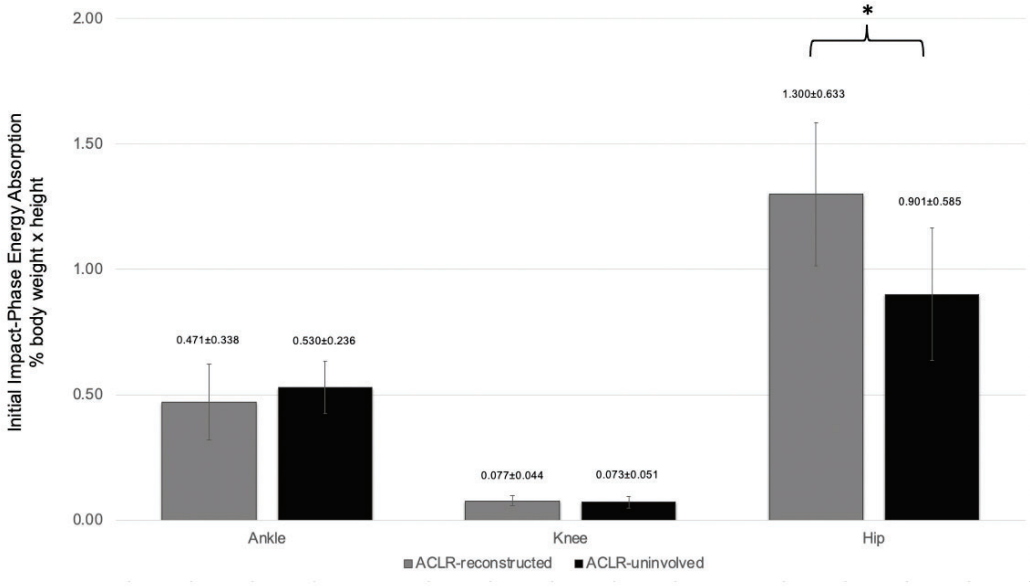

Figure 1. Bilateral comparisons of frontal plane ankle, knee and hip initial impact-phase (i.e., 0-100ms) energy absorption during the first landing of a cross-over triple hop. Regardless of limb, the hip absorbed significantly more energy than the knee and hip during the initial impact-phase of cross-over triple hop landing ($p<0.001$). Furthermore, the hip of the reconstructed limb absorbed significantly more energy than the uninvolved limb during the initial-impact phase of cross-over triple hop landing (p<0.001)*.

Changes in Quadriceps Mucle Quality Over the First Three Months Following Anterior Cruciate Ligament Reconstruction

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Context: Rehabilitation following ACLR focuses on improving quadriceps function, however, dysfunction persists for years after surgery. Most of the research and rehabilitation focus for quadriceps dysfunction target atrophy and neurological factors contributing to reduced voluntary activation. Recent data indicate these deficits may be accompanied by compositional changes in quadriceps leading to poorer muscle quality (QMQ) that further worsens function. Time course of the changes in QMQ following ACLR are poorly understood. The objective of this study was to longitudinally evaluate QMQ over 3 months following ACLR. **Methods:** This longitudinal study enrolled 20 individuals with ACLR and 12 healthy controls. Participants completed three sessions (baseline, 1-month, and 3-months). ACLR participants baseline testing's were completed after ACL injury was confirmed via MRI before surgery, and 1-, and 3-month follow-ups post-surgery. During each session, bilateral panoramic ultrasound images of the vastus lateralis (VL) and rectus femoris (RF) were obtained. QMQ was defined as the echo-intensity (EI) of the muscle image with poorer quality represented by higher values. EI in the ACLR limb were compared to a healthy control limb via 3(time) x 2 (group) repeated-measures ANOVA. The right limb was selected as the comparison limb for healthy controls and evaluated post-hoc via between-group comparisons at each time point using independent samples t-tests, and comparisons across time within the ACLR group were evaluated via paired samples t-tests. A similar method was used to evaluate interlimb EI difference; 3 (time) x 2 (limb) repeated-measures ANOVA, with post-hoc between limb comparisons evaluated at each time point via Bonferroni adjusted paired samples t-tests. **Results:** Time x group interactions were significant for RF EI ($p=0.004$) and VL EI ($p<0.001$). Post-hoc analyses indicated within the ACLR limb, RF and VL EI were significantly higher at 1 ($p=0.001$ and $p<0.001$) and 3 ($p=0.001$ and $p< 0.001$) months compared to baseline but did not differ between 1- and 3-months. EI did not differ between groups at any time point. The time x limb interactions were significant for RF EI ($p<0.001$) and VL EI ($p<0.001$) in the ACLR group. RF and VL EI were significantly higher in the ACLR limb compared to the contralateral limb at 1 ($p=0.003$ and $p<0.001$) and 3 ($p=0.002$ and $p<0.001$) months but did not differ between limbs at baseline ($p=0.784$ and $p=0.145$). Full results are in Table 1. **Conclusions:** QMQ declines immediately following ACLR compared to baseline and the contralateral limb and does not improve by 3 months post-surgery. Poor QMQ is linked to quadriceps dysfunction and potentially influences poor long-term outcomes. Future research is needed to determine the time course of QMQ changes across the entire rehabilitation period and how these changes impact long term knee joint health.

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Table 1. Average Echointensity at Each Time point [Mean (SD)]

		Rectus Femoris EI (AU)	Vastus Lateralis EI (AU)
Baseline	ACLR	89.9 (21.6)	92.7 (22.6)
	Contralateral	88.2 (17.0)	90.4 (22.7)
	Control	89.3 (20.5)	87.2 (22.4)
1 Month	ACL	97.5 (19.2)*†	102.4 (21.9)*†
	Contralateral	88.6 (14.8)	92.7 (20.4)
	Control	89.9 (21.5)	87.38 (23.69)
3 Months	ACLR	97.2 (19.5)*†	102.3 (22.1)*†
	Contralateral	88.4 (13.3)	90.8 (20.5)
	Control	88.0 (22.1)	85.0 (23.0)

*Significantly different from baseline

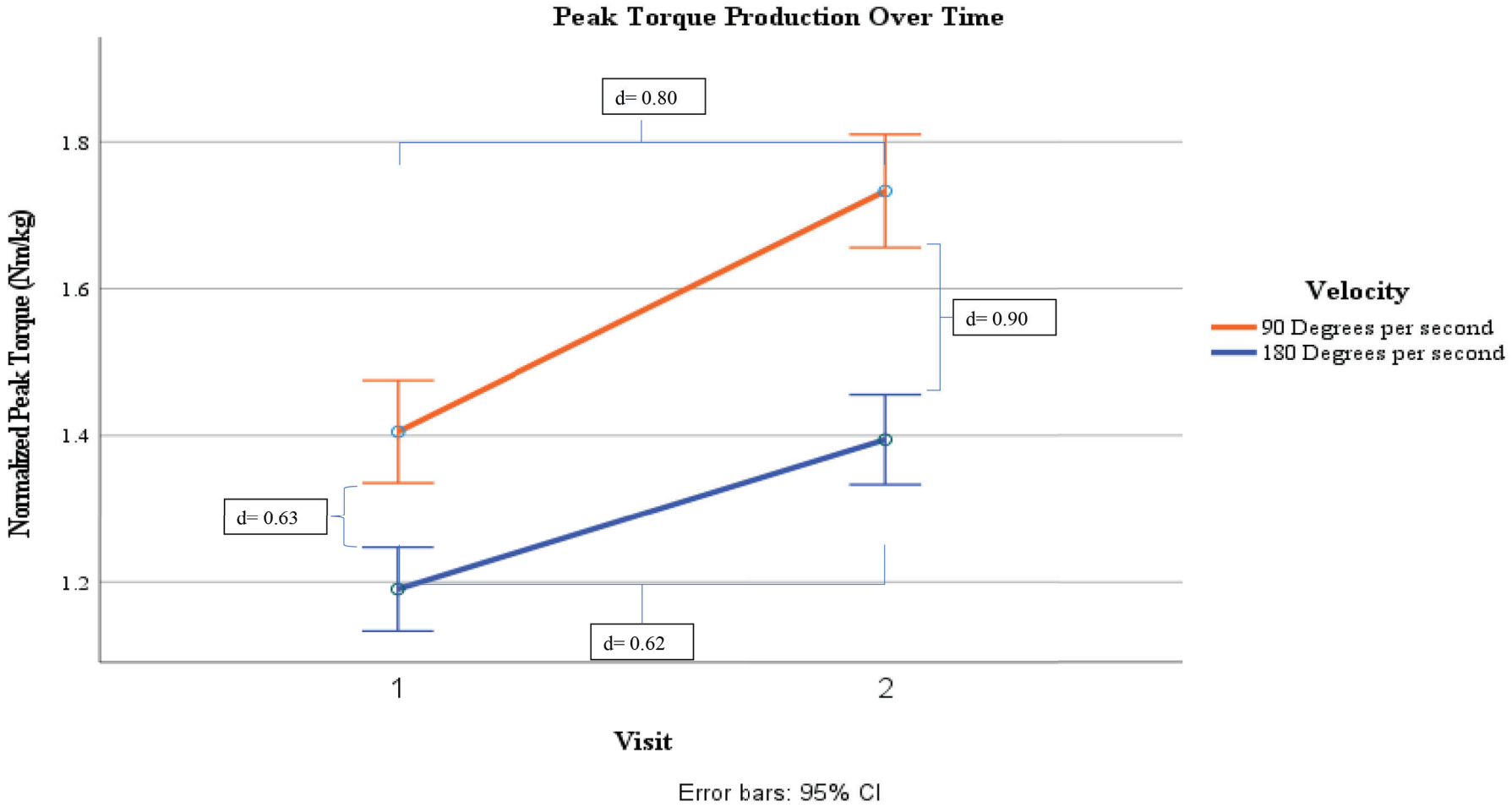
† Significantly different from Contralateral Limb

Knee Extensor Force Velocity Relationship is Altered in Patients Recovering From ACLR

Thompson XD, Bruce AS, Kaur M, Hopper HM, Hart JM: University of Virginia, Charlottesville, VA

Context: Following ACL reconstruction (ACLR) clinical decision making often relies upon strength testing to evaluate progress throughout rehabilitation. Patients often experience persistent quadriceps asymmetry that may affect outcomes. Isokinetic dynamometry is often employed to conduct strength testing, but magnitude of strength alone may not elucidate changes in muscle function over time. The force-velocity (F-V) relationship of skeletal muscle describes the inverse relationship between the velocity of muscle contraction and force production that is characteristic of normally and healthy function. The purpose of this study was to longitudinally evaluate the F-V relationship in patients recovering from ACLR. **Methods:** A total of 116 participants (52 males, 64 females) were tested twice within the first 6-months post primary, unilateral, and uncomplicated ACLR (21.3± 7.81 years, 173.6± 9.46 cm, 75.9± 17.32 kg, months post-surgery Visit 1: 5.7± 1.16, Visit 2: 8.5± 2.75). Quadriceps strength was calculated as peak knee extension torque, averaged from 8 concentric repetitions at 90˚s and 180˚s. Peak torque (PT) at each velocity was normalized to participant body mass. A 2X2 (Time x Velocity) repeated measures ANOVA was used to compare peak torque (PT) at each velocity across time points. Post hoc t-tests were performed for each velocity across time. Tests were considered significant if $p<0.05$. **Results:** There were significant main effects for time ($F(1,115) = 210.7$, $p < .001$), indicating that on average PT production increased over time, and for velocity ($F(1,115) = 399.0$, $p < .001$) indicating on average PT was higher for the slower contraction velocity. There was also a significant interaction ($F(1,115) = 56.0$, $p < .001$). At Visit 1, average PT at 90˚/s (1.41± 0.38 Nm/kg) was significantly higher than 180˚/s (1.19± 0.42 Nm/kg, $p<0.001$) and was significantly increased at visit 2(1.73± 0.31 Nm/kg, $p < .001$) Average PT at 180˚/s also significantly increased from visit 1 to visit 2 (1.39±0.33 Nm/kg, $p<0.001$) but to a lesser magnitude (180˚/s d=0.62 vs. 90˚/s d=0.80). Finally, at Visit 2, PT at 90˚/s remained higher than PT at 180˚/s ($P<0.001$) and the magnitude of the difference in PT between contraction velocities increased between visits (d=0.63 at visit 1 vs. d=0.90 at visit 2, Figure 1). **Conclusions:** Patients recovering from ACLR exhibited higher PT at both 90˚s and 180˚s. The magnitude of change in PT was not non-uniform between the 2 velocities suggesting that PT recovery was not occurring at a similar pace over the rehabilitation period following primary ACLR. This non-uniform recovery in strength across contraction velocities may be an indicator that the F-V relationship is altered as patients recover quadriceps strength following ACLR.

None of the authors have any financial disclosures.



Strength Differences in Injured and Healthy Limbs at 4 Months and 9 Months Post-ACL Reconstruction

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Context: Approximately half of all athletes who undergo ACL reconstruction (ACLR) do not return to competitive sport. Despite the popularity of ACL-related research, consensus on the optimal rehabilitation for an athlete post-ACLR has yet to be established, and protocols that do exist become less formalized during mid- and late-stages of rehabilitation. Previous literature has shown that hip and thigh musculature suffer residual deficits following ACLR, and weakness of these muscle groups may contribute to altered movement patterns and increase the risk of secondary ACL tears. Therefore, the purpose of this study was to identify strength differences between 4 months and 9-months post-ACLR in both the injured and healthy limbs of athletes who wish to return to sport. **Methods:** This was a single cohort study conducted in a research laboratory. A total of 33 participants (18 females; 19.3±3.0 years (range 15-26); 173±9.2cm; 74.2±16.7kg) with a history of primary, unilateral ACLR volunteered for this study. Subjects expressed desire to return to sport at the end of rehabilitation. Participants were tested at 4 and 9 months post-ACLR. This study utilized a handheld dynamometer on the injured and healthy limb to measure isometric force production, which was then normalized to the participant's body weight (%body weight). Muscle groups tested included the gluteus maximus, gluteus medius, quadriceps, and hamstrings. Dependent t-tests were used to compare normalized strength between month 4 and month 9 for both the injured and healthy limbs, with a Bonferroni correction by muscle group ($p < 0.025$). Effect sizes were calculated to determine the magnitude of change between groups. **Results:** Descriptive statistics, p values, and effect sizes for each variable at month 4 and month 9 are presented in Table 1. There were no statistical differences for any of the analyses ($p > 0.027$). The strength differences between month 4 and month 9 in the injured hamstring, injured quadricep, and healthy quadricep were the only groups where we found a positive effect size (0.23, 0.34, and 0.14, respectively). Negative effect sizes were observed for the injured limb's gluteus maximus (-0.50), healthy limb's gluteus maximus (-0.40), injured limb's gluteus medius (-0.29), healthy limb's gluteus medius (-0.22), and healthy limb's hamstring (-0.10), indicating a decrease in strength from month 4 to month 9 post-ACLR. **Conclusions:** Despite most participants actively participating in various forms of rehabilitation during the study period, we observed only moderate changes in lower extremity strength month 4 to month 9, even though these results were not statistically significant. Most concerning was the moderate decrease in gluteus maximus strength and the small increase in quadriceps strength. This information is critical in understanding changes in strength during mid- to late-stage rehabilitation after ACLR.

None of the authors have any financial disclosures.

Table 1. Strength Comparisons of Means for Injured and Healthy Limbs at Month 4 and Month 9 post-ACLR

	M4 mean ± SD	M9 mean ± SD	*P*	Effect Size
Injured GMax	0.52±0.19	0.40±0.23	0.027	-0.50
Healthy GMax	0.51±0.19	0.42±0.23	0.066	-0.40
Injured GMed	0.51±0.09	0.45±0.19	0.15	-0.29
Healthy GMed	0.52±0.10	0.49±0.12	0.23	-0.22
Injured Ham	0.22±0.09	0.24±0.09	0.11	0.23
Healthy Ham	0.28±0.06	0.28±0.07	0.58	-0.10
Injured Quad	0.39±0.10	0.44±0.14	0.11	0.34
Healthy Quad	0.45±0.11	0.47±0.13	0.28	0.14

Abbreviations: M4 = Month 4; M9 = Month 9; GMax = Gluteus maximus; GMed = Gluteus medius; Ham = Hamstring; Quad = Quadricep

Free Communications, Oral Presentations: What Are Our Patients Telling Us? Lower Extremity Symptoms, Psychology, and Quality of Life

Moderator: Shelby Baez, PhD, ATC

Friday, July 1, 2022; 10:20 AM-11:15 AM; Room 204BC

Chronic Ankle Instability Individuals With Pain Have Worse Health-Related Quality of Life Than Those Without Pain

Kosik KK, Hoch MC, Slone S, Bain KA, Gribble PA: University of Kentucky, Lexington, KY

Context: Patients with chronic ankle instability (CAI) routinely display lower levels of health-related quality of life (HRQL) and higher fear-avoidance beliefs than their uninjured counterparts. The increasing recognition that CAI is a multi-factorial pathology along with the importance of personalized care underscores the need for continued research to identify modifiable relationships to improve outcomes during rehabilitation. Up to 79% of patients with CAI self-report mild to moderate pain intensity levels during physical activity. This high rate of pain interference with physical activity suggests it may also negatively impact other important indicators of health status. Therefore, we aimed to examine this relationship by comparing global and dimension-specific measures of HRQL between CAI patients with and without pain. **Methods:** A secondary analysis of young-adults who volunteered to participate in prior cross-sectional studies were included. Previously established criteria by the International Ankle Consortium were followed to identify participants with CAI. Participants were classified as having painful CAI (n=24; age=22 (18-45) years; height=165.7±9.4 cm; mass=75.8±13.0 kg) if they reported any pain intensity level on the Pain subscale of the Foot and Ankle Disability Index. All other participants (n=20; age=23 (19-30) years; height=171.2±9.5 cm; mass=70.0±15.6 kg) were classified as having no ankle pain. Global HRQL was assessed using the modified Disablement in the Physically Active (mDPA) questionnaire. The mDPA is composed of two subscales: the physical summary component (PSC) and mental summary component (MSC). The 12-item mDPA-PSC examines activity limitations and participation restrictions. The 4-item mDPA-MSC evaluates emotional well-being. Each item on both subscales is a 5-point Likert scale with '0' representing completely disagree and '6' indicating completely agree. Scores for each item are combined to create a total score for each summary component, with higher scores indicating more functional limitations and decreased quality of life. Dimension-specific HRQL was evaluated using the ankle version of the Fear-Avoidance Beliefs Questionnaire (FABQ). All 16-items on the questionnaire use a 7-point Likert scale with '0' representing completely disagree and '6' indicating completely agree. The total sum of all 16-items is calculated, with greater scores indicating increased injury-related fear. Data were found to be non-normally distributed. Therefore, separate Wilcoxon sign-ranked tests were performed to assess between-group differences for all primary outcomes. Significance was set at $p<0.05$. **Results:** Participants with painful CAI reported worse physical ($p=0.014$) and mental ($p=0.006$) HRQL than those without pain. Likewise, participants with painful CAI had greater fear-avoidance beliefs than those without pain ($p=0.034$). Descriptive statistics are presented in the Table. **Conclusions:** Residual pain among participants with CAI resulted in worse global and dimension-specific HRQL than those who did not have pain. These findings suggest that unresolved pain among patients with CAI may result in worse outcomes, warranting further consideration when developing comprehensive treatment approaches.

Fellow sponsored by Phillip Gribble, PhD, ATC, FNATA.

None of the authors have any financial disclosures.

Table. Group median and interquartile ranges (25% to 75%) for all primary outcome measures.

Instrument	Subscale	Pain (n = 24)	No Pain (n = 20)
mDPA			
	Physical	15.0 (11.5 to 26.5)	10.0 (7.0 to 13.75)
	Mental	3.5 (0.0 to 7.5)	0.0 (0.0 to 1.0)
FABQ		23.0 (14.0 to 33.0)	15.0 (8.25 to 22.0)

Abbreviations: mDPA, modified Disablement in the Physically Active scale; FABQ, Fear Avoidance Beliefs Questionnaire.

Adolescents and Adults Experience Different Psychological Response to Injury Five Months After ACL Reconstruction

Kuenze C, Collins K, Walaszek MC, Genoese F, Reiche E, Triplett AN, Harkey MS, Wilcox CL, Schorfhaar A, Shingles M, Joseph S, Baez SE: Michigan State University, East Lansing, MI

Context: Emotional regulation develops during adolescence and vastly differs between adolescents and adults. Development of emotional regulation may also result in adolescents experiencing a different psychological response to injury-related trauma, such as sustaining an ACL injury and undergoing subsequent ACL reconstruction (ACLR), when compared to the response in adults. The purpose of this study was to compare psychological readiness for sport, injury-related fear, and knee-related quality of life between adolescents and adults 4-6 months after primary, unilateral ACLR. **Methods:** One hundred seventy participants (98 females, 72 males; age=18.1±2.7 years; time since surgery=5.6±0.8 months) were recruited from a university-affiliated sports medicine clinic in this cross-sectional study. Participants were included if they were 13-25 years old and had undergone primary, unilateral ACLR 4-6 months prior to recruitment. This time point post-ACLR was selected because it aligns with completion of formal outpatient rehabilitation but is prior to clearance for unrestricted activity. Psychological readiness for sport was assessed using the ACL Return to Sport after Injury (ACL-RSI) scale and injury-related fear was assessed using the Tampa Scale of Kinesiophobia (TSK-11). Participants also completed the Tegner Activity Scale to assess pre-injury activity level and the Knee injury and Osteoarthritis Outcomes Scale Quality of Life subscale (KOOS-QOL) to assess knee-related QOL. Participants were categorized as adolescent (age<18 years old; 61 females, 37 males) or adult (age≥18 years old; 36 females, 35 males). Patient-reported outcome measures were compared between groups using analysis of covariance and partial eta squared (ηp2) effect sizes. Binary logistic regression was used to calculate odds ratios and 95% confidence intervals (CI95) for the odds that an adolescent participant would report acceptable psychological readiness for sport (ACL-RSI≥62.0), injury-related fear (TSK-11<17.0), or knee-related QOL (KOOS-QOL≥62.5). Biologic sex and pre-injury activity level were covariates in all analyses. **Results:** Adolescents reported better psychological readiness for sport (adolescent=72.4±20.5; adult=62.1±23.7; p=0.01, ηp2 =0.04) when compared to adults. There were no significant differences in pre-injury activity level (adolescent=9.1±1.0; adult=8.8±1.3; p=0.06, ηp2=0.02), injury-related fear (adolescent=20.1±4.6; adult=20.6±5.0; p=0.69, ηp2 =0.00), or knee-related quality of life (adolescent=66.5±18.3; adult=60.7±17.4; p=0.05, ηp2=0.02) between age groups. Adolescents had 2.63 (CI95: 1.39, 4.99) and 2.08 (CI95: 1.12, 3.89) times greater odds of reporting acceptable psychological readiness for sport and knee-related quality of life when compared to adults, respectively (Table 1). **Conclusions:** Adolescents with ACLR reported significantly better psychological readiness for sport when compared to adults. However, less than 25% of adolescents and adults reported a level of injury-related fear consistent with reduced risk of second ACL injury (Table 1). Clinicians should include a diverse set of patient-reported outcomes that assess multiple constructs of psychological response to injury to ensure identification of adolescent and adult patients who may benefit from targeted psychological intervention.

None of the authors have any financial disclosures.

Table 1. Frequency with which adolescents and adults with ACLR meet criteria for acceptable psychological readiness for sport, injury-related fear, and knee-related quality of life.

		Meets Acceptable Criteria N (%)	Does Not Meet Acceptable Criteria N (%)	Adjusted Odds Ratio (95% CI)
ACL-RSI ≥ 62.0	Adolescent	71 (72.4%)	27 (27.6%)	2.63 (1.39, 4.99)
	Adult	36 (50.0%)	36 (50.0%)	
TSK-11 < 17.0	Adolescent	23 (23.5%)	75 (76.5%)	0.79 (0.37, 1.66)
	Adult	14 (19.4%)	58 (80.6%)	
KOOS-QOL ≥ 62.5	Adolescent	65 (66.3%)	33 (33.7%)	2.07 (1.12, 3.89)
	Adult	35 (48.6%)	37 (51.4%)	

CI: confidence interval; ACL-RSI: ACL Return to Sport after Injury scale; TSK-11: 11-item Tampa Scale of Kinesiophobia (TSK-11); KOOS-QOL: Knee injury and Osteoarthritis Outcomes Scale quality of life subscale

A Comparison of Return-to-Play Outcomes Following Anterior Cruciate Ligament Reconstruction Between Patients Tested Before and During the COVID-19 Pandemic

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Context: Once COVID-19 was declared a global pandemic, overall physical activity rates in the world decreased. ACL reconstructions (ACLR) involves an intense rehabilitation post-surgery, which may be potentially affected by the lockdown periods encouraging individuals to stay at home and the closure or limited operational hours of businesses such as physical therapy services during that period. We hypothesized that ACLR patients whose rehabilitation occurred during the pandemic would have poorer outcomes. The purpose of this study was to determine if ACLR patients who were tested during the pandemic performed differently on return-to-play (RTP) testing than those tested before the pandemic. **Methods:** This is a cross-sectional study performed in research laboratory. Four hundred twenty-six patients (203 males, 223 females, 19.7+4.8yr) who had undergone a primary unilateral ACLR were recruited from a larger University-based point-of-care study. Three hundred sixty-one patients were tested prior to the declaration of a global pandemic due to COVID-19 (Pre). Sixty-five patients were tested after the declaration (Dur). All patients performed knee extension/flexion isokinetic tests, single-leg hop for distance (SLHD) and six-meter timed-hop tests (THT). A limb symmetry index (LSI) threshold of 90% was considered passing. Patient reported outcome measures (PROMs) included Tegner Activity Rating Scale, KOOS, KOOS4 subscale, TSK-17, ACL-RSI. Pandemic group comparisons were analyzed using MANCOVA with age, sex, time of testing post-surgery, and graft type as covariates. Odds ratios (OR [95% CI]) were generated by logistic regression, using the same covariates, to determine if pandemic group influenced the pass rates. All tests were considered statistically significant if the p-value < 0.05. **Results:** The Dur group had greater knee flexion peak torque (Nm/kg) at 90°/sec (1.10 [0.25] vs. 0.96[0.27], P=0.006) and 180°/sec (0.88[0.23] vs 0.72[0.23], $P < 0.001$). The Dur group were more likely to pass the knee flexion peak torque test at 90% LSI (OR= 2.78 [1.08, 7.19, P=.035). The Dur group jumped longer in the SLHD(% height) (0.70[0.06] vs. 0.62[0.04], P=0.04). The Pre group were more likely to pass the THT (OR=4.55 [1.98, 10.47], $P < 0.001$). **Conclusions:** At approximately 6 months following ACLR, patients who completed RTP testing during the pandemic demonstrated stronger hamstring strength and longer single leg hop jumps than those tested before the pandemic. The lack of significant findings among the PROMs suggest no significant pandemic impact on physical activity, quality of life, pain related disability or psychological readiness for returning to pre-injury physical activities following ACLR. During the pandemic patients may have used the flexibility in their schedules to exercise more frequently. However, activities requiring more agility, such as team sports, were more developed among pre-pandemic patients as noted by their being more likely to pass the THT.

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Psychosocial Factors Differ Between Women With Patellofemoral Pain Who Display Central Sensitization vs. Typical Pain Regulation

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Context: PFP is a common condition characterized by persistent anterior knee pain, which is more prevalent with worse long-term outcomes for females. Central sensitization describes dysfunctional pain regulation in the central nervous system. Central sensitization is associated with negative psychosocial factors that are more prevalent in females, including pain catastrophizing, fear-avoidance, and low pain self-efficacy. One PFP study assessed relationships among these variables, but males and females were analyzed together, which may have influenced outcomes. The purpose of this study was to determine whether differences in psychosocial factors exist between females with centrally-sensitized PFP (CS), non-centrally sensitized PFP (NS) and heathy controls (CON). **Methods:** Cross-sectional Descriptive, Self-reported inventories. Thirty-three females participated in the study (20 with PFP, and 13 HC). PFP participants were grouped based on quantitative sensory testing into the CS group exhibiting ≥2 of the following: higher temporal summation of pain, lower conditioned pain modulation, and lower pressure pain thresholds compared to the CON group mean. The NS group exhibited ≤1 of these signs. Demographics for the CS (n=15), NS (n=5), and CON (n=13) are in Table 1. All participants self-reported knee function on the Knee Injury and Osteoarthritis Outcome Score (KOOS) and KOOS-Patellofemoral Subscale (KOOS-PF), and physical activity using the International Physical Activity Questionnaire (IPAQ). The CS and NS groups also reported pain intensity (100 mm Visual Analog Scale), and psychosocial factors including the fear-avoidance beliefs questionnaire, pain catastrophizing scale, pain self-efficacy questionnaire. Pain characteristics were reported on the McGill Pain Questionnaire. Due to unequal sample sizes, Welch's F tests were used for analysis when all 3 groups reported results, and Welch's t-tests were used when only the NS and CS groups data were reported. **Results:** Group differences were observed for the KOOS ($F_{2,8.621}=68.3$, $p<0.001$ and KOOS-PF ($F_{2,8.787}= 56.2$, $p<0.001$) The CS group reported worse perceived function than NS ($p=0.002$) and CON groups ($p<0.001$), while the NS and HC groups were not significantly different ($p=0.064$). The CS group reported greater pain intensity ($t_{10.40}= 5.479$, $p=0.040$), more fear-avoidance beliefs ($t_{5.993}=8.096$, $p=0.029$), higher pain catastrophizing ($t_{12.95}= 6.473$, $p=0.025$), and lower pain self-efficacy ($t_{9.54}=7.964$, $p=0.019$) than the NS group. No group differences in reported physical activity ($F_{2,10.878}=0.11$, $p=0.894$) or pain characteristics ($t_{1,11.84}= 1.51$, $p=0.242$). **Conclusions:** Signs of central sensitization indicate altered central pain processing. Our results demonstrate that females with centrally sensitized PFP exhibit higher pain and more negative psychosocial factors that those without non-centrally sensitized PFP. We cannot determine causality from our study, but further exploration is needed. Clinical interventions to restore proper pain modulation exist should be explored for PFP to improve symptoms and reduce the negative psychosocial factors.

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Table 1. Demographics & Self-Reported Data by Group (Mean ± SD)

Measure	CS Group	NS Group	CON Group	p-value
Age (y)	29.9 ± 7.4	27.2 ± 5.9	28.0 ± 7.0	0.688
Height (cm)	165.9 ± 5.5	169.2 ± 7.2	166.0 ± 9.6	0.671
Weight (kg)	64.5 ± 8.2	73.1 ± 11.6	69.3 ± 7.5	0.212
Symptom Duration (mo)	24 (5, 120)	5 (5, 68)	NR	0.168
KOOS- Overall	67.2 ± 10.1	82.6 ± 10.4	98.5 ± 1.98	<0.001
KOOS- PF	57.8 ± 14.5	84.9 ± 9.9	98.6 ± 2.7	<0.001
IPAQ (Total MET-min)	7578.9 ± 6320.9	7373.7 ± 7282.3	8591.5 ± 5970.4	0.894
Pain Catastrophizing Scale	11.8 ± 7.8	5.0 ± 4.2	NR	0.025
Fear-Avoidance Beliefs Questionnaire- Knee	26.1 ± 7.8	13.6 ± 8.8	NR	0.029
Pain Self-Efficacy Questionnaire	50.5 ± 7.3	58.6 ± 5.0	NR	0.019
McGill Pain Questionnaire (Summed Rank)	23.6 ± 11.9	18.4 ± 6.9	NR	0.242
VAS- Baseline (100mm)	20.4 ± 16.6	5.0 ± 11.2	NR	0.04

KOOS=Knee Injury and Osteoarthritis Outcome Score, KOOS-PF= KOOS-Patellofemoral Subscale, IPAQ= International Physical Activity Questionnaire, VAS=Visual Analog Scale, NR = Not Reported

Influence of Graft Site and Meniscal Involvement on Return to Sport Outcomes 6 Months After ACL Reconstruction

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Context: Prior research suggests that a concomitant meniscal injury with ACL reconstruction (ACLR) has minimal effect on muscle strength after ACLR reconstruction, however prior data was predominantly specific to hamstring grafts. Considering the influence of graft type on muscle function, the effects of meniscal involvement may be confounded. The purpose of this study was to compare the return to sport outcomes at six months after ACLR between meniscus procedures: ACLR (ACLR-only), ACLR with meniscectomy/resection (ACLR- resect), and ACLR with meniscal repair (ACLR-repair). This is the first study reporting the combined influence of meniscal involvement and graft type following an ACLR on clinical outcomes. **Methods:** This cross-sectional study included 314 participants (168 female; mean + SD age, 19.7 + 4.8) with primary unilateral ACLR (Bone patellar tendon bone graft [BPTBG] or Hamstring graft [HSG] autografts). Participants completed return to sport testing at a university research laboratory at 6.6 + 1.3 months post-surgery. Post-surgical testing included: isokinetic assessment of knee extension and flexion, single leg hop, triple hop, and 6-meter timed hop in consistent order for all participants. Patients were divided into three groups depending on meniscal procedure (ACLR- only, ACLR-Resect, ACLR-Repair). As part of the standardized testing, peak knee extension/flexion torque tests at 90°/sec were measured and normalized to body weight (Nm/kg). For the single hop tests the average of the 3 successful maximal effort trials were normalized to body height to provide a unit-less measure. For each graft type, MANCOVAs compared differences between meniscal procedures. Logistic regression assessed the influence of meniscal procedure on tests' pass rates defined as 90% of limb symmetry index (90% LSI). Age, sex, time of testing post-surgery were covariates. Results were considered statistically significant if the p-value was 0.05 or less. **Results:** BPTBG: ACLR-only had greater hamstring strength than ACLR-Repair (1.08 + 0.39 vs. 0.97 + 0.38, P=0.02). ACLR-only were more likely to pass the hamstring strength test than ACLR-Resect (OR [95% CI]) (2.52 [1.32, 4.82], P=0.01) and ACLR-Repair (2.29 [1.07, 4.90], P=0.01). HSG: No significant differences between meniscal groups. **Conclusions:** This study revealed that the influence of meniscal repair on clinical outcomes is dependent on the graft choice. Patients who underwent ACLR with BPTB and meniscal repair demonstrated decreased knee flexion peak torque compared to those with ACLR-only. Furthermore, patients who had a meniscectomy/resection or meniscal repair were at a lower odds of achieving an LSI > 90% for knee flexion peak torque compared to ACLR-only. Although recovery of the quadriceps strength does not appear to be significantly influenced by the addition of a meniscal procedure to ACLR, rehabilitation following ACLR with BPTB and a meniscal procedure should emphasize hamstring function to optimize full recovery.

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The Relationship Between Pain Catastrophizing and Reaction Time in Individuals With ACL Reconstruction

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Context: Psychological impairments after ACL reconstruction (ACLR) may negatively influence sensorimotor processes, such as reaction time (RT), and consequently increase the risk of secondary ACL injury. Pain catastrophizing (PC), a psychological response experienced after ACLR, is a negative cognitive–affective response associated with greater pain intensity, poor rehabilitative outcomes, and decreased quality of life in individuals with ACLR. Examination of critical outcomes that may be related to PC, such as RT, is vital. The purpose of this study was to examine the relationship between PC and RT in individuals with ACLR. We hypothesized that individuals with greater PC would demonstrate slower RT. **Methods:** The relationship between PC and RT was examined using a cross-sectional study design. Eleven participants (8 females; age= 22.2±4.7years) with history of primary, unilateral ACLR at least 9-months post-surgery (28±17months) were included. Participants completed the Pain Catastrophizing Scale (PCS). The PCS is a questionnaire designed to measure an individual's perceptions of their pain experience (i.e., score range = 0-52, higher scores indicate greater PC). RT was measured via a lower-extremity visuomotor RT task (LEVMRT) and a simple RT task (SRT). LEVMRT was measured using the FitLight TrainerTM (FitLight Sports Corp.) which consists of a series of wireless light discs. Participants responded to randomly generated visual stimuli and deactivated a series of 5 systematically arranged discs by tapping the illuminated disc with their foot. Assessment was completed bilaterally and average time between hits was used to measure LEVMRT. SRT was assessed with the Senaptec Sensory Station (Senaptec Inc.), a computer-based sensory assessment. Participants were required to remove their hands from a tablet as quickly as possible in response to a stimulus. The average time taken to respond to the stimulus was used to measure SRT. Higher RT scores (ms) indicated slower / worse RT. Spearman's Rho correlations were used to characterize the association between PCS score, LEVRMT, and SRT. Correlations were interpreted as follows: 0.00 to 0.19 = very weak, 0.20 to 0.39 = weak, 0.40 to 0.59 = moderate, 0.60 to 0.79 = strong, 0.80 to 1.0 = very strong. Alpha was set a priori $P < .05$. **Results:** Median [IQR] were as follows: PCS=14[19], injured limb LEVMRT= .528[.132], uninjured limb LEVMRT= .497[.142], and SRT= .335[.44]. We identified a moderate positive correlation between PCS scores and injured limb LEVMRT (r=0.53, p=0.09), uninjured limb LEVMRT (0.48, p=0.17) and SRT(r=0.47,p=0.14), however these correlations were not statistically significant. **Conclusions:** Individuals with ACLR who exhibited greater PC demonstrated slower LEVMRT and SRT. Through psychologically informed clinical practice, PC may be assessed and addressed throughout the rehabilitation process to potentially improve RT and help mitigate the risk of secondary ACL injury. Future research should explore interventions to address PC to improve RT throughout the ACL rehabilitation process.

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Perceived Instability, Pain, and Psychological Factors Predict Function and Disability in Individuals With Chronic Ankle Instability

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Context: Chronic ankle instability (CAI) is associated with residual instability, pain, decreased function, and increased disablement. Injury-related fear has been associated with CAI, although its relationship to other impairments is unclear. The Fear-Avoidance Model is a theoretical framework hypothesizing a relationship between injury-related fear, chronic pain, pain catastrophizing, and disability. It has been useful in understanding fear's influence in other musculoskeletal conditions but has yet to be studied in those with CAI. Therefore, our objective was to explore relationships between instability, pain catastrophizing, injury-related fear, pain, ankle function, and global disability in individuals with CAI. **Methods:** We used a cross-sectional, anonymous, survey design. A total of 259 people, recruited via e-mail and social media, with a history of ankle sprain completed the survey; of those, 126 participants (age = 32.69±4.38, female = 84.92%, highly active = 73.81%) were identified by the International Ankle Consortium guidelines to have CAI and were included in the analysis resulting in an 82.5% completion rate. The Qualtrics survey included informed consent, a demographic section (gender identity, age, and physical activity level), specific questions and tools to determine the classification of CAI, and the patient-related outcome assessments used as primary outcomes. Specifically, primary outcomes included the Identification of Functional Ankle Instability (instability), the Pain Catastrophizing Scale (pain catastrophizing), the Tampa Scale of Kinesiophobia-11 (injury-related fear), the Quick-FAAM (ankle function), and the modified Disablement in the Physically Active Scale (disability). Pain presence was a binary outcome determined by using both a numeric pain rating scale (> 0 = pain presence) and an activity-based pain question from the Cumberland Ankle Instability Instrument (pain during any level of physical activity = pain presence). All patient-related outcome assessments have established validity and reliability levels, no additional validation was completed for our survey. Relationships between variables were explored through correlation and regression analyses. **Results:** After controlling for instability and pain, pain catastrophizing and injury-related fear were significantly related to function and disability ratings in individuals with CAI. Each variable uniquely contributed to the model and together, they predicted 48.7% ($P < .001$) variance in function and 44.2% ($P < .001$) variance in disability. **Conclusions:** Greater instability, pain, greater pain catastrophizing, and greater injury-related fear were predictive of decreased function and greater disability in those with CAI, supporting the importance of these variables when examining and treating an individual after ankle sprain(s). Our results are consistent with the hypothesized relationships in the Fear-Avoidance Model, although further investigations are needed to determine causality of these factors in the transition to CAI and how these variables may relate to other known impairments within these populations. Further, exploration of intervention strategies for reducing pain and injury-related fear is warranted as this may assist in improving function and disability.

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The Majority of Individuals Meet Criteria for Early Knee Osteoarthritis Symptoms Throughout the First Two Years Post-ACL Reconstruction

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Context: One-third of patients present with radiographic knee osteoarthritis (OA) within a decade after ACL reconstruction (ACLR). However, prior to the development of radiographic OA, patient-reported outcome measures (e.g., Knee Injury and OA Outcomes Score [KOOS]) can detect knee symptoms that indicate early OA. It is unclear how many patients have early OA symptoms during various phases of rehabilitation post-ACLR, but chronic pain is often defined as persistent symptoms for at least 3 months post-surgery. Therefore, the purpose of this study was to determine the prevalence of early OA symptoms during various phases of recovery starting at three months post-surgery up to two years post-ACLR (i.e., 3-5, 6-8, 9-12, 13-24 months). We hypothesized that there would be a significantly larger prevalence of participants meeting the early OA symptom criteria in the early recovery phase (3-5 months) compared to the prevalence in the later phases of post-ACLR recovery. **Methods:** Two hundred twenty-nine participants (124 females; age=19.5±4.6 years) were recruited in an ongoing longitudinal cohort study if they were between 13 and 35 years of age and had undergone primary, unilateral ACLR. For this cross-sectional study, we included the latest time-point post-ACLR for each participant. Presence of early OA symptoms was operationally defined based on the classification criteria validated by Luyten et al (i.e., scoring ≤ 85% on at least 2 of the KOOS Symptoms, Pain, Quality of Life, or Activities of Daily Living subscales). Participants were separated into groups based the time-period post-ACLR: 3-5, 6-8, 9-12, and 13-24 months. We used a Chi Square analysis to determine if there was a difference in the prevalence of early OA symptoms (dependent variable) between the time-periods post-ACLR (independent variable) ($\alpha < 0.05$). **Results:** Table 1 includes the demographics and prevalence of early OA symptoms for participants at each time-period post-ACLR. The highest prevalence of participants had early OA symptoms at 3-5 months (77%) followed by the prevalence at 6-8 months (74%), 9-12 months (62%), and 13-24 months (60%). However, there was no statistically significant difference in the prevalence of early OA symptoms between time-periods post-ACLR [X2=4.95, p=0.18; Table 1]. **Conclusions:** A majority of participants met classification criteria for early OA symptoms at multiple time-periods throughout the entire first two years post-ACLR. While the high prevalence at 3-5 months is often considered unresolved post-operative knee symptoms, it is concerning that significant knee symptoms are persisting up to two years post-ACLR in almost 2 out of 3 people. Instead of conceptualizing OA as an incident event that develops over time after an ACLR, perhaps OA development is due to chronic symptoms that remain unresolved following the initial surgery. Future research should identify interventions to treat the cause of symptoms to prevent persistent symptoms and help maintain long-term joint health.

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Table. Demographics and Prevalence of Early OA Symptoms During the First Two Years Post-ACLR.

Time Post-ACLR	Early OA Symptoms* [n (%)]		Sex	Age (years)	Height (cm)	Weight (kg)
	Absent	*Presence*	n(%) female	mean±SD	mean±SD	mean±SD
3-5 months	14 (23%)	47 (77%)	32 (52%)	19.0±4.1	173.0±9.2	72.8±16.3
6-8 months	24 (26%)	69 (74%)	50 (54%)	19.3±4.3	172.9±9.6	77.8±21.3
9-12 months	19 (38%)	31 (62%)	29 (58%)	19.2±4.9	173.6±11.3	75.6±21.0
13-24 months	10 (40%)	15 (60%)	13 (52%)	21.7±5.9	175.0±8.2	80.1±18.5
Total	67 (29%)	162 (71%)	124 (54%)	19.5±4.6	173.3±9.7	76.2±19.8

OA = osteoarthritis; ACLR = anterior cruciate ligament reconstruction; % = percentage; n = sample size; cm = centimeters; kg = kilograms; *Early OA symptoms is operationally defined using the Luyten et al. classification criteria = scoring ≤85% on at least 2 of the Knee Injury and OA Outcomes Score subscales: Symptoms, Pain, Quality of Life, or Activities of Daily Living.

Group G Streptococcal Infection in the Tibiofemoral Joint of a Collegiate Football Player

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Background: A 19-year-old male collegiate football player presented with idiopathic joint effusion in his left knee. Past history included a patellar fracture one year prior that required surgical excision. The patient could not recall a mechanism of injury, but complained of lack of range of motion with knee flexion and extension, particularly when walking up and down stairs. There was no ecchymosis, broken skin, or other noticeable deformity of the knee. All knee special tests were negative, and there was no point tenderness to indicate an orthopedic injury. **Differential Diagnosis:** Reaggravation of surgical site, lateral meniscus tear, damage to articular cartilage. **Intervention & Treatment:** Day 5, the patient was referred to the team orthopedic surgeon during weekly clinical visits, where he was diagnosed with a possible meniscus tear. The patient's knee was drained in an attempt to alleviate pressure, at which point it was found that his intra-articular fluid was purulent and bloody. The patient was then referred to the emergency department at the local hospital with the new working diagnosis of a staphylococcal, streptococcal, or gonococcal infection. Initial blood work revealed a white blood cell count of 70,000. The patient underwent emergency arthroscopic debridement and irrigation. The patient was held in the hospital for observation and placed on intravenous vancomycin along with hydromorphone to control pain. Day 7, the patient underwent a second arthroscopic irrigation and debridement to remove any other infected or necrotized tissues. Day 8, growth in cultures taken from the patient's knee revealed a group G streptococcal infection. Day 10, the patient was released from the hospital and prescribed oral antibiotics. Follow up blood work three months post hospitalization showed the patient's white blood cell count had returned to normal, and there were no further signs of infection. Patient was able to return to full participation upon the beginning of the spring semester, and competed fully in spring football with only mild knee pain. **Uniqueness:** Most infections of joints are accompanied by an obvious entry site through which the infectious agent can enter the patient's body. In the patient's case, there were no open wounds at the site of infection that might have provided an entry point for the group G streptococcal bacteria. Group G streptococcal bacteria typically infect animals, and when there is a case of a human being infected the presentation is typically as an upper respiratory infection. Additionally, the initial presentation of the infection was obscured by the patient's previous injury and surgery history. **Conclusions:** It is important for healthcare professionals to be cognizant of signs of infection, even when evaluating conditions that appear to be orthopedic in nature. Follow up evaluation of symptoms with musculoskeletal injuries is paramount in recognizing infection early on. In this case, early diagnosis was crucial to providing the patient with proper treatment and a favorable outcome.

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Reduced Ejection Fraction in a Collegiate Basketball Player Following COVID-19

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Background: An otherwise healthy 19-year-old male collegiate basketball player reported for preparticipation physical examinations following having suffered from COVID-19 two months earlier. The patient's symptoms from COVID-19 included: fever, chills, body aches, shortness of breath, sore throat and cough. Within two weeks of onset, all symptoms had resolved. While ill, the patient treated his symptoms with rest, hydration, and acetaminophen. Upon discussing his illness with the team physician, and referring to the NCAA recommended cardiac algorithm, the decision was made to obtain an electrocardiogram. **Differential Diagnosis:** Previous symptomatic infection with COVID-19 warranting cardiac evaluation. **Intervention & Treatment:** Upon further evaluation, it was found that the patient had an abnormal electrocardiogram. This abnormality led to the patient being referred to a cardiologist within system for an echocardiogram and further evaluation. One week after receiving the results of the electrocardiogram, the patient underwent an echocardiogram and bloodwork. The echocardiogram revealed an mild asymmetric septal hypertrophy ejection fraction of 40-45%. After reviewing the results with two other cardiologists to confirm this finding, the decision was made to perform a followup evaluation two months later. During this two-month period, the patient was restricted from any physical activity that elevated his heart rate. At his two-month follow up, which was 12 weeks after his onset of symptoms with COVID-19, the patient completed a stress echocardiogram that revealed his ejection fraction had improved to 50%. In conjunction with the cardiologist, the team physician released the patient to begin a gradual return to participation protocol provided cardiac symptoms did not present. Over the next two weeks, the patient participated in conditioning, weightlifting, and sport specific activities with increasing frequency, volume, and intensity. After the two week reconditioning period, the patient was fully cleared to return to team activities with no further complications. **Uniqueness:** While cardiac complications have been reported with COVID-19 infections, previous studies have described post-COVID cardiac issues in competitive athletes in 3.3-19% of cases. Therefore, this patient's case was novel due to the presentation of cardiac issues following infection. **Conclusions:** When treating patients for viral diseases like COVID-19, it is paramount to understand the impact the disease has on the entire body. As healthcare practitioners treating a highly active population, sports medicine professionals need to strictly follow the cardiac algorithm their practice has chosen to determine the need for cardiac evaluation after a patient recovers from COVID-19. When a patient does develop cardiac issues following COVID-19, it is crucial to incorporate a multidisciplinary team to returning the patient to physical activity that includes the athletic trainer, team physician, and a cardiologist.

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Upper Extremity Deep Vein Thrombosis in a High School Male Football Player

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Background: An 18-year-old senior football player in overall good health with no preexisting conditions complained of tightness and swelling in his right arm on day one of preseason. During observation of the patient, he had some edema as well as cyanosis in his right arm. When performing capillary refill, his arm remained white for a prolonged amount of time, indicating poor blood circulation to the extremity. The athlete reported no pain, but lacked active range of motion in shoulder adduction, elbow flexion/extension, and wrist flexion/extension. He noticed these symptoms after his strength and conditioning lift three days prior. During the lift, he performed repetitive hang cleans with a kettlebell, which is when he began to feel some tightness. He thought he was experiencing normal soreness because of his workout. Due to the circumstances, the first impression was that the patient had either rhabdomyolysis or compartment syndrome, both medical emergencies. The patient's family was called and he was immediately transported to the hospital. Upon further examination, the physician's diagnosis was an upper extremity deep vein thrombosis in his subclavian vein. **Differential Diagnosis:** Rhabdomyolysis, Compartment Syndrome **Intervention & Treatment:** The patient had a thrombolysis where medication was injected into the vein through a catheter to break down the clot. He was started on a blood thinner called Xarelto DVT-PE. He took a 15 mg tablet by mouth twice a day for three weeks. He was then moved to a 20 mg tablet once a day for one week. Once this cycle of medication was finished, he was placed on a regimen of baby aspirin for four days. Upon completion, the athlete had to take two days off from any blood thinning medication and was then cleared to play football with no restrictions. If the clot returned, doctors will consider removal of the first rib to allow for more room in the thoracic outlet. **Uniqueness:** With this condition, the patient did not present with an extreme amount of pain. This will often cause health care providers to misdiagnose their patient. This syndrome is unique because most of the time it occurs in an overall healthy individual who performs any type of weightlifting as a part of a daily regimen. **Conclusions:** Effort-induced thrombosis of the subclavian vein or axillary vein is due to repetitive use of the upper limbs. Although this diagnosis is not very well known, it should be considered in any unexplained subclavian or axillary vein thrombosis. Once one understands the anatomy of the structures of the thoracic outlet and the venous system it is easier to understand how this could happen. Any change in anatomy can cause compression of the vein. For example, when the arm abducts, the subclavian vein is compressed between the clavicle and the first rib. This mechanism will contribute to venous compression and possibly an injury to the area. Signs and symptoms could include vague shoulder or neck discomfort, arm edema, supraclavicular fullness, a palpable cord, extremity cyanosis, and dilated cutaneous veins. The patient should be placed on a return to play protocol once they are off their blood thinners. This is when it becomes the athletic trainer's job to make sure they are returning in a timely manner. The athlete should be instructed to stop any activities in the return to play protocol that result in a return of symptoms, signs, blood loss, or bruising. When a patient presents non-specific symptoms, such as an enlarged arm with little or no range of motion, but yet no pain, athletic trainers should consider the possibility of a blood clot. Finding this diagnosis early can save a patient's life.

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A Qualitative Report of the Perceptions of COVID-19 Pandemic From Collegiate Student-Athletes

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Context: Coronavirus Disease 2019 (COVID-19) is a novel virus that caused a global pandemic. College students, specifically student-athletes, faced an abrupt disruption in access to services and personnel for both academics and athletics in the spring and summer of 2020. It is important to recognize these experiences in order to provide optimal care and support for both current and future student-athletes who may face similar situations. Therefore, the purpose of this study was to describe the lived experiences of collegiate student-athletes following the unprecedented COVID-19 pandemic in terms of academic changes and sport participation concerns. **Methods:** We utilized a phenomenological approach to interview eighteen collegiate student-athletes (7 males, 11 females; mean age=20±1 years). Participants were from NCAA Division I (n=12), Division II (n=1), Division III (n=1), and NAIA schools (n=4) across the United States. Participants were recruited via purposive sampling, in which an interest letter was sent out to faculty members and athletic trainers at different colleges and universities across the United States. These individuals then recruited student-athletes from their respective schools to participate. The participants were interviewed using a semi-structured interview protocol. The interviews were audio recorded and transcribed verbatim using Zoom. The data were analyzed by a 3-person coding team via the consensual qualitative research tradition. Using a multi-phased approach, the data analysis team created a consensus codebook including domains and categories identified from each of the transcripts. Credibility and trustworthiness were established through member checking, researcher triangulation, and external auditing. **Results:** Four domains emerged after data analysis: 1) ambiguity, 2) perspective, 3) bonding and cohesion, and 4) resource utilization. Participants discussed ambiguity in terms of athletic eligibility and participation questions arising due to the pandemic, academic changes that led to uncertainty in their daily life, and constantly changing COVID-19 policies, such as vague testing and quarantining requirements and concerns with the general student body mixing in with the student-athlete population. Participants shared some of their perspectives related to the pandemic as apprehensive and disappointed, particularly at the onset of the pandemic. Student-athletes also expressed a feeling that "COVID-19 is real" when they realized the seriousness of the situation. The participants later described their perspectives as changing in regard to motivation levels and policy adherence such as wearing masks and following daily safety guidelines. Despite the apprehension, most student-athletes felt safe and excited when they returned to campus and sport. The participants shared how bonding and cohesion were affected due to a lack of socialization from isolation guidelines and team development changes after being away from school. However, support system dynamics between family, coaches, and teammates were strengthened due to COVID-19. When describing resource utilization, participants discussed the use of personnel (e.g., coaches and athletic trainers) and supplies (e.g., training regimens and rehabilitation programs). Most participants felt that changes in facility and space availability forced them to adjust their workout schedule and dietary preferences. Lastly, participants described the identification and utilization of resources which enabled them to establish a "new normal" for their academics, workouts, and hobbies during the pandemic. **Conclusions:** The collegiate student-athletes responded in various ways to the constantly changing guidelines related to the COVID-19 pandemic. They utilized various resources to keep a positive attitude towards the "new normal" of the 2020 sports year. At the same time, the student-athletes also reported struggling with these changes and the effects that they had on their daily lives, with some perceiving a more negative impact than others. Athletic trainers should know these effects in order to provide the best care to their student-athletes who continue to live and compete during the pandemic.

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IGF-I, Vitamin D and C-Reactive Protein Biomarkers Related to Current Musculoskeletal Conditions

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Context: Musculoskeletal injuries are one of the most common reasons for attrition during military training. Emerging evidence suggests biomarkers including serum Insulin-like growth factor-I (IGF-I), vitamin D (25(OH)D) and high-sensitivity C-reactive protein (hsCRP) may be related to musculoskeletal injuries in the military. The purpose of this abstract is to explore whether IGF-I, 25(OH)D and hsCRP are related to current self-reported pain and/or musculoskeletal injury in military officers beginning a secondary training course. **Methods:** Data were collected as part of a larger cohort study involving male (N=398, Age=24.9±2.9) and female (N=72, Age=25.1±3.2) military officers entering secondary training. Current pain and musculoskeletal injury were assessed using a self-reported questionnaire. For analysis, responses were combined to indicate presence or absence of a musculoskeletal condition (MSK). Serum samples acquired upon entry to training were analyzed for IGF-I, 25(OH)D and hsCRP by Quest Diagnostics (Baltimore, MD). Biomarker levels were stratified into tertiles for analysis. One-way ANOVA and t-tests were used to compare biomarker values by sex, season training commenced (Summer, Fall, Winter, Spring) and race. Logistic regressions with odds ratios and 95% confidence intervals were used to investigate relationships between current self-reported MSK and levels of IGF-I, 25(OH)D and hsCRP controlling for age, race and seasonality. **Results:** 12.1% (48/398) of males and 19.4% (14/72) of females self-reported a current MSK. On average, biomarker levels were within reference ranges, however, mean 25(OH)D levels (33.0±8.8 ng/mL) approached lower limits (30 ng/mL). Approximately one in three (36.8%, 173/470) reported to training with suboptimal 25(OH)D levels (<30 ng/mL). Significant differences in 25(OH)D levels by training seasons ($F(3,466)=23.8$, $p<0.001$) and by race ($F(4,465)=9.1$, $p<0.001$) were identified. 25(OH)D levels were lower in winter (30.6±6.5 ng/mL, $p<0.001$) and spring (30.8±8.8 ng/mL, $p<0.001$) compared to summer (37.7±8.8). 25(OH)D levels were significantly lower in African Americans (26.3±8.5 ng/mL, $p<0.001$) and Hispanics (28.8±8.1 ng/mL, $p=0.002$) compared to Caucasians (34.0±8.7). Similar findings were indicated with IGF-I, which was significantly greater in African Americans (168.7±45.6 ng/mL, $p=0.02$) and Hispanics (170.1±46.3 ng/mL, $p<0.001$) compared to Caucasians (196.1±42.7). Mean IGF-I was significantly greater in females compared to males (205.2±49.7 ng/mL vs. 188.8±43.4 ng/mL, $p=0.01$). 25(OH)D and hsCRP did not differ by sex (25(OH)D: Males: 33.0±8.6 ng/mL, Females: 33.5±10.2 ng/mL, $p=0.69$; hsCRP: Males: 0.9±1.6 mg/L, Females: 0.7±0.9 mg/L, $p=0.10$). IGF-I, 25(OH)D, and hsCRP were not related to current MSK (Table 1). **Conclusions:** Although unrelated to current self-reported MSK, 37% of the sample had suboptimal 25(OH)D. In contrast to civilian populations, IGF-I was significantly higher in service member women as compared to men. IGF-I, 25(OH)D and hsCRP were not significantly related to having a current self-reported MSK in males or females. Future research should use a longitudinal approach to track MSK along with relevant biomarkers throughout training to enhance predictive capabilities.

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Pain Interference Is Affected by Self-Reported Resilience in Service Members

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Context: Resilience is the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress. Studies in military patient populations have demonstrated resilience is associated with chronic pain. How resilience impacts pain experience among training Service Members is yet unknown. The purpose of this study was to investigate whether self-reported resilience was related to the perception of pain interference with sleep, mood, activity, and stress during the previous six months in military officers entering a secondary training course. **Methods:** Male and female officers entering secondary training rated their resilience on the 10-item Connor-Davidson Resilience Scale (CD-RISC), 8-item Short Grit Scale (Grit-S) and 2-item Maslach Burnout Inventory (Burnout) as part of a larger cohort study. Each was adapted to refer to the most recent training environment. A modified Defense Veteran's Pain Rating Scale asked about pain level (0: no pain, to 10: as bad as it could be, nothing else matters) and pain interference with sleep, mood, activity, and stress (each 0: no interference to 10: completely interferes, averaged together) over the previous six months. Resilience scores and pain levels are presented as means±standard deviations. T-tests compared male (M) and female (F) values. Generalized linear fixed effect modeling assessed the association between pain interference (pain intf) and scores on the CD-RISC, Grit-S, and Burnout scales while controlling for pain level. Because of the unbalanced sample size between males and females, separate sex-specific models were run. Fixed effects, significance levels and coefficients (CO)±Standard Error (SE) are presented. **Results:** A total of 1,653 officers (M=1,458, age=24.7±2.9 years; F=195, age=25.0±3.10 years) were consented and enrolled at entry to training. Almost 30% (n=412/1,458) of male and 37% (n=72/195) of female officers reported experiencing pain over the previous six months. Mean pain levels were 4.8±1.8 for males and 4.8±1.8 for females (p=0.96), while mean pain intf was 2.3±1.8 for males and 3.0±2.0 for females (p=0.002). Males and females did not differ on the Burnout (M: 3.0±2.9 vs. F: 2.4±2.4; p=0.08) or Grit-S (M: 3.8±0.6 vs. F: 3.9±0.5; p=0.08) scales, but males had slightly higher CD-RISC scores (M: 33.63±5.02 vs. F: 31.39±5.15, p=0.001). In males, there was a significant association between pain intf and Burnout ($F_{1,405}=4.83$, p=0.03; CO±SE 0.05±0.02), CD-RISC ($F_{1,405}=3.94$, p=0.048; CO±SE -0.31±0.02) and pain level ($F_{1,405}=190.25$, p<0.001; CO±SE 0.59±0.04). Only pain level was significant in female modeling ($F_{1,66}=103.53$, p<0.001; CO±SE 0.78±0.08). **Conclusions:** Upon entry to a secondary training course, military officers of all sexes demonstrated positive relationships between pain level and pain interference. Further, among male officers only, greater self-reported burnout and lower self-reported resilience on the CD-RISC scale were associated with greater pain interference. Studies to further characterize the effects of self-perceived resilience on pain and associated training outcomes are warranted.

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Knowledge, Attitudes, and Comfort With Sexual Health Following a Multi-Modal Educational Intervention

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Context: Sexual health is a complex state of well-being that requires a respectful approach to sexuality and sexual relationships. Previous research has identified a lack of comfort with sexual health screening in peer health professions. Therefore, the purpose of this study was exploring the effects of an educational intervention aimed at improving athletic training student (ATS) knowledge, attitudes, and history taking skills relative to sexual health. **Methods:** A repeated-measures design was used to assess the effect of the educational intervention. The study included students from one professional post-baccalaureate athletic training program. As part of the curriculum, participants (n=20; males=4, females=16; age=23±2 years) were enrolled in a primary care course with a one-week module focused on the reproductive system and sexual health screening. After the module, the ATSs engaged in a standardized patient encounter to practice their sexual health history taking skills. Prior to (November 2020) and following the educational intervention (March 2021), the ATSs completed an online questionnaire containing 2 previously validated instruments. The 24-item Sexual Health Knowledge and Attitudes (SHKA) survey was used to evaluate the effectiveness of the curriculum focused on sexual health using a 14-item knowledge assessment and 10-item Likert scale (1=strongly disagree, 10=strongly agree) assessment of attitudes. Next, the 10-item Sexual History-Taking (SHT) survey assessed students' comfort (1=very comfortable, 4=very uncomfortable) and previous training (1=no training, 4=extensive training) when taking a sexual history. Data analysis included pre-post paired-samples t-test on the SHKA knowledge assessment correct score, as well as each SHKA attitude item and SHT item. Descriptive statistics were used for all SHKA and SHT items. **Results:** At pre-intervention, 95% (n=19) of the ATSs felt they needed additional training taking a sexual history. We identified a significant 15% improvement, with a large effect size, in sexual health knowledge on the SHKA from pre- to post-intervention (pre=10.7±1.5 / 14; post=12.8±0.95 / 14; 95% CI=1.37337,2.82663; df=19, $p \leq 0.001$; Cohen's D=1.55259). Overall, participants improved between pre- and post-intervention on the SHKA for comfort speaking to peers about issues related to sexuality (pre=7.30±2.08, post=8.10±1.65; p=0.028) and agreement that a person with a spinal cord injury is a sexual being (pre=7.74±2.62, post=9.47±0.84, p=0.006). However, participants demonstrated a decrease in comfort looking at external genitalia for medical purposes (pre=6.89±1.85, post=5.58±1.98, p=0.004). Table 1 provides a breakdown of the comfort and training items relative to the SHT survey. **Conclusions:** The data indicate curricular content and intentional training via SP encounters designed for sexual health education improved ATSs' knowledge, attitudes, and comfort when engaging patients and peers in conversation about sexual health needs. However, considering the complexities of sex, gender identity, and sexual health, athletic training programs need to incorporate trainings and educational modules throughout the curriculum to inspire and integrate inclusive, patient-centered care behaviors.

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Table 1. Sexual Health History Taking Survey Data (n=20)

	Pre-Intervention			Post-Intervention		
How comfortable do you feel…	Comfortable	Uncomfortable	Neutral	Comfortable	Uncomfortable	Neutral
Initiating a discussion about safe sexual practices with your patients	11 (55%)	6 (30%)	3 (15%)	15 (75%)	4 (20%)	1 (5%)
Taking your patient's sexual history	14 (70%)	3 (15%)	3 (15%)	17 (85%)	3 (15%)	0 (0%)
Managing your patients' sexual health issues	9 (45%)	4 (20%)	7 (35%)	15 (75%)	4 (20%)	1 (5%)
Initiating a discussion about safe sexual practices with your LGBTQ patients?	9 (45%)	8 (40%)	3 (15%)	12 (60%)	6 (30%)	2 (10%)
Taking your LGBTQ patient's sexual history?	12 (60%)	5 (25%)	3 (15%)	14 (70%)	5 (25%)	1 (5%)

Pneumothorax Caused by Soccer Ball Collision in a Secondary School Athlete: A Case Study

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Background: Seventeen-year-old male varsity soccer athlete sustained a direct blow to the chest during soccer practice. The patient's routine yearly sports physical had a pulse of 76 and a BP of 113/72. The patient presented to the athletic training staff during a varsity practice session complaining of acute upper chest pain and back pain. He reported taking a direct blow from a soccer ball from a normal overhead throw-in, which typically has speeds of 12-19 m/s. The patient reported difficulty with breathing along with not feeling his normal self. Vitals were taken; initial blood pressure:120/58, pulse: 52bpm, pulse oximetry: 98-99%, normal bilateral lung and heart sounds. Five minutes after the collision the patient started to experience sharp anterior to posterior pain on the left side around the heart area. The patient attempted to lay down in a supine position at which time his discomfort, along with cramping of the diaphragm, and breathing difficulty increased, along with a drop of his pulse oximeter reading to 96%. When returned to a seated position the pulse oximetry returned to 98%. It was determined that patient would need to be seen at the emergency department (ED). Vital and heart/lung sounds were monitored and ice bag treatment was applied to the chest area. The patient was transported to the nearest emergency department trauma center less than 20 minutes after he reported to the athletic trainer. **Differential Diagnosis:** Based on the mechanism of blunt trauma and the evaluation by the athletic training staff, the differential diagnosis included chest contusion, clavicle fracture, sternum fracture, or rib fracture. **Intervention & Treatment:** The ED attending physician noted the patient presented with chest pain from blunt trauma to the anterior left superior chest area and the patient experienced shortness of breath which worsened over time. Chest radiograph with frontal and lateral views revealed a significant collapse of the left lung secondary to pneumothorax. Within the pleural spaces, a large left pneumothorax was present with no pleural effusion. The radiologist diagnosed a large left tension pneumothorax. The attending physician requested surgery consultation for placement of a pigtail catheter chest tube. A left midclavicular chest tube was inserted. The patient was hospitalized for three days for monitoring and then was released once the left lung was fully functional. The patient was returned to full athletic activity after seventeen days by his attending physician. The patient was functionally tested by the athletic training staff; he showed no limitations. At the time of returning to full activity with the varsity soccer team the patient had and continues to have no residual side effects. **Uniqueness:** A tension pneumothorax during athletics is rare. Common causes of tension pneumothorax involve blunt trauma incidents such as unrestrained motor vehicle accidents, falls, and altercations involving laterally directed blows. Typically the blunt trauma is associated with a rib fracture. This Level 4 case study presents the case of a pneumothorax associated with blunt trauma from a soccer ball without a rib fracture with the patient returning to full athletic activity after seventeen days. Notably, it typically takes six to eight weeks to fully recover from a collapsed lung. Pain is also a major restriction for return to play which this patient did not have at return. **Conclusions:** Inappropriate management or missed diagnosis could have resulted in a life-threatening situation. The athletic trainer's role in knowing the patient and noting little details provided a positive outcome. Return to play guidelines post a pneumothorax is limited. This case study would recommend that a full literature review and consensus on the return to play guidelines for a pneumothorax be explored.

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Understanding the Help-Seeking Behaviors of Student-Athletes: Effect of a Multidisciplinary Healthcare Team and the Perception of Barriers and Facilitators for Seeking Help

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Context: The study aims to understand the effect of implementing an integrated healthcare approach by identifying attitudes surrounding help-seeking behaviors such as satisfaction of care, barriers and facilitators of student-athletes regarding their mental health. **Methods:** The study employed a concurrent triangulation design. Participants included 411 student-athletes from 18 different intercollegiate teams at a mid-major NCAA Division I institution in the mid-Atlantic region. Participants were recruited through non-probability sampling. Paper surveys were administered during pre-determined athletic related events such as team meetings, team lifts, and/or team practices during a fall semester. A 12–item instrument comprised of ten quantitative items and two open-ended questions was utilized for this study. The qualitative portion of the study was the open-ended questions asked on the survey. These open-ended questions allowed the participant to expand on their quantitative responses and provide insight into their thoughts and feelings surrounding the topic of mental health. The instrument was adapted from Murray's Help Seeking Survey1. Some questions were adapted from an unpublished needs assessment conducted at another university. The Barriers to Care Checklist2 was used to address barriers to seeking help. The checklist of facilitators in question 10 of the instrument was based on the systematic review conducted by Moreland, Coxe, and Yang3. The quantitative data was analyzed using SPSS version 25.0 for descriptive statistics. T-tests were used in comparing gender for each stated research question. Correlation analysis was used to determine the strength of the relationship between each variable in the study. A constant comparative method was used to code responses from the open-ended questions. Similar data points were grouped and identified into themes or categories. These themes were then compared to the quantitative results and discussed further to illustrate stronger points. **Results:** Of 411 respondents 54% female (n=221) and 46% male (n=190). Findings suggested a prevalence of mental health challenges among student-athletes, especially overwhelming stress 68.86% (n=283), struggles with time management 67.15% (n=276), anxiety 43.55% (n-179), burnout 34.7% (n=143), depression 26.03% (n=107). Female respondents reported a higher level of satisfaction with the care received from friends, $2(1, N = 411) = 11.42$, $p < .001$, teammates, $2(1, N = 411) = 9.77$, $p < .01$, and athletic trainers, $2(1, N = 411) = 7.69$, $p < .01$, in comparison to their male counterparts. The results of t-tests indicated that there was a gender difference on whether student-athletes believed they received an adequate orientation to resources and support services on campus, $t(408) = 2.714$, $p = 007$. Pearson correlation indicated that there was a significant positive association between receiving an adequate orientation to support services and resources and a positive help-seeking environment within the team ($r(410) = .60$, $p = .221$). Qualitative findings were divided into positive help-seeking experiences, negative help-seeking experiences, and neutral/no help-seeking experiences. 107 respondents reported a positive help-seeking experience while 35 reported a negative help-seeking experience. 93 respondents reported neutral feelings or no experience. **Conclusions:** This study identified the prevalence of mental health challenges among collegiate student-athletes as well as the significant gender differences between resource utilization, satisfaction of care, and the perceptions of barriers and facilitators. Based on these findings, we can draw three conclusions: First, student-athletes require frequent and substantial educational programming about how to manage mental health as a student-athlete. Second, a foundational peer support network should be established within an athletic department. Lastly, there should be educational programming specifically for coaches, support staff, and faculty members including how to identify struggling student-athletes, how to appropriately refer them, and how to support them throughout their mental health struggles.

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****Pre-Professional/Professional Student Award Winner****

Financial Impact of Embedded Injury Prevention Experts in U.S. Army Initial Entry Training

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Context: Nearly 25% of males and 50% of females suffer from musculoskeletal conditions (MSK) during U.S. Army Initial Entry Training (IET), which increases the likelihood they will separate from service by the end of training. To address this problem, the U.S. Army has embedded injury prevention experts (IPE), specifically athletic trainers and strength and conditioning coaches, into IET. However, little is known about the financial impact of IPE, particularly whether sunk costs (i.e. training dollars spent on soldiers discharged from service early) are decreased when the number of MSK-related early discharges from service is reduced. Our aim was to determine whether embedding IPE in IET would be associated with lower sunk costs as a result of fewer soldiers being discharged from service early for MSK-related reasons. **Methods:** We leveraged monthly administrative, medical, and readiness records on 198,166 soldiers (age=20.7+/-3.2 years; body mass index=24.4+/-3.5) who began IET during 2014-2017. Early discharge from service was defined as occurring within six months of beginning IET, since most soldiers complete IET and arrive at their first assigned units by then. All four IET sites employed IPE from 2011-2017 except for two sites during April 2015-November 2015. Soldiers who began IET at these two sites during these times were categorized as not having IPE exposure. All others were categorized as having IPE exposure. Logistic regression was used to assess the unadjusted association between IPE access and odds of MSK-related early discharge from service. Financial impact was assessed by quantifying differences in yearly sunk costs between groups with and without IPE exposure, and subtracting IPE hiring costs. Yearly sunk costs were calculated by summing monthly sunk costs. Monthly costs were calculated since time of discharge is an important consideration; money spent on soldiers increases with time in training. **Results:** Among 198,166 soldiers with records utilized in this study, 7.11% (n=14,094) did not have exposure to IPE during IET. Among 14,094 soldiers without IPE exposure, 2.77% (n=391) were discharged early due to MSK-related reasons. Among the 184,072 soldiers with IPE exposure, 1.01% (n=1,861) were similarly discharged. IPE exposure was associated with reduced odds of MSK-related early discharge (odds ratio=0.36, 95% confidence interval=0.32-0.40, p<0.001). Yearly sunk costs when soldiers did and did not have access to IPEs were $10.50 million and $29.40 million, respectively. After accounting for IPE hiring costs, IPE exposure was associated with $15.34 million in savings per year. **Conclusions:** Employing IPE is associated with reduced sunk costs due to fewer soldiers being discharged from service early for MSK-related reasons. Savings are estimated to be $15.34 million per year, an amount 4x as large as the cost of hiring IPE. Continued employment of IPE will sustain the positive financial and operational impacts in the U.S. Army.

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Prevention of Ankle Sprains in Collegiate Football Players Using Balance Training and Hip Strengthening

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Context: Ankle sprains represent the most common injury in football. Balance deficiencies and reduced hip strength have been touted as important risk factors for ankle sprains. Some success has been shown using preventative balance training programs in high school football players, but limited efforts have considered either of these risk factors in developing ankle sprain prevention in collegiate football athletes. Therefore, the purpose of this study was to examine the effectiveness of a prevention program emphasizing balance training and hip strengthening to reduce ankle sprain rates in collegiate football players. **Methods:** A cohort of 795 Division I collegiate male football players cleared for full participation in team activities volunteered. Teams were pre-selected to participate in a Prevention program (n= 438; Age=19.79±1.34yrs; Height=188.27±6.86cm; Mass=106.35±22.78kg) or a Control group (n=357; Age=19.75±1.34 yrs; Height= 186.67± 7.05cm; Mass= 103.78± 19.36kg). Players in both groups utilized prophylactic ankle supports during practice and games. Participants allocated to the Prevention group performed 10-minute supervised sessions that emphasized a progression of static postural control and hip strengthening exercises 3 times/week for 8 weeks prior to the competitive season. The Control group players refrained from any prevention activities in the pre-season. As part of a larger study, time-loss injuries (absence from at least one game or practice) to the lower extremity during team activities were recorded by certified athletic trainers during fall competition seasons. Only ankle sprain injuries and non-injured players were used in this analysis. Distributions of ankle sprain and non-injury status were placed in a 2x2 contingency table; from which Relative Risk Reduction (RRR), Absolute Risk Reduction (ARR), and Numbers Needed to Treat (NNT) were used to evaluate the potential success of the Prevention program at reducing ankle sprains. **Results:** There were 54 reported ankle sprains in the Control group (15.1% event rate) compared with 27 ankle sprains in the Prevention group (6.2% event rate). This yielded a RRR=59%, ARR=8.9%, and NNT=11.24. **Conclusions:** A prevention program consisting of balance training and hip strengthening was associated with a > 8% decrease in ankle sprain rate in collegiate football players. Projecting ankle sprain risk to a common Division I football roster of approximately 90 players, the NNT suggests that using this prevention approach could lead to prevention of approximately 8 ankle sprains/team. While this is promising, more work is needed to determine the optimal dosage and constituency of ankle sprain prevention programs, while also considering timing (i.e. pre-season vs. regular season maintenance) to maximize effectiveness and implementation of ankle sprain prevention.

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****Pre-Professional/Professional Student Award Winner****

A Mindfulness Breathing Exercise Program Improves Dynamic Postural Control in Collegiate Soccer Athletes With a History of Lateral Ankle Sprain

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Context: Lateral ankle sprain (LAS) is the most common musculoskeletal injury reported in soccer, and postural control deficits are typically observed as clinical deficiencies following LAS. Recent literature has documented that altered diaphragm contractility and breathing patterns are associated with postural control deficits in individuals with a history of LAS. Addressing altered diaphragm function and dysfunctional breathing mechanics through a mindfulness breathing exercise program (MBEP) in athletes with a history of LAS may contribute to improvement in postural control, but the effect of an MBEP on postural control has not been investigated. Therefore, the purpose of this study was to investigate the effectiveness of MBEP in improving dynamic postural control among collegiate soccer players with a history of LAS. **Methods:** Thirty-eight male collegiate soccer players with a history of LAS volunteered for this randomized controlled trial. Soccer players were randomly assigned into a MBEP (n=17; age=20.1±1.1yrs; height=176.5±7.0cm; mass=69.8±8.4kg) or control group (n=21; age=20.5 ±1.2yrs; height=172.6±6.3cm; mass=66.7±5.9kg). The MBEP group performed a 6-week MBEP (2, 30-minutes supervised sessions per week) on top of normal strength training and daily team practices. Players in the control group did no intervention exercises and continued with their normal training and daily practices. Players underwent dynamic postural control assessments before and after the intervention. Dynamic postural control was assessed with the SEBT in the anterior (SEBT-A), posteromedial (SEBT-PM), and posterolateral (SEBT-PL) reaching directions. Three trials of each SEBT direction were averaged and normalized as a percentage of stance leg length (%). A separate two-way repeated ANOVA was used to analyze each dependent variable. In the case of statistically significant interactions, a post hoc univariate analysis with pairwise comparison was performed to identify the location of significant differences. A significance level of $P < 0.05$ was set a priori. Cohen's d effect sizes using the pooled standard deviations were calculated, along with 95% confidence intervals (CI) for each pairwise comparison to determine the magnitude of difference in SEBT variables between independent variables. **Results:** There were significant group by time interactions for the SEBT-A (P=0.027) and SEBT-PM (P=0.011). In the MBEP group, the post-intervention scores of the SEBT-A (Pre=67.3±5.9%, Post=69.3±6.9%, P=0.003, d=0.32, 95%CIs:-0.36, 0.99) and the SEBT-PM (Pre=90.9±4.6%, Post=94.8±4.9%, $P < 0.001$, d=0.80, 95%CIs:0.09, 1.48) were higher than the pre-intervention scores. No significant changes in the SEBT-A and SEBT-PM were observed in the control group (SEBT-A: Pre=68.2±3.2%, Post=68.2±3.8%, P=0.951, d=0.01, 95%CIs:-0.59, 0.62; SEBT-PM: Pre=90.8±5.6%, Post=91.3±6.1%, P=0.503, d=0.10, 95%CIs:-0.51, 0.70). **Conclusions:** A 6-week MBEP improved the SEBT-A and SEBT-PM scores while SEBT performance did not change in the control group. A 6-week MBEP may be effective in improving dynamic postural control in collegiate soccer players with a LAS history. Incorporating an MBEP in rehabilitation may have beneficial effects in athletic patients with LAS.

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A Six-Week Diaphragmatic Breathing Exercise Program Improves Diaphragm Function and Breathing Patterns in Collegiate Soccer Players With Lateral Ankle Sprain History

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Context: Because lateral ankle sprain (LAS) is the most prevalent in soccer athletes, it is important to develop an effective intervention strategy. Altered diaphragm function and breathing mechanics have been linked to LAS. Further, previous work demonstrates associations of diaphragm contractility and dysfunctional breathing patterns with clinical deficiencies commonly observed in patients following LAS. Incorporating diaphragmatic breathing (DB) exercises may have beneficial effects in athletes with LAS, but DB exercises have had little implementation as part of an intervention protocol in those with LAS. Therefore, the purpose of this study was to determine the effectiveness of a DB exercise program in improving diaphragm movement and breathing mechanics among soccer athletes with a history of LAS. **Methods:** Participants were recruited from a Division 1 college soccer team, and 38 male players with a LAS history volunteered for this randomized controlled study. Soccer players with a LAS history were randomized to receive a 6-week DB exercise program (n=17; Age=20.1±1.1yrs; Height=176.5±7.0cm; Mass=69.8±8.4kg) or control intervention (n=21; Age=20.5±1.2yrs; Height=172.6±6.3cm; Mass=66.7±5.9kg). Players in the intervention group performed a total of 12 supervised 30-minute sessions, 2 times per week for 6 weeks. The players in the control group did no exercises. Outcome assessments were conducted before the first and after the 12th sessions. An ultrasonography assessment was performed to quantify right hemi-diaphragm excursion and inspiration time while breathing quietly in supine. Breathing patterns were assessed using the Hi-Lo test in the sitting position. The Hi-Lo test was scored based on the presence or absence of anterior-posterior abdominal excursion and superior rib cage migration, from which dysfunctional or DB patterns were categorized. Two-way repeated-measures ANOVAs with Bonferroni post hoc tests were employed to analyze diaphragm variables. A generalized estimated equations approach with a post hoc pairwise comparison with Bonferroni correction was used to analyze differences in outcome of breathing patterns. Significance was set at $P < .05$. **Results:** Significant group×time interactions were evident for diaphragm excursion (P=.049), inspiration time ($P < .001$), and distributions of breathing pattern category (P=.004). In the intervention group, diaphragm excursion (Pre=2.2±0.8cm, Post=2.8±0.8cm, P=.001) and respiratory time (Pre=1.3±0.4s, Post=1.9±0.6s, $P < .001$) at the post-intervention assessment were significantly greater compared with the pre-intervention assessment. There were significantly more diaphragmatic breathers at the post-intervention assessment compared with the pre-intervention time point (Pre=5.9%, Post=70.6%, P <. 001). No significant changes in diaphragm and breathing pattern variables were observed in the control group (Excursion: Pre=2.2±0.5cm, Post=2.4±0.7cm, P=.407; Time: Pre=1.5±0.6s, Post=1.4±0.5s, P=.34; Hi-Lo: Pre=28.6%, Post=28.6%, P=1.000). **Conclusions:** The 6-week DB exercise program increased diaphragm excursion, respiratory time, and percent of diaphragmatic breathers in collegiate soccer athletes with a LAS history. Twelve sessions of a DB exercise program may induce improvements in diaphragm function and breathing mechanics in athletic patients with LAS.

This study was supported by the Japan Society for the Promotion of Science, Grant in Aid for Young Scientists (#20K19433).

****Post-Professional Terminal Degree Student Award Winner****

Action-Observation Brain Activity Associate With Kinesiophobia After Anterior Cruciate Ligament Reconstruction

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Context: Individuals with prior anterior cruciate ligament reconstruction (ACLR) history suffer from kinesiophobia and demonstrate altered brain activity for motor control. However, technical limitations result in the inability to capture brain activity during complex movements. By taking advantage of mirror neurons, motor imagery, and action-observation, studies can assay the brain activity associated with more complex injury-relevant movements. Therefore, the purpose of this study was 1) to compare brain activation patterns between ACLR individuals and matched healthy controls during an action-observation drop vertical jump (DVJ) paradigm and 2) explore how kinesiophobia (measured by the Tampa Scale of Kinesiophobia [TSK-17]) may further alter brain activity in ACLR individuals. **Methods:** This cross-sectional study enrolled 24 individuals, 12 with ACLR (7 females, 20.67±2.06years, 1.71±0.1m, 68.27±15.39kg, 7.42±1.08 Tegner, 32.25±5.58 TSK-17) and 12 matched controls (7 females, 23.25±3.08years, 176.11±10.06cm, 72.08±14.88kg, 7.67±1.23 Tegner, 26.40±4.86 TSK-17 [10 controls reported TSK-17]). Functional magnetic resonance imaging (fMRI) was used to evaluate brain activity during our action-observation paradigm. The paradigm consisted of five baseline (participants observed a first-person perspective standing image) and four action-observation DVJ sessions (participants watched first-person perspective DVJs and imagined executing the DVJ) between the baseline sessions; each session lasted 30 seconds. Two separate general linear models: 1) second-level mixed-effect paired group analysis and 2) second-level mixed-effect correlation analysis with two explanatory variables (group and TSK-17) and three contrasts (group mean and brain activity positively & negatively associated with TSK-17) were performed. We used the Oxford Centre for Functional MRI of the Brain Software Library (FSL) with an a priori threshold at z/>\3.1 and p/<\0.05 with cluster correction for multiple comparisons. An independent t-test was used to determine if there was a difference in TSK-17 between ACLR and control groups with α/<\0.05. **Results:** ACLR group showed decreased brain activity in the right ventrolateral frontal cortex, including the primary motor cortex, par operculairs, and corticospinal tract, compared to control group (98 voxels [peak Montreal Neurological Institute (MNI) voxel x=44, y=-2, z=32], z=5.01, p=0.01). Brain activity in the right cerebellum, including crus I & II, lobule VIIIb & IX, and middle cerebellar peduncle, was positively correlated with kinesiophobia in ACLR individuals (93 voxels [peak MNI voxel x=32, y=-58, z=-42], z=4.47, p=0.02). There was a significant difference in TSK-17 between ACLR (32.25±5.58) and control (26.4±4.86) groups (p=0.017, d=0.21). **Conclusions:** Brain areas, engaged in cognitive appraisal of visual information related to planning and executing movements, had decreased activity in the ACLR group. Additionally, elevated kinesiophobia in ACLR individuals was associated with increased activity in cerebellar areas responsible for cognitive and sensorimotor processing. Therapeutic modalities that target 1) visual and cognitive functions (virtual-reality, dual-task, and external-focus of attention) and 2) pain management (pain-education and fear-avoidance) may be beneficial in ACLR rehabilitation to combat the altered brain activity.

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Effectiveness of a Framework to Disseminate and Implement Preventive Training Programs in Youth Basketball

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Context: Preventive training programs (PTPs) reduce lower extremity sport-related musculoskeletal injury by improving components of movement control, yet are infrequently adopted in youth sport. Barriers commonly include time needed to implement the PTP, a lack of sport-specificity and appropriately challenging exercises. The 7 Step Framework to guide PTP dissemination and implementation includes establishing administrative support, developing an implementation team, identifying barriers and solutions, developing an evidence-based and appropriate PTP, training the staff and athletes, fidelity, and having an exit strategy. The purpose of this study was to examine whether a PTP disseminated and implemented using the 7 Step Framework is effective in improving movement control in both middle school and high school aged elite female basketball athletes. **Methods:** A cohort study design was used to evaluate the effectiveness of an evidence-based delivered PTP with 8 youth basketball teams. Teams were categorized as middle or high school based on grade level (MIDDLE: grades 5-8; HIGH: grades 9-12). Movement control during a standardized jump-landing task was evaluated using the valid and reliable LESS before (PRE) and after (POST) the season. The research team followed the 7 Step Framework, which included gaining organizational buy-in, designing a PTP specifically for the target population, conducting team PTP workshops, and periodic follow-ups by research staff during the 3-month season. The LESS was scored using an automated scoring system (Physimax Technologies LTD, Tel Aviv, Israel) integrating an Xbox Kinect camera (Microsoft, Redmond, WA), which has been validated against traditional LESS scoring. A higher LESS score indicates poor movement control than a low LESS score. A repeated measures analysis of variance (ANOVA) was used to evaluate differences in movement control (LESS score) between time points (PRE, POST) and age groups (MIDDLE, HIGH) ($P < 0.05$). Post-hoc pairwise comparisons were evaluated using 95% confidence intervals. **Results:** While all athletes on each team completed the PTPs, 34 participants completed both PRE and POST test sessions (MIDDLE: n=20, HIGH: n=14). Regardless of age group, overall LESS score improved over time (PRE: 7.76±2.02 errors; POST: 6.37±2.17 errors, P=0.003). However, HIGH demonstrated lower LESS scores compared with MIDDLE at POST (MIDDLE: 7.53±1.88 errors, HIGH: 4.71±1.33 errors, $P < 0.001$). **Conclusions:** PTPs are essential in reducing injury, but improvements in dissemination and implementation are needed to maximize effectiveness. In this study, implementation of PTPs that were designed for the target population using an evidence-based framework demonstrated improvements in movement control over the season in high school aged basketball athletes. However, a revised strategy, or lower expectations for short-term changes in movement control may be needed for younger athletes.

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Quantifying Changes in Collegiate Volleyball Training Throughout the COVID-19 Pandemic Via Wearable Technology

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Context: Collegiate athletics were disrupted by the COVID-19 pandemic, resulting in altered training schedules. While some teams were able to compete during 2020, the abnormal training cycle presented as a possible risk for injury in the 2021 season. Changes in training volume can be quantified in court sports, such as volleyball, by equipping wearable sensors on athletes throughout practices. These changes in training volume (i.e., active minutes and total jump count) and jump quality (i.e., jump count > 15" and average jump height) could then be compared across seasons. In turn, we aimed to identify differences in training volume and jump quality between the 2020 and 2021 seasons in a cohort of collegiate volleyball athletes. We hypothesized that while training volume would increase, jump quality would decrease. **Methods:** Ten (20±2 years, 1.80±0.07 m, 72.6±6.6 kg, 10±2 years of experience) female collegiate volleyball players, volunteered for this longitudinal field study spanning across the 2020 and 2021 seasons. No participants sustained injuries removing them from practice for > 7 days during the 2020 or 2021 season. VERT sensors (Fort Lauderdale, FL) were placed at the waist in an elastic band for each practice. Active minutes, total jump count, jump count >15", and average jump height were calculated within the VERT Team System Basic application for each participant's practice. To normalize average jump height between participants, a baseline jump assessment was performed at the beginning of each season and the resulting average jump heights were calculated as a percentage of baseline jump height. Practice averages, per participants, were calculated for each variable. Multiple, one-tailed, paired t-tests (α=0.05) were used to compare the 2020 and 2021 season averages. Following the 2021 preseason, an exploratory survey of lower extremity injuries was completed. **Results:** A significant increase in jump count was identified, partially supporting our hypothesis (Table 1). While there was no change in jump count > 15", minutes of activity, or average jump height, the increase in overall jump count suggests that the athletes were being asked to jump more often, with the same quality, than the season altered by COVID-19. This increase in training load could have resulted in an increased risk of injury. Although injuries were not monitored during the 2020 season, the exploratory survey following the 2021 preseason revealed 60% (n=6) of participants developed a pathology, where symptoms were noted in a specific anatomical location (thigh/knee=4, shank/ankle=2) but did not result in being withheld from practice. **Conclusions:** Athletes returning to consistent training following the COVID-19 pandemic may maintain quality of jumps but asked to increase quantity. These same athletes may be experiencing lower extremity pathologies regardless if they don't warrant removal from practice. Wearable sensors can assist in monitor training loads, especially following seasonal training alterations.

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Table 1. Season Averages of Volleyball Practices.

	Active Minutes	Total Jump Count	Jump Count > 15"	Jump Height (% Max)
2020 (mean ± sd)	78 ± 28	84 ± 61	50 ± 42	82 ± 13
2021 (mean ± sd)	84 ± 26	95 ± 67	54 ± 49	82 ± 16
p value	0.21	0.01	0.16	0.48

Sensor-Based Gait-Training to Reduce Contact Time for Runners With Exercise-Related Lower Leg Pain: A Randomized Controlled Trial

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Context: Runners with exercise-related lower leg pain (ERLLP) have exhibited increased ground contact time during outdoor running compared to healthy runners. It is currently unclear if incorporating contact time feedback during outdoor running improves biomechanics, decreases pain, and increases function above standard of care exercises. The purpose of this study was to assess the effects of a 4-week outdoor gait-training program to reduce contact time in conjunction with home exercises (FBHE) compared to home exercises alone (HE) for runners with ERLLP. **Methods:** Twenty runners with ERLLP were randomly allocated into FBHE or HE groups (FBHE group: 4M, 6F, 23±4 years, 22.0 ± 4.3 kg/m2; HE: 3M, 7F, 25±5 years, 23.6±3.9 kg/m2). Both groups completed eight sessions of home exercises over four weeks. The FBHE group received vibrotactile feedback through wearable sensors and a paired wristwatch to reduce contact time during outdoor running. Patient-reported outcome measures (PROMs), and indoor and outdoor gait assessments were conducted for both groups. PROMs were collected at baseline, 2-, 4-, and 6-weeks, while gait assessments and clinical measures were conducted at baseline and 4-weeks. Feedback retention was assessed at 6-weeks for the FBHE group. Separate repeated measures analysis of variance (RMANOVAs) were used to assess the influence of group and timepoint on all primary outcomes. Alpha was set a priori to .05 for all analyses. **Results:** While both groups reported increased function through to the 6-week follow-up (p=.01), the FBHE group reported significantly increased function and recovery beyond the HE group (Running Injury and Recovery Index: Mean Difference [MD]= 16.8%, p<.001; Exercise-Induced Leg Pain Questionnaire: MD=14.6%, p<.001). There was a significant group by time interaction for Global Rating of Change (GROC) scores, and for sensor-derived contact time. Post-hoc analyses reflected that the FBHE had improved GROC scores at 4- and 6-weeks compared to 2-weeks (MD2vs6: 1.3, p=.02; MD2vs4: 2.1, p<.001) and compared to the HE group (MD: 1.3, p=.04). The FBHE group had significantly decreased contact time at 4-weeks compared to baseline and the HE group for indoor (MD: -36ms, p<.001) and outdoor running (Figure). Contact time changes were retained at 6-weeks from the 4-week timepoint during outdoor running (MD: -3ms, p=.71). The FBHE group had increased cadence at 4-weeks compared to baseline during and outdoor running (MD: 7 steps/min, p=.01), and compared to the HE group at 4-weeks for indoor (MD: 16 steps/min, p=.02) and outdoor running (MD: 4 steps/min, p=.01). **Conclusions:** FBHE was more effective than HE alone for runners with ERLLP, manifested with decreased pain, improved self-reported function, and improved outdoor and indoor spatiotemporal gait biomechanics. Clinicians should implement this ecological gait-training intervention among ERLLP runners to improve patient outcomes.

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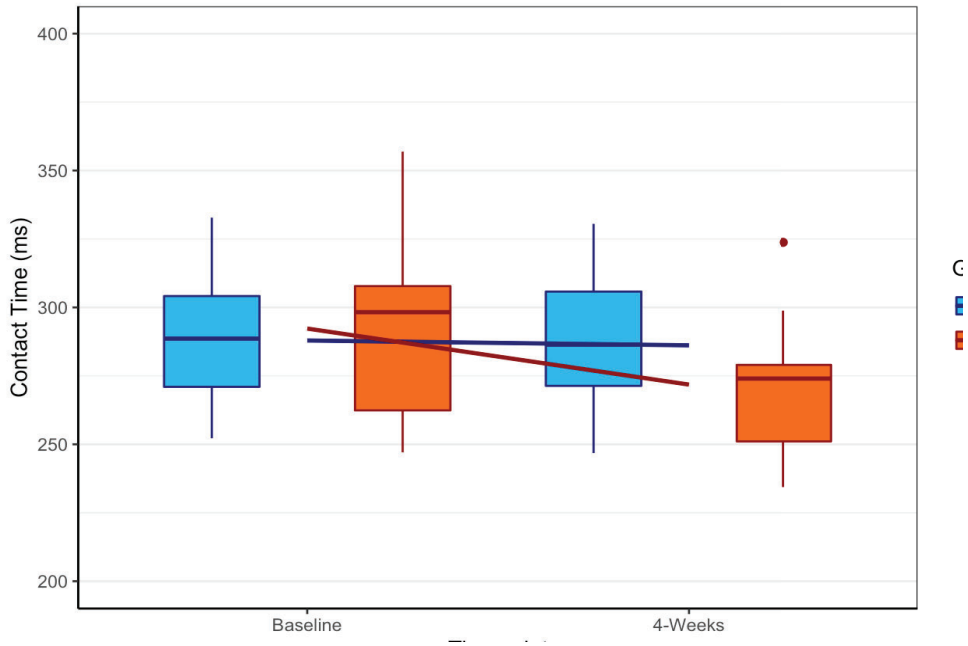

Caption: Box plot graphs with trendlines demonstrating the change in contact time from baseline prior to interventional procedures, to the 4-week timepoint following either contact time gait-training feedback with home exercises (FBHE; orange), or home exercises alone (HE; blue). There was a significant group by time interaction, such that the FBHE group significantly decreased contact time from baseline to four weeks, and compared to the HE group at four weeks.

Abbreviations: FBHE, contact time gait-training feedback with home exercise; HE, home exercise; ms, milliseconds.

Does Treatment Provided for Lateral Ankle Sprains Differ Between Patients With Recurrent and First-Time Injuries?: A Report From the Athletic Training Practice-Based Research Network

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Context: Ankle sprains are one of the most common injuries that athletic trainers (ATs) treat. However, it is unknown if a previous medical history impacts the management of these injuries. Our objective was to compare the treatment of LAS injuries by ATs between patients with and without a history of a previous sprain. **Methods:** This was a retrospective analysis of electronic patient records, created by ATs between October 2009 and October 2021 for 125 athletic training facilities ¬(high school=103, college=19, other=3) located in 28 states. Participants included 133 ATs (female= 68, age= 29.4±8.0 years, years certified=7.2±7.8, years employed at site=3.0±4.1) within the Athletic Tra¬¬ining Practice-Based Research Network. Injury documentation was extracted using the ICD-10 code for LAS (845.0: sprain of ankle). Summary statistics (frequencies, percentages means±standard deviations, medians and interquartile ranges [IQRs]) were calculated to describe patient characteristics (sex, age), injury demographics (sport, mechanism of injury [MOI]), and type of AT service (CPT code). Data for the number of AT services, number of episodes of care (EOC, patient encounter) and duration of care (days between intake and last documented EOC) did not meet assumptions for parametric tests, therefore, Mann-Whitney U tests were used to evaluate group differences (previous medical history of ankle sprain [PMH], no previous medical history of ankle sprain [No PMH], p<.05). **Results:** During the study period, 307 patients with no PMH of LAS (male=57.7%, age=16.0±2.0 years) and 214 patients with a self-reported PMH of ipsilateral LAS (male=55.1%, age=16.8±2.2 years) were diagnosed with an ankle sprain injury. The majority of patients reported twisting (38.2%, n=199), contact (22.8%, n=119), and non-contact (20.3%, n=106) MOIs, while participating in basketball (30.1%, n=157), football (24.0%, n=125), and soccer (13.4%, n=70). The most common AT services were similar between groups: therapeutic exercise (No PMH= 20.0%, n=931/4660; PMH=20.8%, n=610/2938), therapeutic activities (No PMH=17.7%, n=825/4660; PMH=16.8%, n=483/2938); hot or cold packs (No PMH=16.8%, n=784/4660; PMH=16.8%, n=493/2938); strapping (No PMH=15.7%, n=731/4660; PMH=17.2%, n=504). No differences between groups were observed in the number of AT services (No PMH: median=11 services, IQR=6-20; PMH: median=10 services, IQR=5-18, p=0.12), number of EOC (No PMH: median=6 visits, IQR=4-9; PMH: median=6 visits, IQR=4-10, p=0.834), or duration of care (No PMH: median=10 days, IQR=5-21; PMH: median=12 days, IQR=5-24, p=0.73) per injury. **Conclusions:** Our data suggest that ATs treat patients with LAS similarly, regardless of whether they have experienced a previous sprain in that ankle, with therapeutic exercise and activities being the most commonly documented treatments. These data are encouraging, given the high rates of ankle sprain and reoccurrence in athletic populations. Further research should explore the impact of treatment combinations and treatment variables on short & long-term patient outcomes, including the development of chronic ankle instability.

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Perceptions of Self-Care and Work-Life Balance Among Secondary School Athletic Trainers

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Context: The athletic training research agenda identifies a need for exploration on strategies for improved work-life balance (WLB). One unexplored area is self-care practices used to maintain WLB. The COVID-19 pandemic has added to challenges experienced by individuals and has impacted their ability to maintain work-life balance, as well as engage in self-care practices. While secondary school setting represents one of the largest clinical practice workplaces and is growing as an employment setting, often the athletic trainer is the solo medical care provider which can have implications on WLB and self-care. The purpose of this study was to explore the self-care practices of secondary school athletic trainers with a focus on WLB. **Methods:** Fourteen (6 males, 8 females) athletic trainers employed in the secondary school setting completed one-on-one phone interviews and were 37 ± 8 years old (range 25-52), with an average of 13 ± 9 years of experience (range 2-28 years). Our participants had been employed in the secondary school setting (4 private, 10 public) for 11 years (range 2-32 years). Recruitment of participants was purposeful, following criterion sampling (full-time employment in secondary school, 1 year of experience). We used a phenomenological research design to better understand WLB and self-care practices of secondary school setting athletic trainers Semi-structure interviews were conducted The interview guide was reviewed for content by 3 experts and piloted before interviews were completed. All interviews were recorded, transcribed, and analyzed using an inductive approach as prescribed by the phenomenological approach. Immersion of the data was key to the process. Data saturation guided recruitment, peer review and intercoder reliability were used as steps to help ensure data credibility. **Results:** Four major themes were identified from the data. Theme 1: Engaging in self-care practices stimulated WLB. Self-care practices are used to help foster the mental health and physical well-being; participants shared finding WLB by participating in activities that helped them become "a priority too." Theme 2: Work-life balance strategies were designed for disengagement, as it focused on "me" time. Long work hours were overcome by focusing on life roles when in them. Participants recognized that work reduced the time they had for themselves, so they made sure to "focus on themselves". Disengagement allowed for participants to "relax" and "unwind", and "focus on more than just work." Theme 3: Physical self-care practices helped create work-life balance and reduce stress. Examples included exercise, walking, or sleep. Participants discussed taking care of themselves by engaging in exercise or other healthy practices by staying active. All participants averaged 7 ± 1 hours of sleep a night. Theme 4: Social self-care practices were centered on community and support, as our participants discussed the relationships with spouses, friends, and family as mediating their stress and stimulating their WLB. It helped reduce the stress they managed during their workdays. **Conclusions:** Secondary school athletic trainers are engaging in self-care practices regularly and connect those activities to their WLB. Self-care practices are designed to create "me time" and are geared towards physical and social self-care activities. The time demands of the athletic training job, were combatted by using role engagement. Additionally, our results speak to the interchangeable thoughts of self-care practices, stress relief, and WLB. Secondary school athletic trainers are encouraged to engage in various self-care practices that include physical and social aspects that also help create disengagement from their work lives. Given the established link between lack of WLB and burnout and the impact burnout can have on patient care, it is imperative to continue identify strategies athletic trainers use to maintain their WLB.

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Scholarly Output of Athletic Training Faculty

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Context: The objective of this study was to evaluate the scholarly output of current athletic training academicians to establish benchmarks that can be used to measure the accomplishment, value, and contribution of athletic training faculty. **Methods:** A cross-sectional, online, descriptive survey design was used to collect data needed to make inferences about contemporary athletic training faculty productivity. The survey instrument was created based on questionnaires used previously by researchers to investigate scholarly output of occupational therapy and physical therapy faculty. The survey consisted of 39 total questions related to: demographic information, academic appointment, and scholarly productivity. To determine construct and content validity, the survey was sent to 5 athletic training faculty who provided feedback related to content and delivery. Study participants were recruited with assistance from the National Athletic Trainers' Association (NATA), which distributed the survey to those employed as university or collegiate faculty members. Data collection occurred over a six-week period with reminder emails being sent at 1, 3 and 5 weeks post-distribution. The survey instrument was distributed to 716 faculty members. Although a total of 223 recipients responded to the invitation to participate, only 182 participants completed the survey, which resulted in a 25.4% return rate. A modified Scholarly Productivity Index (mSPI) was calculated (dependent variable) to objectively measure scholarly output in relation to both academic rank and institutional Carnegie Classification (independent variables). The mSPI was calculated by dividing the total number of scholarly products by the number of years spent in the respective productivity period. Along with descriptive statistics, an analysis of variance was used to determine if academic rank and institutional Carnegie Classification were associated with scholarly productivity. Significant results were evaluated with Games-Howell post hoc tests. **Results:** The mean mSPI scores across the traditional academic ranks were not statistically significant ($F_{2,179} = .239$, $P = .788$), with mean mSPI values ranging between 7.77 ± 1.66 and 9.38 ± 1.50 amongst assistant, associate, and full professors. Institutional Carnegie Classification was associated with scholarly productivity ($F_{4,67.3} = 3.603$, $P = .01$), with faculty members employed at institutions of higher education with a classification of Very High Research Activity (R1) having significantly higher mSPI scores (17.4 ± 3.73) as compared with faculty members at institutions with other designations. No statistical interaction was noted between academic rank and Carnegie Classification ($F_{14,41} = 1.597$, $P = .121$). **Conclusions:** The use of mSPI scores appears to be an acceptable means of benchmarking the scholarly productivity of athletic training faculty. Study results indicated that athletic training faculty are generally productive regarding scholarly output and tend to remain equally productive as they transition through the various academic ranks. Finally, institutional Carnegie Classification appears to play a significant role in faculty productivity.

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Gender Microaggression and Macroaggression Experiences of Women Athletic Trainers

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Context: Gender discrimination has not been widely studied in the profession of athletic training. Women in other industries have faced gender discrimination in the workplace. As the profession of athletic training is majority women, the issue of gender discrimination towards women is important to explore. The purpose of this study was to describe gender-based aggressions experienced by women athletic trainers (AT). **Methods:** A cross-sectional, web-based survey was used to explore the occurrence of gender discrimination experienced by women ATs within their working and educational environments. The survey was comprised of demographic questions, the Schedule of Sexism Events (SSE), and questions on incident reporting. The SSE ranks items on a Likert Scale (1 = the event never happened to 6 = the event happens almost all the time). Items within the SSE are contextualized to either event in the past year or events in their entire life. The survey was distributed to 5,667 women ATs through the NATA. 539 people accessed the survey (9.5%). 478 participants (age = 34.2 ± 8.63 years [range = 23 – 66 years], years of experience = 10.95 ± 8.2 years [range= 0 - 40 years]) completed the entire instrument (88.6% completion rate). Descriptive statistics were used to analyze demographic variables, gender-based work- and education-related items of the SSE, and incident reporting. **Results:** When asked about unfair treatment while interacting with teachers, professors, or engaging in academics, 89% (n=425) of participants indicated they experienced unfair treatment in their lifetime. Comparatively, 53% (n=252) women ATs experienced unfair treatment from teachers, or professors, or while engaging in academics in the last year. When asked about unfair treatment by an employer, boss, or supervisor, 88% (n = 421) of participants experienced unfair treatment in their lifetime where 55% (n=267) have experienced unfair treatment in the past year. When asked about unfair treatment by co-workers, fellow students, or colleagues, 90% (n=430) indicated they experienced unfair treatment in their lifetime compared to 61% (n=292) in the past year. When asked if they had experienced gender-based macroaggressions and microaggressions in the workplace, 41% (n=198) experienced both types of aggressions; 5% (n=22) experienced macroaggressions and 29% (n=137) experienced microaggressions. Alarmingly, only 25% (n=119) of participants have reported aggression in the workplace. **Conclusions:** Women ATs experience gender-based aggressions in the workplace within their lifetime; however, they are not reporting aggressions in the workplace. Future research should explore how gender-based aggressions influence athletic trainer retention in specific workplaces, settings, and the profession. Additional research can explore what strategies can be used to eliminate gender-based aggressions in the athletic training workspace. All ATs have the responsibility to work towards an inclusive, equitable, and welcoming workplace.

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Impact of COVID-19 on Athletic Training Services in Secondary Schools

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Context: During the 2020/21 academic year, secondary schools (SS) across the nation were affected by the emergence of COVID-19, requiring schools to suspend in-person attendance and athletic activities. With unprecedented disruptions to everyday school operations, athletic trainers in the SS setting saw changes to daily routines and interrupted or cancelled athletics schedules. The purpose of this study is to identify furlough of employment, no change in status, and odds of being furloughed by employment setting as reported by SS athletic trainers (SSATs) across the United States. **Methods:** Employment disruption related to COVID-19 questions were implemented in the Athletic Training and Locations and Services (ATLAS) survey prior to the start of the 2020/21 academic year (AY). The question, "Since March of 2020, did the school's AT services experience any of the following directly related to the COVID-19 pandemic? (Choose all that apply) - Selected Choice" was included to capture any disruptions in employment due to the pandemic. Response choices of interest included "furlough of AT by employer" and "no employment change". Survey responses were captured from August 1, 2020, through June 1, 2021. Respondents that took the ATLAS survey and answered the question during this time were included in analysis (n=2205). Employment providers of SSATs included Independent Contractors (IC), Medical or University Facility (MUF), and School District Employee with and without teaching responsibilities (SD). Pearson's Chi-Square (χ^2), contingency tables, and odds ratios (OR) were utilized to determine if there was a relationship between employment disruption, how the SSAT was employed during this time, and odds of the SSAT experiencing furlough of employment-by-employment setting. IC employed SSATs were removed from analysis given that they were self-employed and were not subjected to furlough during this time. **Results:** The 3x2 contingency table of employment disruption due to COVID-19 are in Table 1. Percent of SSATs employed by SD included 38.5% of survey responses (n=849/2205), while MUF employed SSATs were 58.2% (n=1284/2205) and lastly, IC accounted for 3.3% of the dataset (n=72/2205). Employment settings that saw the highest percent of SSATs furloughed were MUF (89%, n=525/589) while SD had the highest percent of no change in employment status (50%, n=819/1616). There was a significant relationship observed in SSAT employment setting (χ^2= 380.3, p=0.00) and job disruption. The odds ratio of a SSAT being furloughed during this time were 18.80 times higher (95%CI: 12.90, 27.64) in MUF employed SSATs when compared to SD employees. **Conclusions:** A significant relationship was observed between SSATs employment setting and employment disruption from the pandemic. Findings from this study observed MUF employed SSATs at 18.8 higher odds ratio of being furloughed compared to their SD colleagues. These findings are vital to key stakeholders to maintain continuity of healthcare in secondary school settings.

The Korey Stringer Institute is a non-profit organization within the Department of Kinesiology at the University of Connecticut. Corporate partners of KSI include the National Football League, Gatorade, the National Athletic Trainers' Association, Nielsen-Kellerman, CamelBak, Defib Tech, and First Line Technology. This original research abstract utilizes data from the Athletic Training and Locations Services (ATLAS) Project, which is co-owned by the NATA and KSI.

Table 1. Secondary School Athletic Trainer Employment Disruptions during the 2020/21 Academic Year. *Indicates statistical significance, p<0.05

Employment Setting	Furlough of AT services by the employer (n)	No employment status changes (n)	Total (n)	χ^2, p-value	OR, (95% CI) vs. SD
IC	34	38	72	195.9, p=0.00*	24.43 (13.55, 44.02)
MUF	525	759	1284	380.3, p=0.00*	18.80 (12.90, 27.64)
SD	30	819	849	NA	NA
Total	589	1616	2205		

Measure of Moral Distress for Athletic Trainers: A Mixed-Methods Validation Study

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Context: Moral distress occurs when a person knows the right course of action but feels they are unable to follow this action due to external constraints. Research has shown that health care providers frequently have feelings of moral distress, and these feelings can lead to burnout, medical errors, and moral disengagement. Moral disengagement is a process of convincing oneself that ethical standards do not apply typically caused by higher levels of moral distress. Current data shows that athletic trainers (AT) are at risk for moral disengagement due to job setting, but no data exists on perceived levels of moral distress across the profession. The Measure of Moral Distress for Health Care Professionals (MMD-HP) is a validated tool to measure levels of moral distress in health care professionals. However, the MMD-HP was validated with medical professions that typically work within a hospital setting. ATs work in settings outside of hospitals, and therefore many of the items within the MMD-HP might not be accurate to their experiences. Data on moral distress within ATs could lead to preventative actions related to burnout and moral disengagement. The purpose of this study is to validate a version of the MMD-HP in ATs (MMD-AT). **Methods:** The research team used a mixed methods validation design to establish face and content validity of the MMD-AT. Six individuals (3 practicing ATs, 2 educators/researchers; 1 retired AT) participated as expert panelists for review. The review process started with the MMD-HP, which consists of specific written scenarios that might cause moral distress. Participants rate both how frequently they experience such a situation on a 5-point Likert scale from "never" to "very frequently" and what level of moral distress they have felt or might feel if faced with such a situation on a 5-point Likert scale from "none" to "very distressing." For round 1, panelists received a document with the current MMD-HP items and were asked to respond to how the items related to their experience in athletic training with an opportunity to provide corrective feedback. For rounds 2 and 3, panelists were provided an electronic questionnaire via Qualtrics asking to indicate whether the item was "sufficient as written" or "needs attention." Comments related to the items were addressed between rounds. Only items that were deemed "sufficient as written" by 80% or more panelists were included in Round 4. In round 4, panelists were asked to score whether the items were relevant on a 4-point Likert scale using the Lynn process for content validity index (CVI). We used these scores to calculate an item-CVI (I-CVI) for each item. Items with an I-CVI of > .79 were deemed relevant. We also calculated a scale-CVI average with a benchmark score of .80 or higher as valid. **Results:** Four rounds of review established face and content validity for the MMD-AT. In round 1, panelists revised 19 items focusing on clarity and the usefulness in athletic training. In round 2, panelists revised 8 more items, this time focusing on grammatical issues. In round 3, panelists revised 5 additional items, with the revisions focused again on grammatical errors and clarity of understanding. In round 4, 80% (20/25) of the items had an item-CVI of > .79, deeming them relevant. Eliminated items were deemed irrelevant due to their focus on the hospital setting or to areas of health care that athletic trainers do not typically see (e.g. long-term palliative care). The overall tool also had a scale-CVI of .80, establishing content validity. **Conclusions:** The MMD-HPAT is a valid tool for the evaluation of moral distress within ATs. Measures of moral distress in athletic training can lead to greater vitality within the profession.

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Perceived Stress as an Indicator of Work-Family Conflict and Burnout Among Secondary School Athletic Trainers

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Context: Burnout and work-family conflict (WFC) has been thoroughly researched in the athletic training (AT) profession independently, where perceived stress has been sparsely researched. There is a gap in the literature as to how perceived stress is related to WFC and burnout. Perceived stress is an individual's perception and feelings toward how much stress they are experiencing at any given point of time. This can impact the day-to-day tasks of the athletic trainer, as well as lead to more chronic feelings of stress, burnout, and conflict. The perceived stress scale (PSS) was initially developed to be used to predict risk of health issues. Investigating PSS within athletic trainers would contribute to the literature regarding the AT's health and well-being, and its impact on quality of patient care provided. **Methods:** Objective: Investigate the relationship between PSS, WFC, and burnout among secondary school athletic trainers. **Patients or Other Participants:** Secondary school athletic trainers were recruited through the Athletic Training Locations and Services (ATLAS) database via email to participate in an online survey. 7,386 emails were sent in Spring 2021, 861 participants began the survey (11% response rate), and 831 surveys were completed (97% completion rate). 573 (195 males, 372 females, 3 transgender females, 3 not listed) responses remained after filtering for incomplete surveys. **Data Collection and Analysis:** A cross-sectional survey using Qualtrics LLC Software Program (Provo, Utah) was used to collect basic demographic information along with three scales: PSS, WFC, and Copenhagen burnout inventory. Frequency and descriptive statistics were analyzed, and scale scores were calculated as instructed. Nonparametric tests were used to determine any differences within scales between genders. Linear regression was utilized to investigate whether PSS is a predictor of WFC. **Results:** Perceived stress was moderately correlated with WFC ($r_s[573] = .562$, $p < .001$). No differences were found between men and women within the PSS scores (P= .223). Participants reported a mean score of 40.36 (? 15.63) on the WFC scale, 40.1 (? 16.28) on the burnout scale, and 15.99 (? 7.02) on the PSS. Perceived stress accounts for 26% of the variability for WFC (b = 1.13, t572 = 14.132, p = <.001). A significant regression was yielded (F[1,571] = 199.702, p <.001, and R2 of .259. **Conclusions:** Perceived stress is a predictor of WFC. However, perceived stress is not a predictor of burnout, until further research is completed. As the athletic trainer perceived a higher level of stress, this exacerbated their experiences of conflict between work and home. Burnout is a byproduct of unresolved prolonged stress, as the stress continues burnout is unfortunately inevitable. Stress should be further investigated as a predictor of factors that contribute to work-life balance, and the impact on the health of the athletic trainer.

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Ankle Joint Kinematics During Ankle Inversion Perturbation Among Chronic Ankle Instability, Coper, and Control Subjects

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Context: Lateral ankle sprains (LAS) are one of the most common sports-related musculoskeletal injuries and the mechanisms of LASs have been broadly investigated. In addition, individuals with chronic ankle instability (CAI) have consistently displayed altered neuromuscular control during inversion perturbation. However, little is known about the effects of anticipatory motor controls to ankle inversion perturbation during single-leg landing among CAI, coper, and control groups. The purpose of this study was to examine ankle joint kinematics during ankle inversion perturbation under anticipated and unanticipated conditions among CAI, coper, and control groups. **Methods:** This study design was a single cohort and controlled laboratory trial. Participants were categorized according to the Foot and Ankle Ability Measure (FAAM) and Ankle Instability Index (AII) questionnaires. Twenty-two CAI patients (M=11, F=11; 22±3 yrs, 174±8 cm, 71±10 kg, 84±19% FAAM ADL, 71±17% FAAM Sports, 6.4±1.1 AII), 22 matched controls (M=11, F=11; 21±2 yrs, 173±7 cm, 71±10 kg, 100% FAAM ADL, 100% FAAM Sports, 0 AII), and 22 matched copers (M=11, F=11; 21±2 yrs, 174±8 cm, 70±13 kg, 100% FAAM ADL, 100% FAAM Sports, 0 AII) participated. Participants completed 5 trials of both anticipated and unanticipated single-leg landing onto a tilted force platform (25º) from a height of 30cm while ankle joint kinematic data were collected using high-speed video (250Hz) and a force plate (1000Hz). Main outcome measures were ankle inversion angle at initial contact, time to maximum inversion angle, maximum inversion angle and velocity, and total ankle displacement. Two-way repeated ANOVAs (group × condition) were used to examine the differences between condition (Anticipated and unanticipated conditions) and group (CAI, coper, and control). **Results:** Table 1 shows that significant condition by group interactions for ankle displacement ($p<0.01$) and maximum ankle inversion velocity ($p=0.01$) were found. During the unanticipated condition, CAI and control subjects showed increased total ankle displacement compared to the anticipated condition (CAI: 4.8±2.8º vs 11.6±5.1º, $p<0.01$; Control: 4.4±3.5 vs 7.7±3.9º $p<0.01$). Moreover, only CAI patients displayed increased maximum inversion velocity under the unanticipated condition (116.4±67.6 º/s vs 256.6±128.0 º/s, $p<0.01$). However, copers did not show any differences in measurement outcomes between anticipated and unanticipated conditions. Regardless of group, ankle displacement (4.8±3.7º vs 8.6±4.9º, $p<0.01$) and maximum ankle inversion velocity (111.4±82.0 º/s vs 194.1±128.6 º/s, $p<0.01$) were increased whereas the inversion angle at initial contact was decreased (7.7±5.3º vs 4.6±4.7º, $p<0.01$) under the unanticipated condition. **Conclusions:** Present data suggest that CAI patients demonstrated more vulnerable ankle joint kinematics during ankle inversion perturbation under the unanticipated condition relative to copers and controls. However, copers displayed similar motor control patterns to controls under the anticipated and unanticipated condition, which may be a coping mechanism to prevent further injuries.

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Table 1
Ankle Kinematic data during anticipated and unanticipated trials (mean ± SD).

	Condition		p Value		
Variable	Anticipated	Unanticipated	Condition x Group	Condition	Group
Inversion angle at Initial contact (º)					
CAI	7.6 ± 5.4	3.9 ± 4.7			
Coper	8.5 ± 6.3	5.3 ± 5.7	0.77	**<0.01**[d]	0.50
Control	7.0 ± 4.2	4.7 ± 3.7			
Maximum Inversion Angle (º)					
CAI	12.4 ± 3.9	15.5 ± 4.6			
Coper	13.4 ± 4.4	12.5 ± 3.7	0.059	0.27	**0.02**[e]
Control	11.4 ± 3.4	11.5 ± 3.9			
Ankle Displacement (º)					
CAI	**4.8 ± 2.8**[a]	**11.6 ± 5.1**[b,c]			
Coper	5.2 ± 4.8	7.3 ± 4.5	**<0.01**	**<0.01**[d]	**<0.01**[e,f]
Control	**4.4 ± 3.5**[a]	7.0 ± 3.9			
Maximum Inversion Velocity (º/s)					
CAI	**116.4 ± 67.6**[a]	**256.6 ± 128.0**[b,c]			
Coper	115.4 ± 111.2	168.0 ± 114.5	**0.01**	**<0.01**[d]	**<0.01**[e,f]
Control	101.1 ± 60.9	152.5 ± 89.9			
Time to Maximum Inversion (s)					
CAI	0.08 ± 0.04	0.09 ± 0.04			
Coper	0.07 ± 0.03	0.07 ± 0.02	0.87	0.20	0.31
Control	0.07 ± 0.03	0.08 ± 0.03			

[a]: Differences between anticipated and unanticipated condition within Group
[b]: Differences between CAI and Control under the unanticipated condition
[c]: Differences between CAI and Coper under the unanticipated condition
[d]: differences between anticipated and unanticipated condition regardless of group
[e]: Differences between CAI and Control regardless of condition
[f]: Differences between CAI and Coper regardless of condition

Cross-Education Effects on Balance Performance in Individuals With Chronic Ankle Instability: A Systematic Review

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Context: Cross education effects can be defined as the performance improvement in the untrained limb after unilateral exercise training. Cross-education can be achieved by the interhemispheric communication in the brain that can allow unilateral activity to stimulate the ipsilateral motor cortex corresponding to the contralateral limb. Individuals with CAI experience a host of sensorimotor impairments, the most common of which is likely deficient balance. Since balance is sometimes deficient bilaterally in those with CAI, cross-education training could be a useful method for improving balance performance in this population. While some evidence supports its efficacy, no investigator has conducted a thorough review of the literature to determine how cross-education affects balance performance in people with CAI. Therefore, the aim of this study was to conduct a systematic review of existing literature of cross-education effects on balance performance in the CAI population. **Methods:** We conducted a literature search in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement via PubMed, SPORTDiscus, and CINAHL Plus. Search terms included (ankle instability) AND (rehabilitation OR therapy OR exercise OR intervention OR training). To be included in the systematic review, studies were required to be written in English, involve participants with CAI, have participants perform a unilateral therapeutic exercise for the lower extremity, and measure balance performance on the untrained lower extremity before and after the intervention. The quality of each article was evaluated through the Downs and Black checklist. Data were extracted based on study design, participants' characteristics, inclusion criteria, independent and dependent variables, intervention, and results. Baseline and post-intervention balance performance data of participants' untrained limbs were collected to calculate Hedge's g effect size and 95% confidence interval. **Results:** The initial search returned 2542 results, ultimately leading to six studies being included in this systematic review. Based on quality assessment, two studies were of good and fair quality with scores of 19 and 17 respectively, while remaining studies were of poor quality with scores less than 14. Studies varied in regards to which limb was trained (involved or uninvolved), methods of balance assessment, and modes of therapeutic exercise. Five studies reported a cross-education effect occurred, of which, four conducted balance training and one conducted ankle strengthening. Effect sizes indicate that three studies conducting balance training identified large, statistically significant cross-education effects on balance performance (Figure 1). **Conclusions:** Our result suggests that unilateral therapeutic exercise might improve balance performance on the untrained limb of individuals with CAI. However, due to the limited evidence regarding the cross-education effect for individuals with CAI, further studies are necessary to identify which training parameters are most effective for generating the cross-education effect for CAI patients.

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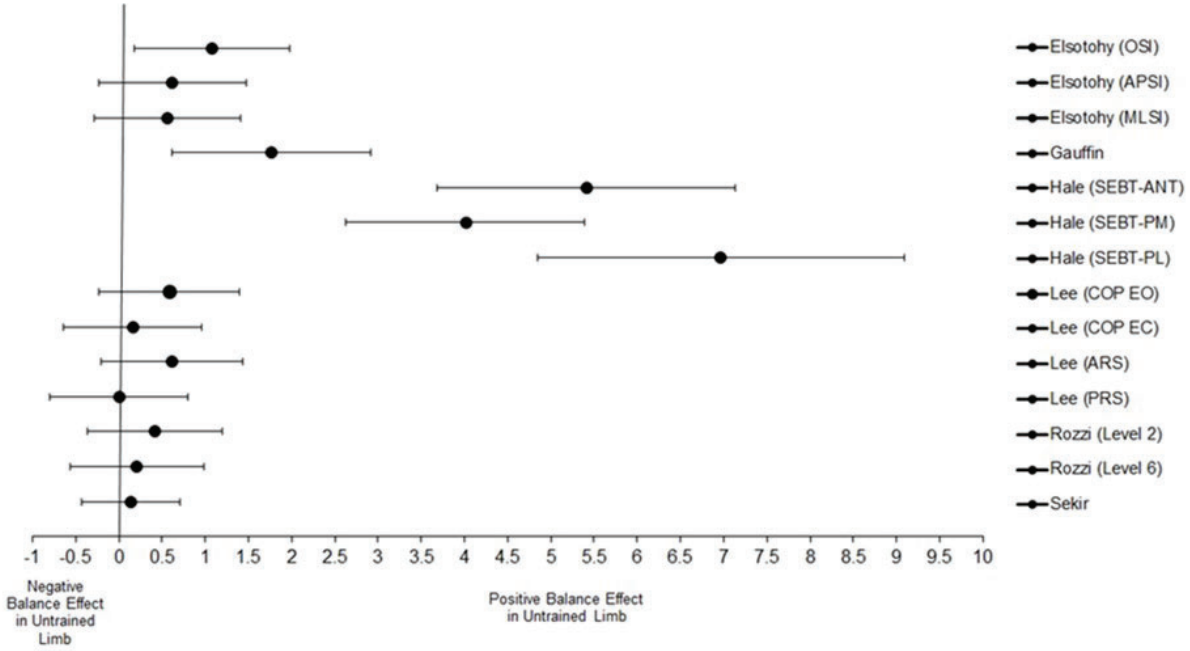
Figure 1. Cross-Education Effect Sizes of Included Studies



OSI, Overall stability index; APSI, Anterior-posterior stability index; MLSI, Medial-lateral stability index; SEBT-ANT, Star Excursion Balance Test-anterior; SEBT-PM, Star Excursion Balance Test-posteromedial; SEBT-PL, Star Excursion Balance Test-posterolateral; COP EO, Center of pressure eyes open; COP EC, Center of pressure eyes closed; ARS, Active reposition sense; PRS, Passive reposition sense.

Effects of Stroboscopic Glasses During 4-Week Balance Training on Time-to-Stabilization in Individuals With CAI

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Context: Individuals with CAI rely more on visual information during postural control due to impaired proprioceptive function. Rehabilitation involving stroboscopic glasses may help decrease visual reliance during postural control. The purpose of this study was to identify effects of balance training with stroboscopic glasses on reliance of visual information. **Methods:** This study was a laboratory randomized controlled trial. Forty-eight people with CAI were equally assigned to one of 2 groups: a strobe group (n=24, Age=24±3 years, Height=1.75±0.08 m, and Mass=72.2±12.2) or a control group (n=24; Age=21.5±2.3 years, Height=173.1±8.3 cm, and Mass=87.3±9.9). The 4-week dynamic balance (3 times a week) training included hop-based tasks, one-leg stance, etc. The strobe group wore stroboscopic glasses during the training, while the control group did not. Subjects performed a maximum jump from 70 cm away from a force plate and landed on the force plate before and after the training. During the landing, time-to-stabilization (TTS) was calculated in three directions: anteromedial, mediolateral, and vertical. Subjects performed the jump-landing under two visual conditions: eyes-open and strobe vision. A repeated measures ANOVA (Group x Time) were used to assess the influence of the stroboscopic glasses on postural control (TTS). **Results:** There was no significant difference in demographics between the groups. There was no significant interaction in TTS for all three directions ($P > .05$). Regardless of group, subjects showed shorter TTS-Vertical at the posttest compared to the pretest under the two visual conditions (Eyes-open: 2.1-s vs. 4.5-s, $P < .001$; strobe vision: 2.4-s vs. 4.2-s, $P < .001$). There were no group main effects ($P > .05$). **Conclusions:** The 4-week dynamic balance training was effective at enhancing dynamic postural control in individuals with CAI. However, there were no additional effects of balance training with stroboscopic glasses on postural control. Especially, balance training with stroboscopic glasses could not decrease visual reliance during dynamic postural control calculated by TTS. To sum up, stroboscopic glasses do not appear to be effective in both developing balance and decreasing visual reliance during dynamic postural control in individuals with CAI.

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Impact of Manual Therapy on Landing Kinematics and Kinetics in People With Chronic Ankle Instability

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Context: During landing, people with chronic ankle instability(CAI) display less plantarflexion in flight,1 greater inversion at initial contact,1 and shorter time to peak vertical ground reaction force(vGRF)2 which may lead to excessive talar loading and cartilage degeneration.3 Joint mobilizations(JM) and plantar massage(PM) are common manual therapies used to modulate neuromuscular control by restoring joint arthrokinematics4 and facilitating cutaneous receptor activity.5 However, the effects of multiple JM or PM treatments on landing biomechanics in people with CAI remains unknown. The purpose of this study was to determine the impact of two weeks of JM or PM treatments compared to no treatment on landing kinematics and kinetics in people with CAI. **Methods:** Fifty-seven participants with CAI volunteered for this study (Age: 20.9±3.2 yrs, Height: 171.8±9.8 cm, Mass: 72.0±13.6 kg, No. Sprains: 4±3, Ankle Instability Instrument: 7.3±1.3 yes responses, Foot and Ankle Ability Measure – Activities of Daily Living: 79.0±11.3%). Participants were randomized into three groups (JM: n=20, PM: n=19, Control n=18). Grade 3 anterior-posterior JMs were applies to the talocrural joint. PM was applied as effleurage and petrissage to the plantar foot. Participants in the treatment groups received 6 treatments (2 min on, 1 min off, 2 min on) over 2 weeks. The control group maintained their normal activity. Double limb landing biomechanics were captured immediately before treatments began and within 72 of the final treatment. Control participants completed baselines and posttests 2 weeks apart. Sagittal plane ankle position 200 ms prelanding(flight), frontal plane ankle position at initial contact, peak vGRF, and time to peak vGRF were calculated at baseline and posttest sessions. **Results:** Separate 2x3 repeated measures ANOVAs (Group X Time) were used to examine baseline to posttest changes between groups. No significant differences were noted for sagittal ankle plane position during flight ($F_{(2,54)}=0.653$, $p=0.525$), ankle frontal plane position at initial contact($F_{(2,54)}=1.682$, $p=0.196$), or peak vGRF($F_{(2,54)}=0.024$, $p=0.976$). However, there was a group x time interaction effect for time to peak vGRF($p=0.018$) with PM group having longer time to peak vGRF at posttest (mean difference=0.005s, $p=0.015$, effect size: $g=0.46$). No differences in time to peak vGRF were identified for the JM or control groups. **Conclusions:** In those with CAI, two weeks of PM increases time to peak vGRF creating a longer time to attenuate landing forces. Neither JM or PM altered biomechanics during flight or initial contact in those with CAI. While speculative, PM may help those with CAI attenuate landing by priming neural activity in the lower leg to improve muscle spindle activity. However, the small effect size suggests that this treatment may not have a large clinical impact. While JM are effective at improving other CAI related impairments,6 we cannot recommend their use with the intent to alter landing biomechanics.

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Neither the Use of Neuromuscular Electrical Stimulation Nor Transcutaneous Electrical Nerve Stimulation Improves Dynamic Balance or Function in Patients With Chronic Ankle Instability

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Context: Neuromuscular electrical stimulation (NMES) and transcutaneous electrical nerve stimulation (TENS) are frequent interventions in clinical settings used to restore muscle function after injury. Although commonly used in models of knee ligament injury, its use in ankle injury and the treatment of chronic ankle instability (CAI) is less common, despite both injuries being tied to neuromotor dysfunction. We therefore aimed to determine if a 2-week intervention with TENS or NMES improved dynamic balance or functional status in patients with chronic ankle instability. **Methods:** Twenty participants with CAI, identified through the Identification of Functional Ankle Instability instrument (IdFAI, >10) and history of injury, were recruited for this study and randomized into NMES (4M/7F, 23.6±4.7yrs, 169.3±13.1cm, 74.5±17.5kg) or TENS (4M/5F, 21.9±4.1yrs, 172.6±10.1cm, 73.0±18.7kg) groups. Subjects were assessed for dynamic balance through a forward 70cm double-to-single leg hop-to-stabilization, with dynamic postural stability indices (DPSI) extracted. Functional status was assessed through the side-hop test where participants hop laterally 10 times over 2 lines, 30cm apart as quickly as possible. Patient-reported function was assessed using the Foot & Ankle Ability Measure activity of daily living (FAAM-ADL) and sport (FAAM-sport) subscales, and the Disablement in the Physically Active Scale (DPAS). Variables were measured at baseline, following the 2-week intervention (post), and 2-weeks after the intervention (retention). The intervention consisted of 10 sessions over two weeks of 11 minutes of either NMES (10s:50s on/off, 2s ramp, 75Hz burst frequency, 250μsec duration, sub-noxious level) or TENS (100Hz, 100μsec, suprasensory threshold). Data were compared with factorial analysis of variance with the between-subjects factor of group (TENS vs. NMES) and within-subjects factor of time (baseline, post, retention) (α=0.05). **Results:** Means & standard deviation are presented in the Table. No group-by-time effects were observed for DPSI(F[2,36]=0.079, P=0.924). No group-by-time effects were observed for the side-hop test (F[2,36]=0.142, P=0.868). Similarly, no group-by-time effects were noted for any patient-reported outcome measures (FAAM-ADL: F[2,32]=0.500, P=0.611; FAAM-Sport: F[2,32]=1.456, P=0.248; DPAS: F[2,30]=2.045, P=0.147). Similarly, no main effects of time were observed for any variables (p>0.05). **Conclusions:** Our data suggest that neither the use of NMES nor TENS in isolation over 2 weeks results in statistically significant improvements in balance or other functional measures in patients with chronic ankle instability. While uncommon that these interventions would be provided without the addition of rehabilitation exercises, both NMES & TENS have been documented to provide neuromodulatory effects that could contribute to motor disinhibition. However, these data largely come from models of knee joint injury, and do not seem to hold true at the ankle joint.

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	NMES			TENS			
	Baseline	Post	Retention	Baseline	Post	Retention	p
DPSI	0.508 (0.056)	0.505 (0.046)	0.507 (0.056)	0.488 (0.042)	0.486 (0.047)	0.494 (0.045)	0.924
SHT (s)	14.1 (6.1)	13.6 (10.3)	12.6 (6.7)	13.8 (5.1)	12.5 (3.4)	13.4 (4.6)	0.868
FAAM-ADL (%)	97.1 (2.1)	97.4 (2.9)	96.5 (4.5)	96.9 (5.6)	95.9 (8.1)	96.9 (5.7)	0.611
FAAM-Sport (%)	91.4 (7.0)	92.9 (9.4)	92.9 (9.1)	92.9 (9.2)	88.8 (13.1)	89.7 (14.3)	0.248
DPAS	9.6 (4.9)	5.6 (6.8)	5.4 (7.7)	6.0 (6.5)	6.4 (7.5)	6.0 (7.3)	0.147

Table: Means (standard deviations) for dependent variables. *DPSI:* dynamic postural stability index; *SHT*: side-hop test; FAAM-ADL, Foot & Ankle Ability Measure Activity of Daily Living Scale; FAAM-Sport, Foot & Ankle Ability Measure Sport Subscale; DPAS, Disablement in the Physically Active Scale

The Association Between Injury-Related Fear and Drop-Landing Kinetics in Dysfunctional Breathers With Chronic Ankle Instability

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Context: Injury-related fear and altered jump-landing kinetics have been identified in patients with CAI and considered as important contributors to successful rehabilitation and recovery. Recently, previous investigations have identified alterations in diaphragm contractility and breathing mechanics in individuals with CAI. The diaphragm and breathing patterns contribute significantly to an increase in fear-avoidance via a complex neural interaction between the brainstem, the limbic system, and the cerebral cortex. Previous work has documented potential associations between injury-related fear and jump-landing mechanics in patients across other musculoskeletal conditions. However, an influence of injury-related fear on landing kinetics in CAI athletes with dysfunctional breathing patterns is currently unknown. Therefore, the purpose of this study was to investigate the association between injury-related fear and single-leg drop landing kinetics in CAI athletes with dysfunctional breathing patterns. **Methods:** A cross-sectional study design was used for this investigation. Participants were recruited from middle and high schools, and 17 adolescent female athletes (Age=15.0±1.6yrs; Height=158.2±4.5cm; Body Mass=52.3±8.3kg), who have CAI as defined by the International Ankle Consortium guidelines, with dysfunctional breathing patterns volunteered to complete a single test session at each school. Breathing patterns were assessed using the Hi-Lo breathing test in the standing position. Athletes were included as dysfunctional breathers if they displayed superior rib cage migration and no visible anterior-posterior abdominal excursion. Injury-related fear was assessed with the 17-item version of the Tampa Scale of Kineshiophobia (TSK). Landing kinetics were assessed during the single-leg drop landing task, and six trials of ground reaction force (GRF) data were recorded with a force plate. During the single-leg drop landing task, participants jumped and landed on the same limb. Variables of interest include time to stabilization (TTS), rate of force development (RFD), peak vertical GRF (vGRF), peak mediolateral GRF (ML-GRF), and peak anteroposterior GRF (AP-GRF). Each kinetic variable was normalized as a percentage of body mass (%). Spearman's rank correlation analysis was employed to examine correlations between the TSK and kinetic variables. Significance was set at $P < 0.05$. **Results:** Fair to moderate correlations of TSK (36.8±7.2) were observed with peak ML-GRF(37.6%±12.6, r=0.44, P=0.04). No significant correlations of TSK were observed with other drop landing variables (TTS: -r=0.01, P=0.47; RFD: r=0.36, P=0.08 peak vGRF: r=0.17, P=0.26; peak AP-GRF: r=-0.31, P=0.11). **Conclusions:** Our findings indicate that an increase in injury-related fear may associate with an increase in peak ML-GRF during the single-leg drop landing task in youth dysfunctional breathers with CAI. High levels of injury-related fear could be a potential source for altered landing kinetics in CAI athletes, especially with dysfunctional breathing patterns. Future investigation is needed to determine whether incorporating diaphragm breathing exercises has beneficial effects on reducing injury-related fear and improving landing mechanics in CAI patients with dysfunctional breathing patterns.

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The Effects of Joint Mobilization on Dorsiflexion Range of Motion in Patients With Chronic Ankle Instability: A Critically Appraised Topic

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Context: Ankle instability is prevalent in the active population and can potentially lead to lasting ligamentous laxity and reduced range of motion (ROM) and even chronic ankle instability (CAI). Joint mobilizations have long been used to improve joint ROM after injury to restore normal joint arthrokinematics. In athletes with CAI, how does the use of joint mobilizations effect dorsiflexion (DF) ROM? **Methods:** Google Scholar, PubMed, CINAHL Complete, MEDLINE with Full Text, Science Full Text Select, SPORT Discus with Full Text databases were searched in October 2021. The primary search terms used were: (Athletes OR Athletics) AND (Joint Mobilizations OR Joint Manipulation) AND (Range of Motion OR Functionality) AND (Ankle OR Ankle Instability). Studies were included if they evaluated patients with ankle instability, included joint mobilization as the intervention, and were published within the past 10 years. Outcome assessed was ROM measured via the weight bearing lunge test (WBLT), or DF ROM. Pre- and Post-intervention measurements were analyzed using calculated 95% confidence intervals. Additionally, effect sizes were calculated between pre- and post-intervention. The PEDro scale was used to assess validity. **Results:** Titles and abstracts of 182 studies were reviewed and 16 studies were selected for full text screening. After secondary screening 3 randomized control trials (RCT) were analyzed for this critically appraised topic. Confidence intervals (CI) and effect sizes (ES) were calculated, except for one reported by the authors. In the first RCT a statistically significant ($F_{1,28}$)=4.252, P=0.049) group-by-time interaction for DF ROM was noted. There was a statistically significant (t14=2.296, P=0.040) increase in DF ROM between pretest 17.4+6.5(95%CI:14.04,20.76) and posttest 20.1±6.6 (95%CI:16.69,23.51) when compared to the control group pretest 18.2±5.6 (95%CI:15.31,21.09) and posttest 17.8±4.1(95%CI:15.68,19.92) ROM. This represented a moderate effect (d=0.42) between the mobilization and control group. The second RCT noted a significant (P=0.005) increase in WBLT DF ROM from pretest [Median=8.25 (Lower Quartile=3.42, Upper Quartile=12.42)] to posttest [Median=9.29 (Lower Quartile=5.42, Upper Quartile=16.13)] in the self-mobilization group. This equaled a large effect (d=0.89) while the clinician applied mobilization group failed to demonstrate a statistically significant difference. The third RCT noted a statistically significant ($P < 0.001$) different group-by-time interaction between the control (posttest: 53.41±1.92 (95% CI:52.71,54.11), sham (posttest 53.83±1.71 (95% CI:53.2154.45) and experimental groups (posttest 60.54±1.67 (95% CI:59.93, 61.15). The mobilization group had a substantial effect (d=4.03) from pretest to posttest. There was negligible to low effect sizes (d=0.04, d=0.06) within the control and sham-mobilization groups respectively. There was a substantial between-group ES (d=3.96) between the control and mobilization groups. First RCT PEDro (7 / 10), second and third RCT PEDro (8 / 10). **Conclusions:** There is SORT level C evidence to support the use of joint mobilizations to increase DF ROM in patients with CAI. This conclusion is based on high-level disease-oriented evidence.

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Assessment of Concussion Recovery Using a Dynamic Stability Task

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Context: Researchers have suggested that lower-extremity musculoskeletal injury risk after concussion is significantly higher compared to a non-concussed teammate. The risk remains elevated for up to a year after return to play (RTP) and has been associated with dynamic balance deficits. Monitoring concussion recovery includes, in part, assessment of static balance through clinical tests. Research has suggested that clinical assessment of static postural stability may not challenge an athletic population enough to discern the quality of neuromuscular control of balance. The use of a dynamic, sport-related movement may improve assessment around the time of RTP. The purpose of this study was to determine if concussed athletes (CONC) have worse dynamic stability around RTP than healthy controls (HC) when assessed using a single-leg landing task. **Methods:** Concussed intercollegiate football athletes (n=9, 19 ± 2 years, 1.87 ± 0.08 m, 96.0 ± 19.9 kg) were assessed over the course of their recovery and matched to HC teammates (n=7, 20 ± 2 years, 1.88 ± 0.03 m, 104 ± 18.5 kg). The task used to assess dynamic postural control was a single-leg (dominant) landing from a jump onto a force plate. The landing was assessed from both forwards and lateral jumps, with both jumps occurring over a 6" hurdle from 70 cm away. Measurement occurred on 3 occasions spanning the RTP date. The assessment timepoints included the first day of the standard concussion return-to-play protocol (RTPP1, 24 hours symptom-free, mild exertion), the fifth day (RTPP5, full participation), and one week after the second test date (POST). The dynamic postural stability index (DPSI), a root-mean-square measure of the ground reaction forces from the first 3 seconds after landing, was used to assess dynamic stability. A two-factor repeated measures ANOVA (task direction, time; α=0.05) tested the CONC DPSIs. Independent t-tests (α=0.05) with correction for multiple comparisons compared CONC at each point to HC. **Results:** The DPSI was significantly lower in the lateral hop compared to the forward jumps for both groups ($p = .024$). The CONC DPSI at POST was significantly lower than both RTPP1 ($p = .002$) and RTPP5 ($p < .001$). In comparison to HC, CONC DPSIs were significantly lower at 1-week post-RTP in the forward ($p = .034$) and lateral ($p = .006$) directions. **Conclusions:** One week after clinical recovery from concussion and with full athletics participation, the CONC group showed improved stability. While plausible, the CONC group also performed better than HC on both hop directions at this same point. This was unexpected, as it was believed a more challenging task may elicit postural control deficits even after RTP had occurred. Overall, a different implementation of a dynamic task may help determine if there are any lingering effects of concussion during recovery.

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Associations Among Concussion History, Mental Health History, Mental Health Stigma, and Mental Health Care-Seeking/Readiness

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Context: Mental health (MH) treatments post-concussion effectively mitigate emotional symptoms. However, negative stigma surrounding MH and treatment may be a care-seeking barrier. Despite this evidence, minimal research has investigated concussion, MH stigma, and MH care-seeking/readiness. Therefore, this study's purpose was to investigate differences in MH history (symptoms, diagnoses, and treatments), perceived MH stigma, perceived psychotherapy care-seeking barriers, and psychotherapy readiness between those with and without a concussion history. **Methods:** This study was a cross-sectional, online survey with recruitment occurring through social media, snowball, and email recruitment mechanisms. The survey scales are commonly used and were previously validated. The independent variable was concussion history (yes/no). Dependent variables included: 1) presence of MH symptoms (yes/no); 2) MH diagnosis history (yes/no); 3) MH treatment history (yes/no); 4) perceived MH stigma (STIG-9, nine questions rated from 0=disagree to 3=agree, range=0-27); 5) perceived psychotherapy stigma (five questions rated from 1=strongly disagree to 5=strongly agree, range=5-25); 6) perceived psychotherapy barriers (six questions rated from 1=strongly disagree to 5=strongly agree, range=6-30); and 7) psychotherapy readiness (Readiness for Psychotherapy Index, 20 questions rated from 1=strongly disagree to 5=strongly agree, overall readiness score was calculated from the four subscale scores using the following equation: [(perseverance+openness+distress)-disinterest], range=5-70). Higher scores indicated higher perceived MH stigma, perceived psychotherapy barriers, and psychotherapy readiness. Separate binomial regression models identified the association between concussion history and MH symptoms, diagnosis, and treatment history. Separate linear regression models identified the association between concussion history and perceived MH stigma, perceived psychotherapy barriers, and psychotherapy readiness. **Results:** Overall, n=304 completed the survey and were used in analyses (79.14% female, 85.05% white, and 32.45% with a concussion history). Overall, 85.26% of those with a concussion history and 84.08% of those without reported MH symptoms. In those with a concussion history, 44.19% reported worsening MH symptoms post-concussion yet only 20.59% reported seeking MH treatment post-concussion. There were no associations between concussion history status and self-reported MH history (symptoms, diagnoses, and treatments), perceived MH stigma, perceived psychotherapy stigma, perceived psychotherapy barriers, and psychotherapy readiness ($p>0.05$). Although not significant, reporting a MH diagnosis history was slightly higher in those with a concussion history (72.45%) vs. without (62.75%). Similarly, receiving MH treatment was slightly more prevalent in those with a concussion history (80.72%) vs. without (76.02%). **Conclusions:** Results indicate similar perceived MH stigma, care-seeking barriers, and psychotherapy readiness between those with and without a concussion history. Additionally, in those with a concussion history, gaps exist between those who experience worsening MH symptoms post-concussion and those who seek MH treatment. Future research is necessary to identify whether access to MH resources, MH stigma, and/or other barriers my explain this gap in post-injury care and overall MH care-seeking.

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Comparing Clinical Presentations of Concussions in High School Girls' Sports: 2014/15-2018/19

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Context: Inherent differences in gameplay between high school (HS) sports may necessitate that athletic trainers (ATs) take different approaches to clinical management of sport-related concussion (SRCs) occurring in various sports. While previous studies have characterized the epidemiology of SRCs in HS sports, targeted examinations are needed to elucidate differences in SRC presentation between sports with varying head impact dynamics in gameplay. To this extent, among HS girls' sports, soccer is dissimilar to all others. We hypothesize that symptom characteristics of SRCs in HS girls' soccer will be different than in other girls' sports due to differences in gameplay-related head impacts in soccer as compared with other HS girls' sports. Methods: SRCs in HS girls' sports captured within the National High School Sports-Related Injury Surveillance Study (HS Reporting Information Online (RIO)) during the 2014 / 15 – 2018 / 19 academic years were examined. ATs at participating institutions reported SRCs and accompanying symptom characteristics. Rates (per 10,000 AEs) were estimated; symptom prevalence (expressed as a proportion), total symptom count (summarized as medians and interquartile ranges (IQRs)), and symptom resolution time (SRT; categorized as < 7 days, 7-21 days, ≥ 21 days) distributions were used to characterize SRCs in each sport individually, and within a pooled sample of all sports excluding soccer. Differential symptom prevalence was examined using Prevalence Ratios (PR); PRs with 95% Confidence Intervals (CIs) excluding 1.00 were deemed significant. Wilcoxon Rank Sum tests were used to compare total symptom counts, and X2 tests were used to compare SRT distributions between SRCs in girls' soccer and the pooled sample of other girls' sports; statistical significance was evaluated at the 0.05 level. Results: A total of 989 soccer-related SRCs and 1,539 SRCs in other sports were analyzed. Among soccer-related SRCs, headache (96.2%), dizziness (71.7%), and difficulty concentrating (55.2%) were the mostly prevalently reported symptoms. While similar patterns were observed among SRCs in other sports (Table 1), the prevalence of confusion / disorientation was lower (PR= 0.89; 95%CI: 0.79, 0.99), and the prevalence of dizziness was marginally higher (PR= 1.06; 95%CI: 1.01, 1.11) in this group than in soccer-related SRCs. Notable differences were observed when comparing soccer-related SRCs with SRCs in other sports (particularly field hockey, and lacrosse) for prevalence of dizziness, difficulty concentrating, disorientation and irritability (Table 1). Total symptom count (z= 1.10, p= 0.27) and distributions of SRT (X2= 5.1, p= 0.08) were comparable between SRCs in girls' soccer and other sports. Conclusions: Findings indicate that clinical presentations of SRCs may vary between athletes of girls' soccer and other sports in HS, although clinical outcomes may be comparable. Future research may be directed towards better understanding the relationships between repetitive head impact exposure and SRC symptom presentations in HS girls' sports athletes.

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Table 1. Characteristics of concussion symptom presentations in High School Girls' Sports reported within High School Reporting Information Online (HS RIO™) 2014/15-2018/19

	GSOC (n=989) IR= 8.0	OTH (n=1,539) IR= 3.2	GVB (n= 403) IR= 3.2	GBB (n=600) Rate= 3.6	GSB (n=223) IR= 2.3	GFH (n=94) IR= 2.7	GLAX (n=219) IR= 4.4
Nausea	26.8	28.7	27.0	30.7	29.6	28.7	25.6
Sensitivity to Light	57.4	55.8	54.1	58.5	53.8	58.5	52.1
Sensitivity to Noise	39.3	38.7	39.2	41.7	35.4	31.9	35.6
Dizziness	71.7	75.9	78.7	75.3	70.9	79.8	75.8
Loss of Consciousness	1.2	0.6	0.0	1.2	0.9	0.0	0.0
Headache	96.2	95.8	95.5	95.3	96	96.8	96.8
Tinnitus	6.6	5.1	4.2	6.0	6.3	2.1	4.6
Amnesia	8.1	6.6	5.7	8.5	5.4	3.2	5.9
Difficulty Concentrating	55.2	52.5	54.1	54.3	51.6	43.6	49.3
Confusion/Disorientation	35.5	31.3	34.0	33.0	29.6	22.3	26.9
Hyperexcitability	1.8	1.6	1.0	2.2	0.9	1.1	2.3
Irritability	16.0	13.5	10.9	17.5	11.2	9.6	11.0
Drowsiness	36.7	33.0	33.0	34.8	30.9	33.0	30.1
Median Total symptom count (IQR)	4.0 (3.0)	4.0 (3.0)	4.0 (3.0)	4.0 (3.0)	4.0 (3.0)	4.0 (2.0)	4.0 (2.0)
SRT < 7 days	38.2	43.0	44.4	42.5	42.6	50.0	38.8
SRT 7-21 days	38.0	35.7	36.2	35.5	36.8	10.6	38.8
SRT > 21 days	8.1	7.0	6.2	5.3	8.5	13.8	9.6

Note: GSOC- Girls' soccer, OTH- all other girls' sports, GVB- girls' volleyball, GBB- girls' basketball, GSB- girls' softball, GFH- girls' field hockey, GLAX- girls' lacrosse, GSWIM- girls' swimming and diving; IR- injury rate per 10,000 athlete exposures; SRT- all symptom resolution time. Symptom prevalence expressed as a fraction of all reported concussions that presented with a given symptom. Symptom resolution time expressed as a distribution of all concussions with reported symptom resolution times (SRT was not reported in ~15% of all concussions analyzed).

Comparing Knowledge of and Attitudes Towards Concussions Between Collegiate Athletes Who Are Deaf or Hard-of-Hearing and Athletes Who Are Hearing

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Context: Individuals who are deaf or hard-of-hearing (D/HoH) participate in collegiate athletics, however, little to no evidence is available regarding their knowledge of and attitudes towards concussions. The objective of this study was to examine differences between collegiate athletes who are D/HoH and athletes who are hearing regarding knowledge of and attitudes towards concussions. **Methods:** Data from this cross-sectional survey were collected through a web-based survey platform (Qualtrics LLC, Provo, UT) from two National Collegiate Athletic Association Division III athletic programs. One of these universities is specifically designed to be barrier-free for students who are D/HoH. Three-hundred-ten athletes who are D/HoH and 430 athletes who are hearing were invited to participate in the study. Three recruitment emails were sent over 7 days. One-hundred-thirty athletes (70 athletes who are D/HoH; 60 athletes who are hearing) completed the survey (17% response rate). The questionnaire used was the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS). The 40-question RoCKAS consists of the concussion knowledge index (CKI, sections 1, 2, and 5) and the concussion attitudes index (CAI, sections 3 and 4). The CKI included 14 basic true-false items, 3 applied true-false items, and recognition of eight common concussions symptoms. The score ranges from 0-25, with higher scores (i.e. larger number) suggesting a higher level of knowledge. The CAI included 15 items (5-point Likert scale, strongly disagree to strongly agree). The score ranges from 15-75, with a higher score (i.e. larger number) suggesting a safer attitude. Independent t-tests were performed to determine differences in the CKI, symptom score, and CAI between athletes who are D/HoH and athletes who are hearing. Alpha level was set a priori at $p=0.05$. **Results:** Two athletes did not pass the interval validity scale of the RoCKAS and were not included in the final analysis. Athletes who are hearing demonstrated a higher CKI component mean score (19.83±0.29) compared to athletes who are D/HoH (16.52±0.30) ($t(126)=6.63$, $p<0.001$). Specifically to concussion symptom recognition (section 5), athletes who are hearing were able to recognize more concussion symptoms (6.93±1.11) compared to athletes who are D/HoH (5.51±2.00) ($t(126)=4.86$, $p<0.001$). There was no significant differences in the CAI between athletes who are hearing (46.85±3.41) and athletes who are D/HoH (47.30±4.00) ($t(126)=-0.69$, $p=0.487$). **Conclusions:** These results suggests that athletes who are D/HoH have poorer knowledge of concussions and symptom recognition skills but similar attitudes towards concussion as that of athletes who are hearing. Current concussion educational interventions are either in written or spoken form and may not be inclusive to athletes who are D/HoH. Health care professionals should consider an athlete's preferred mode of communication in order to improve the efficiency and effectiveness of concussion education.

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Comparison Between Adult and Youth Lacrosse Helmet Impact Mitigation Capabilities

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Context: Although it is reported that boys' and men's lacrosse participants experience head impacts of similar magnitudes, the biomechanics and consequences of impacts to youth and adult athlete heads differ substantially. Youth athletes do not have well developed neck musculature and youth athletes have a higher injury risk for any given impact compared to adults. However, it is unknown how the impact attenuation properties of youth helmets compare to adult helmets. Therefore, this study aims to benchmark the relative impact mitigation performance of these categories of lacrosse helmet. **Methods:** Three youth helmets from two manufacturers and three adult helmets from two manufacturers (total n=12) were tested on a custom pendulum apparatus. Helmets were fit on an appropriately sized NOCSAE head form (small for youth, medium for adult) and impacted at two velocities (1.5 and 2.9 m/s) at four locations on the head (front, front boss, side, and rear boss). Nine accelerometers in a 3-3-3 configuration recorded peak linear acceleration (PLA) and peak rotational acceleration (PRA). Independent variables included helmet type (youth, adult), manufacturer (Cascade or Schutt), and impact location (front, front boss, rear boss, side) **Results:** The mean PLA and PRA of the headform following impact at four locations at two velocities are reported in figures 1. A mixed model ANOVA yielded significant interaction ($F_{9,24} = 4.438$, $P = 0.002$, $\eta p2 = 0.625$). For the rear boss location, statistically significant differences were seen between the Cascade adult with both of the Schutt helmets (Youth: $P = 0.006$, Adult: $P = 0.001$). The Cascade youth helmet was also statistically difference from the Schutt Adult ($P = 0.031$). All other pairwise comparisons at the different locations were not statistically different. **Conclusions:** While all helmet impacts resulted in accelerations that were well below established injury thresholds, youth helmets surprisingly outperformed adult helmets in mitigating PLA. Youth and adult helmets performed similarly in mitigating PRA, which has been hypothesized to play a larger role in injury generation than PLA.

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Development and Validation of a Novel Concussion Documentation Audit Tool

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Context: Concussions are complex conditions that ATs evaluate and manage; however, research indicates that ATs are not engaging in high-quality documentation practices for concussion evaluation. To date, there is no comprehensive tool available for ATs to evaluate their concussion documentation patterns. Therefore, this study aimed to develop and validate a novel Concussion Documentation Audit Tool (CDAT) to assist ATs in auditing their concussion documentation for completeness. **Methods:** To develop the CDAT we conducted a thorough literature review of best practices for concussion evaluation and medical documentation; we identified 36 critical components for initial concussion evaluation documentation. To establish face and content validity, a panel of healthcare professionals with diverse expertise reviewed and provided feedback on the content and structure of the CDAT, which was subsequently updated per their recommendations. The 36 established criteria had values assigned with 2 points when the criterion was fully met, 1 point when the criterion was partially met, and 0 points when the criterion was not met. Two rounds of piloting, totaling 12 concussion notes, were completed by 3 auditors (certified ATs with 2-35 years' experience), and the CDAT was further revised based on those pilots. To establish concurrent validity, 2 certified ATs (10+ years of experience each) subjectively rated those same notes as "very good", "good", "fair", or "poor", which were converted to numerical scores of 100%, 75%, 50%, and 25% respectively. A convenience sample of 53 notes from 2 local clinical sites (1 high school, 1 college) were graded using the CDAT and the subjective rating rubric. Agreement between CDAT and subjective rating scores as well as concurrent validity were evaluated using Bland-Altman analyses and Spearman ρ correlation, respectively ($p < 0.05$). **Results:** The 36 critical components included in the CDAT were divided into four subsections based on expert feedback: history (9 items), presentation (10 items), physical exam (10 items), assessment and plan (7 items). Bland-Altman analyses (Figure) indicated poor agreement between CDAT and subjective scores (-14.6±10.8% [95% CI: -17.6,11.6], $p < 0.001$). CDAT and subjective scores had a strong positive correlation ($\rho=0.81$, $p < 0.001$). **Conclusions:** Scores on the CDAT were approximately 14% lower than subjective assessment, indicating the completeness of initial concussion documentation may be overestimated by ATs, supporting the need for a standardized audit tool like the CDAT. Expert validation, in conjunction with the strong relationship between CDAT and subjective scores, endorse the tool's validity to audit the completeness of initial concussion documentation. Future research should aim to use the CDAT to audit a broader sample of concussion documentation notes and explore the utility of the CDAT for quality improvement within healthcare organizations and as a learning apparatus for athletic training students.

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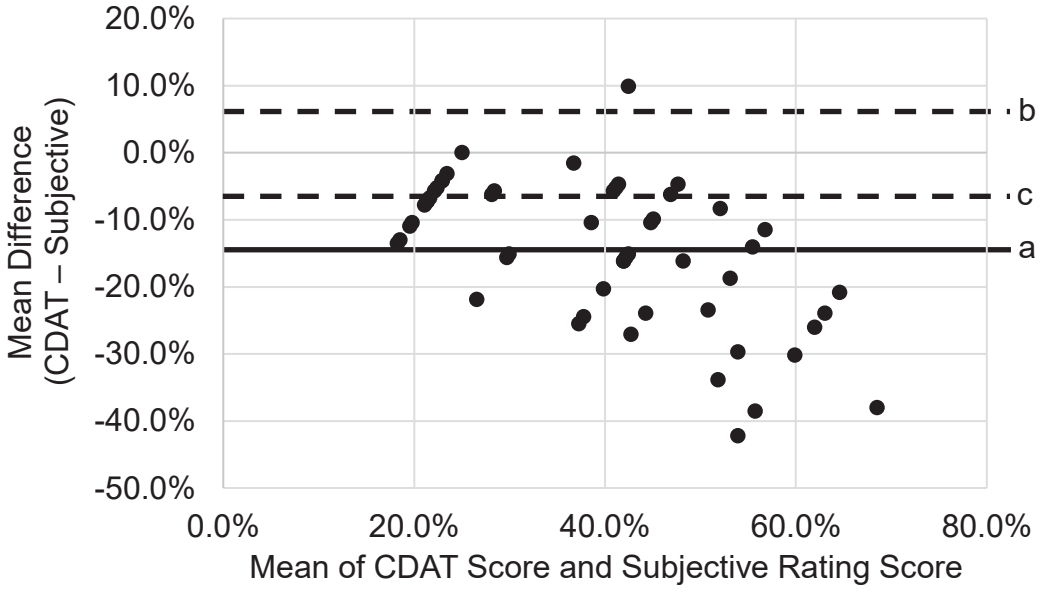

Figure. Bland-Altman Plot for CDAT Score and Subjective Rating Score Agreement. a indicates mean difference, b indicates upper limit of agreement, c indicates lower limit of agreement.

Differences in Visual and Sensorimotor Skills in College Students With and Without a History of Concussion

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Context: Visual and sensorimotor assessments are utilized following concussion due to the influence these systems have on successful return to school and sport. Current research has demonstrated deficits in depth perception, reaction time, and eye-hand coordination following concussion. However, there is limited evidence examining if there are persistent deficits in visual and sensorimotor skills in college students with a history of concussion. Deficits in these areas may contribute to academic and athletic challenges, along with the potential for subsequent injury. Therefore, the purpose of this study was to examine differences in visual and sensorimotor skills in college students with a history of concussion compared to those without a history of concussion. **Methods:** A cross-sectional study of college students was performed in a university laboratory setting. Selection criteria included college students ages 18-30 years without a history of neurological condition (e.g., moderate or greater TBI, epilepsy). Participants completed 10 visual and sensorimotor assessments on a computerized sensory station (Senaptec Sensory Station, Senaptec Inc., Beaverton, OR) including visual clarity, contrast sensitivity, depth perception, near-far quickness, perception span, multiple-object tracking, reaction time, target capture, eye-hand coordination, and go / no-go. Mann-Whitney U tests were used to compare differences in visual and sensorimotor skills between students with and without a history of concussion. Hedge's g effect sizes (ES) and 95% confidence intervals (95% CI) were used to detect clinically meaningful differences. Statistical significance was set at $p < 0.05$. **Results:** Seventy-one participants (56 female, 15 male; age=21.1 ± 2.3 years) were included, with 30 (42.3%) reporting 1 or more concussions and 41 (57.7%) reporting no concussion history. The concussion history group had an average time since injury of 4.6 years (SD=3.5 years) and 15 (50%) had more than 1 diagnosed concussion. Participants with concussion history performed better on perception span compared to those without a history of concussion (p=0.004, ES=0.683, 95% CI=0.196-1.165). No significant differences were observed between groups for the remaining 9 assessments (Table 1). **Conclusions:** Findings from this study suggest minimal to no differences in visual and sensorimotor skill performance in college students with a history of concussion compared to those without a history of concussion. Therefore, athletic and academic personnel may not need to implement long-term sensorimotor rehabilitation or accommodations for students who have been diagnosed with one or more concussions. However, future research should identify if differences in sensorimotor skills exist in different populations (e.g., athletes and nonathletes, specific sports), students with a lower average time since injury, and greater number of prior concussions.

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Table 1. Visual and Sensorimotor Assessment Scores Between Concussion History and No Concussion History Groups

	Concussion History (n=30)	No Concussion History (n=41)	*p*-value	Effect Size (95% CI)
Visual Clarity (LogMAR; lower is better)	-0.07 (0.6)	-0.07 (0.7)	0.58	-0.13 (-0.60-0.34)
Contrast Sensitivity (LogCS; higher is better)	1.4 (0.8)	1.4 (1)	0.68	-0.01 (-0.48-0.46)
Depth Perception (Arcsec; lower is better)	217 (220)	124 (220)	0.77	0.04 (-0.43-0.51)
Near-Far Quickness (# Correct; higher is better)	23 (26)	22 (21)	0.32	0.21 (-0.26-0.68)
Perception Span (Total Score; higher is better)	49 (38)	34 (33)	<0.01*	0.68 (0.19-1.15)
Multiple-Object Tracking (Composite Score; higher is better)	1642.2 (2473.3)	1324.6 (1995.9)	0.23	0.29 (-0.18-0.75)
Reaction Time (Msec; lower is better)	327 (99)	340 (141)	0.19	-0.38 (-0.85-0.09)
Target Capture (Msec; lower is better)	200 (175)	200 (400)	0.15	-0.48 (-0.96- -0.003)
Eye-Hand Coordination (Msec; lower is better)	49944.5 (12097)	50958 (22229)	0.15	-0.42 (-0.89-0.05)
Go/No-Go (Total Score; higher is better)	4 (21)	3 (23)	0.22	0.13 (-0.34-0.59)

* = significant *p*-values ($p<0.05$). Group data are presented as median (range). LogMAR = Logarithm of the Minimum Angle of Resolution, LogCS = Logarithm of Contrast Sensitivity, Msec = Millisecond

Earlier Initiation of Rehabilitation Services Improves Recovery Outcomes Following Pediatric Concussion

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Context: Previous concussion management strategies advocated for prescribed rest until complete symptom resolution. Active rehabilitation strategies for those unable to recover naturally were not prescribed until four or more weeks post-concussion. More recent evidence suggests earlier initiation of active rehabilitation may expedite clinical recovery. However, the effect of this shift towards earlier rehabilitation start times has not been directly assessed. Our objective was to determine the effect of rehabilitation start time (2-weeks vs. 4-weeks post-concussion) on clinical recovery outcomes in children with concussion. **Methods:** A total 600 youth (out of 2,412 possible cases, 24.9%) presenting to a specialty concussion clinic between September 2015 and August 2019 were selected using a random number generator. Active rehabilitation services (aerobic exercise programs, vestibular therapies, and/or cervicogenic treatments) were provided as clinically indicated. Rehabilitation was initiated 4-weeks post-concussion prior to September 2017, which aligned with expert consensus at that time, or 2-weeks post-concussion from September 2017 onwards, which aligns with current best practice and the clinic's available resources. Cox proportional hazard models analyzed the effect of rehabilitation start time on length of rehabilitation services (days between rehabilitation start and clinical recovery) and total recovery time (days between concussion and clinical recovery). Separate 3 (visit) by 2 (group) linear models were run for symptom outcomes gathered via the Post-Concussion Symptom Inventory (PCSI) and Chi-square analyses assessed the proportion of patients with persisting symptoms at 30-days post-concussion. **Results:** In the multivariable Cox models controlling for sex, age, days to clinic presentation, initial symptoms, and prior concussion history, total length of rehabilitation services (4-weeks: 49 + / - 46 days; 2-weeks= 38 + / - 25 days, OR=1.73 [95% CI: 1.22, 2.45], p=0.002), and recovery time (4-weeks: 52 + / - 42 days; 2-weeks= 45 + / - 30 days, OR=1.49 [95% CI: 1.18, 1.88], $p < 0.001$) were significantly shorter for patients beginning rehabilitation 2-weeks post-concussion. A significant group by time interaction was present for total PCSI scores, indicating that patients eligible to begin rehabilitation services 2-weeks post-injury had a faster rate of symptom resolution over time compared to patients not eligible for rehabilitation until 4-weeks post-concussion ($F(2,320)=3.59$, p=0.029). No group differences were observed in the proportion of patients who experienced persisting symptoms (4-weeks: 72 youth (54.1%), 2-weeks: 71 youth (55%), p=0.88). **Conclusions:** Expediting the initiation of active rehabilitation services from 4-weeks to 2-weeks post-concussion improved the rate of symptom resolution and overall recovery times in a pediatric specialty clinic, with the two-week start group recovering approximately a week earlier than the four-week start group. More acute rehabilitation initiation may provide meaningful clinical benefits for children with concussion. Future studies should investigate the optimal rehabilitation timing and dosage to improve recovery outcomes post-concussion.

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Exploring Concussion Reporting Behaviors of Minority High School Athletes: A Qualitative Approach

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Context: Previous research has identified social disparities when it comes to athlete knowledge and reporting behaviors of concussions. Few studies use a qualitative research design when examining these issues which can be useful when trying to better understand and appreciate an individual's experiences around a specific topic. The purpose of this study was to examine the perception of minority high school athletes pertaining to concussion reporting using a qualitative research design. **Methods:** Using a qualitative grounded theory design, data were collected through semi-structured interviews. Minority high school athletes were chosen as the population of interest based on previous research highlighting social disparities related to concussion health. Participants (n=11) included 8 male and 3 female high school athletes (ages 15-18) participating in 6 different sports (basketball, football, soccer, softball, track & field, and volleyball) from a high school in the southeast United States. All eleven athletes self-identified as either African American or bi-racial. The interview guide was created and formatted based on the purpose of the study, current research on social determinants of health and concussion, as well as the authors experience with concussions and qualitative research design. Interviews were digitally recorded, transcribed verbatim, and analyzed via content analysis. The interviewer was an African American athletic trainer (AT) trained in qualitative research design who also worked at the high school as an AT. The interviewer had a strong rapport with the athletes which allowed for a more personal interaction and richer understanding of the athletes' perceptions of concussion reporting. Upon completion of the eleventh interview, data saturation was determined through constant comparison and simultaneous notes taken by the interviewer. Credibility was established by several mechanisms, including investigator triangulation during research analyses, member checks, and peer review. **Results:** Two major themes emerged from the data pertaining to concussion reporting behaviors of minority high school athletes. These themes were 1) lack of concussion education and 2) negative reporting behaviors related to concussions. Athletes provided insight to common perceived deficiencies in concussion education, including lack of explanation about the definition of concussion. Most of the participants indicated they learned about concussions through social media and the movies. When discussing concussion education, all athletes indicated they were given information, but most said they just signed the paper given to them and "don't know specifics" about concussions because they "don't read it". There was also a consistency across all participants when discussing concussion reporting and that the importance of the game or the time of season played a major role in their decision to report to a coach or health care provider. Athletes described situations like "the state championship" and "[the fear of] losing their starting position" as reasons to hide symptoms from a coach or athletic trainer. **Conclusions:** Our data suggests that concussion reporting behaviors of minority high school athletes are situational and dependent on several factors, including importance of the game, time of year, and their current knowledge or lack thereof about concussions. In addition, educational deficits regarding concussions were confirmed across all participants. Using a qualitative research design was helpful in highlighting the common perceptions of minority high school athletes when it comes to reporting concussion. This information should be considered by athletic trainers, coaches, and administrators when updating and implementing concussion education programs within their high school, specifically those with large numbers of minority athletes.

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Hindsight Is 20/20: False-Positive Rates and Associated Risk Factors on the Vestibular Ocular Motor Screen (VOMS) in Collegiate Athletes

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Context: The Vestibular Ocular Motor Screen (VOMS) is a sideline tool used to evaluate function and to provoke symptoms following a suspected sport concussion (SC). Gender and history of motion sickness are known modifiers associated with a false-positive VOMS assessment at the pre-injury (baseline) assessment, however, additional risk-factors may exist. The purpose of this study was to evaluate the overall false-positive rate of baseline VOMS scores in collegiate athletes as well as to identify additional risk-factors that may contribute to a false-positive VOMS test at the baseline assessment. **Methods:** Participants in our prospective study consisted of 203 (87 females and 115 males) Division I collegiate athletes who were 18.6 ± 1.4 years of age. All participants were administered the Athlete Sleep Behavior Questionnaire (ASBQ), Generalized Anxiety Index (GAD-7), the ImPACT battery, Patient Health Questionnaire (PHQ-9), Revised Head Injury Scale (HIS-r), the Sensory Organization Test (SOT), and the VOMS as part of a multidimensional baseline assessment. Participants were divided into two groups based on if they did or did not have a false-positive VOMS assessment as indicated by a total symptom score of ≥8 and/or a distance to near point convergence ≥5cm. These criteria were previously established as clinical cutoffs in collegiate athletes. Group comparisons for gender and age were performed using a chi-squared ($\chi 2$) and independent t-test, respectively. A binary logistic regression (LR) with adjusted odds ratios (aOR) was performed to determine the interaction of gender, corrected vision, ADHD, ImPACT (Visual Memory, Visual Motor Speed, Reaction Time), history of diagnosed concussion, history of treatment for headache and/or migraine, GAD-7, PHQ-9, ASBQ, and SOT (Equilibrium Score and Somatosensory, Visual, and Vestibular sensory ratios) composite scores on positive VOMS at baseline. Due to a low correlation coefficient, the Verbal Memory composite was excluded from the analyses. Explained variance in the LR equation was determined using Nagelkerke R2. All analyses were performed with $\alpha = 0.05$. **Results:** Approximately 26.1% (53/203 [24 males, 29 females]) had a false-positive on the VOMS. Females had significantly more false-positives than males [$\chi 2(1)=2.40$, $p=.04$]. The binary LR accounted for 21% of the total variance (R2=0.21). The PHQ-9 total score was the only significant predictor of a false-positive VOMS assessment (OR=1.26, 95% CI [1.004-1.60] p=.04]. Results of the LR are shown in Table 1. **Conclusions:** The overall false-positive rate of VOMS was slightly higher when compared to previously reported values. The PHQ-9 total score increased the likelihood of a false-positive VOMS assessment in the absence of sport concussion. The interaction of a variety of modifiers should be considered in the presence of a false-positive VOMS assessment to determine if clinical interventions are warranted.

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Risk Factors Associated with False-Positive Baseline Assessments on the VOMS.

Risk factor	β	SE	*p*	Odds Ratio	95% Confidence Ratio
Gender, female	0.27	0.38	0.48	1.31	(0.62, 2.78)
Corrective Vision	-0.51	0.43	0.23	0.59	(0.26, 1.38)
Medical History	**β**	**SE**	***p***	**Odds Ratio**	**95% Confidence Ratio**
ADHD	-0.38	0.80	0.63	0.68	(0.14, 3.29)
Headache	0.76	1.02	0.45	2.13	(0.29, 15.9)
Migraine	0.10	0.79	0.90	1.10	(0.23, 5.21)
Depression/Anxiety	-0.04	0.75	0.95	0.96	(0.22, 4.15)
Concussion History	-0.56	0.46	0.22	0.57	(0.23, 1.41)
Hours of Sleep	-0.12	0.16	0.43	0.88	(0.65, 1.21)
ImPACT Composite Scores	**β**	**SE**	***p***	**Odds Ratio**	**95% Confidence Ratio**
Visual Memory	-0.02	0.02	0.39	0.98	(0.95, 1.02)
Visual Motor Speed	0.02	0.04	0.72	1.01	(0.94, 1.10)
Reaction Time	1.65	3.71	0.65	0.19	(0.00, 279.36)
Patient Reported Outcomes	**β**	**SE**	***p***	**Odds Ratio**	**95% Confidence Ratio**
GAD-7 Total	0.12	0.10	0.24	1.12	(0.92, 1.37)
ASBQ Total	-0.04	0.03	0.21	0.96	(0.91, 1.02)
HIS-r Duration	0.18	0.16	0.24	1.20	(0.89, 1.63)
HIS-r Severity	-0.22	0.18	0.20	0.80	(0.57, 1.13)
PHQ-9 Total*	0.24	0.12	0.04	1.26	(1.00, 1.60)
Sensory Organization Test	**β**	**SE**	***p***	**Odds Ratio**	**95% Confidence Ratio**
Equilibrium Score	-0.17	0.09	0.06	0.84	(0.71, 1.01)
Somatosensory Ratio	-0.16	0.09	0.09	0.85	(0.71, 1.03)
Visual Ratio	0.03	0.05	0.51	1.03	(0.94, 1.14)
Vestibular Ratio	0.05	0.04	0.21	1.04	(0.97, 1.13)

Table 1. Binary multivariate logistic regression analysis of risk factors contributing to a false-positive on the Vestibular/Ocular Motor Screen (VOMS). *= $p<0.05$

Individual Symptom Report Prevalence in Youth With One, Two, and Three or More Persistent Symptoms After Concussion

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Context: Persistent symptoms after concussion can cause considerable distress, dysfunction, and/or delayed return to sport or school. It is unclear which specific symptoms are most-commonly-reported in youth – especially as it pertains to those reporting fewer vs. greater numbers of persistent post-concussion symptoms. Thus, the purpose of this investigation was to determine individual symptom report prevalence in youth experiencing 1-2 vs. 3+ symptoms 1 month following a sport-related concussion. **Methods:** Participants in this prospective cohort study were children aged 8-18 years presenting to community practice clinics within 72 hours of sustaining a sport-related concussion. At an initial visit, participants completed informed consent and provided information about demographics, medical history, and the current injury. One month later, persistent symptoms were assessed via parent report of their child's symptoms on the Rivermead Post-Concussion Symptoms Questionnaire (RPQ). Respondents indicated the severity of 18 separate symptoms on a scale from 0 (Not experienced) to 4 (Severe). Two-hundred forty-five children participated in the follow-up period, and those with valid symptom data were used for analysis (n=236; mean age=14.3±2.1 years; n=97 females). Frequencies and proportions were calculated for each symptom in both groups (1-2 vs. 3+), and between-group differences in symptom reporting were computed using Fisher's Exact Tests. **Results:** On average, 2.2 / 18 symptoms (SD=3.7, range=0-16) were reported as worse than pre-injury at the one-month timepoint. Of the 236 participants in this sample, n=136 (57.6%) reported 0 RPQ symptoms as worse than before the injury. In those reporting just 1-2 RPQ symptoms as worse than before the injury (n=38), the most common were headaches (16 / 38; 42.1%) and fatigue (11 / 38; 28.9%). In those reporting 3+ RPQ symptoms as worse (n=62), headaches (44 / 62; 71.0%) and fatigue (40 / 62; 64.5%) were again the most common, followed by frustration (38 / 62; 61.3%), and irritability (37 / 62; 59.7%). Several symptoms were present only in the 3+ group: nausea/vomiting, depression, blurred vision, restlessness, and reduced tolerance to emotional stress. Individuals with 3+ persistent symptoms were significantly more likely than those with 1-2 to report 16 of the 18 symptoms (P values < .05; see Table). **Conclusions:** Findings provide nuance to characterizing persistent post-concussion symptoms in youth and may help inform future interventions for those experiencing any number of post-injury symptoms. Awareness of the high prevalence of headache and fatigue in both groups and emotional symptoms among those with 3+ highlights a need for targeted interventions to ameliorate these symptoms in particular. In addition, knowledge that many items seem to be present primarily or only in those with 3+ persistent symptoms underscores the importance of continued emphasis on developing multi-faceted, holistic approaches to rehabilitation for these individuals.

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Table. Symptom report frequencies, proportions, and comparisons between those rating 1-2 and 3+ symptoms as worse than pre-injury at one month follow-up.

	1-2 symptoms n = 38	**3+ symptoms** n = 62	**Fisher-exact *P*-value[a]**
Symptom	Count (proportion)	Count (proportion)	
Headaches	16 (42.1%)	44 (71.0%)	.006**
Fatigue	11 (28.9%)	40 (64.5%)	.001**
Frustrated	3 (7.9%)	38 (61.3%)	< .001**
Irritability	3 (7.9%)	37 (59.7%)	< .001**
Longer to think	1 (2.6%)	33 (53.2%)	< .001**
Poor concentration	1 (2.6%)	33 (53.2%)	< .001**
Forgetful	3 (7.9%)	30 (48.4%)	< .001**
Emotional stress	0 (0%)	28 (45.2%)	< .001**
Noise sensitivity	1 (2.6%)	28 (45.2%)	< .001**
Dizziness	4 (10.5%)	27 (43.5%)	.001**
Light sensitivity	2 (5.3%)	27 (43.5%)	< .001**
Sleep disturbance	2 (5.3%)	23 (37.1%)	< .001**
Fear	4 (10.5%)	17 (27.4%)	.074
Restlessness	0 (0%)	17 (27.4%)	< .001**
Depression	0 (0%)	16 (25.8%)	< .001**
Blurred vision	0 (0%)	13 (21.0%)	.001**
Nausea/vomiting	0 (0%)	7 (11.3%)	.042*
Double vision	1 (2.6%)	6 (9.7%)	.247

[a] * denotes significance at $P < .05$, ** $P < .01$

Normative Values for Pupillary Light Reflex Metrics Among Healthy Service Academy Cadets

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Context: Assessments of the pupil's response to light has long been an integral part of neurologic examinations. More recently, the pupillary light reflex (PLR) has shown promise as a potential biomarker for the diagnosis of mild traumatic brain injury (mTBI). However, to date, few large-scale normative data are available for comparison and reference, particularly in military service members. The purpose of this study was to report normative values for eight PLR measurements among healthy service academy cadets based on sex, concussion history, and sleep. **Methods:** Freshmen entering a United States Service Academy completed a quantitative pupillometric assessment in conjunction with baseline concussion testing. PLR measurements were conducted using a Neuroptics PLR-3000 with a 121 microWatt light stimulus. The device measured maximum and minimum pupil diameter (millimeters), latency (time to maximum pupil constriction post-light stimulus [seconds]), peak and average constriction velocity (millimeters/second), average dilation velocity (millimeters/second), percentage pupil constriction, and T75 (time for pupil re-dilation from minimum pupil diameter to 75% maximum diameter [seconds]). During baseline testing, cadets also reported concussion history (yes, no) and hours slept the night before (<5.5, ≥5.5). Normative values for each PLR measurement were calculated as mean±standard deviation, percentiles, and interquartile range. Mann-Whitney U tests were used to assess differences based on sex, concussion history, and hours slept for each PLR measurement. Alpha was set at 0.05 and non-parametric effect sizes (r) were calculated for statistically significant results. Effect sizes were interpreted as no effect (r<0.1), small (r≥0.1-<0.3), medium (r≥0.3-<0.5), or large (r≥0.5). **Results:** Of the 1197 participants baselined, 514 cadets (131 female; 18.91±0.96y) consented and completed a valid baseline pupillometric assessment. Eighty participants reported at least one previous concussion and participants reported an average of 5.88±1.63 hours slept the previous night. Table 1 displays normative values for the eight PLR measurements. Mann-Whitney U results suggest females had larger initial (z=1.97; p=0.049; r=0.09) and end pupil diameter (z=2.13; p=0.034; r=0.09), and faster average dilation velocity (z=2.48; p=0.013; r=0.12). No statistically significant differences were detected based on concussion history or hours slept. Among the statistically significant results observed between males and females, only a small effect was present for dilation velocity. **Conclusions:** This study provides the largest population-specific normative values for eight PLR measurements. Initial and end pupil diameter, and dilation velocity differed by sex, however these differences may not be clinically significant as initial and end pupil diameter displayed no effect and a small effect was detected for dilation velocity. Concussion history and sleep as stratified in the current study did not impact PLR measurements. Sex, concussion history, and sleep do not appear to influence PLR measurements in service academy cadets and thus may not have a clinically relevant impact on interpreting PLR measures as a biomarker for mTBI management.

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Table 1. Normative values for eight pupillary light reflex measurements.

		Percentile							
PLR Measurements	Mean±SD	10	25	50	75	90	IQR	Min	Max
Initial Pupil Diameter, mm	4.56±0.68	3.70	4.10	4.50	5.00	5.50	0.90	2.80	6.60
End Pupil Diameter, mm	3.07±0.44	2.50	2.80	3.10	3.30	3.60	0.50	2.00	4.90
% Constriction	32.52±5.71	25.00	28.80	32.70	36.60	39.50	7.80	11.40	49.00
Latency, seconds	0.22±0.02	0.20	0.20	0.23	0.23	0.23	0.03	0.13	0.30
Constriction Velocity, mm/s									
Average	-2.83±0.64	-3.67	-3.28	-2.88	-2.39	-1.95	0.89	-7.53	-1.78
Peak	-4.25±0.91	-5.39	-4.85	-4.28	-3.65	-3.02	1.20	-7.53	-1.78
Dilation Velocity, mm/s									
Average	1.31±0.29	0.91	1.13	1.33	1.51	1.68	0.38	0.38	2.05
T75, seconds	1.94±0.97	0.90	1.20	1.70	2.54	3.38	1.34	0.53	4.85

Abbreviations: PLR=Pupillary Light Reflex; SD=Standard Deviation; IQR= interquartile range (75th percentile-25th percentile); mm=millimeters; mm/s=millimeters/second; T75=time to 75% redilation

Perceptions of Academic Concerns and Performance Ability Among Adolescents Following a Sport-Related Concussion

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Context: Sport-related concussions (SRC) occur frequently in adolescents and can negatively impact classroom performance. Following SRC, adolescents have reported decreased cognitive and school function, and have concerns for returning to the classroom. However, it is unclear how these academic concerns change throughout recovery or how symptoms affect perceptions of academic performance. The purpose of this study was to 1) describe adolescents' perception of academic concerns and confidence in their school's ability to provide academic support, and 2) determine if a relationship existed between acute concussion symptoms and perceptions of academic performance. **Methods:** Academic outcomes from a prospective longitudinal HRQL study were analyzed. Forty-seven (age=15.94 ±1.49 years; male=68.1%, n=32/47; female=31.9%, n=15/47) interscholastic athletes who sustained a medically diagnosed SRC were recruited from secondary schools. Patients completed the Concussion Learning Assessment and School Survey (CLASS) and the Post-concussion Symptom Inventory (PCSI) at days 3, 10 post-injury and at return-to-play (RTP). The CLASS is an 11-item multiple-choice survey that assesses concern regarding school performance post-concussion. The PCSI has 21 items where patients report their perceived symptoms on a 0-6 Likert scale, with lower scores noting lower symptom severity. Both measures are valid and reliable. Descriptive statistics were used for each CLASS item and the PCSI individual symptom and total symptom severity scores. Spearman's rho correlations were used to determine the relationship between total concussion symptom score at day 3 and perception of if the injury affected school performance (4-point Likert scale), grades ("yes", "no", "not yet but they might") and the participants' confidence in the school's ability to support the students' return (4-point Likert scale) (alpha=0.05). **Results:** On day 3 post-injury, 27.7% of adolescents were moderately concerned for their academic success (Table 1). By RTP, 66% (n=31) adolescents reported "no concern". Descriptive results for patients' perceptions on if grades were affected post-injury and their confidence are also included in Table 1. As total symptom score increased, concern regarding the injury affecting school performance (rs=0.640, p < 0.001) and grades being affected (rs=0.443, p=0.004) also increased. However, we did not find a relationship between total symptom score and confidence in the school's ability to support the respondents' return (rs=-0.058, p=0.721). **Conclusions:** Our results highlight that adolescents who suffered a SRC had an increased perception of academic concern immediately following the injury. These perceptions and concerns related to academic dysfunction tend to subside throughout their recovery. Concern for academic ability increased as symptoms increased, however the patients' confidence in the school's ability to support them did not have a relationship with symptom burden as the majority of patients had high confidence in the school to provide support. Clinicians and school personnel should strive to support students academically throughout recovery, especially in the initial days following injury.

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Table 1. Percentage and frequency of responses across recovery for selected CLASS items.

Item	Responses	Day 3 % (N=47)	Day 10 % (N=47)	RTP % (N=47)
How concerned are you about this injury affecting your school learning and performance?	Not Concerned	25.5 (12)	29.8 (14)	66.0 (31)
	Mildly	36.2 (17)	21.3 (10)	10.6 (5)
	Moderately	27.7 (13)	8.5 (4)	6.4 (3)
	Very Concerned	4.3 (2)	0(0)	2.1 (1)
	Missing/No Response	6.4 (3)	40.4 (19)	14.9 (7)
Have your grades been affected (dropped)?	Yes	12.8(6)	19.1 (9)	10.6 (5)
	No	36.2 (17)	29.8 (14)	66 (31)
	Not yet, but they might	40.4 (19)	10.6 (5)	8.5 (4)
	Missing/No Response	10.6 (5)	40.4 (19)	14.9 (7)
How confident are you in your school's ability to support your return?	Not Confident	0 (0)	2.1 (1)	2.1 (1)
	Mildly	14.9 (7)	4.3 (2)	10.6 (5)
	Moderately	17 (8)	12.8 (6)	6.4 (3)
	Very Confident	59.6 (28)	38.3 (18)	63.8 (30)
	Missing/No Response	8.5 (4)	42.6 (20)	17 (8)

Physical Load Burden Following Sport-Related Concussion and Clinical Recovery Among Collegiate Football Athletes: Pilot Findings

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Context: Clinical practice guidelines advocate early recognition and immediate removal from play after sport-related concussion (SRC) to reduce physical demands and head impact exposure from continued participation. Global Positioning System (GPS) player monitoring can objectively measure traveled distances and acceleration changes to estimate player load (plLoad) and may be an innovative approach to investigate delayed removal from play after SRC. Our primary objective was to compare plLoad, plLoad rate (plLoad/min), distance traveled (meters), symptom severity, and duration until medical clearance between football athletes immediately removed from play compared to delayed removal. We hypothesized athletes with immediate removal will have lower plLoad and symptom severity and earlier return to medical clearance than those with delayed removal. **Methods:** We conducted an exploratory analysis of 8 (age=20.7±2.6 years; height=187.6±5.2 cm; weight=104.7±20.3 kg) male Division-I college varsity football players enrolled in a prospective study during the 2017-2019 seasons. Participants wore helmets equipped with Head Impact Telemetry (HIT) System instrumentation to quantify peak linear (g) and rotational (rad/s2) accelerations and HIT severity profile (HITsp), and the Catapult Vector GPS monitoring system collected plLoad, plLoad rate, and distance traveled. The greatest HITsp for each participant identified that individual's SRC, and the plLoad and PlLoad rate were subsequently computed in the time duration between SRC and session's conclusion. Participants completed the Sport Concussion Assessment Tool (SCAT3) symptom checklist within 72 hours of injury. Bonferroni corrected (a priori P=0.01) independent- samples t-tests were conducted to compare immediate removal (IR) and delayed removal/continued participation (DRCP) groups across head impact severity, plLoad, and clinical outcomes. **Results:** Four (50%) participants continued play after a suspected SRC event, sustained an additional 10.8±8.7 impacts, and were assigned to the DRCP delayed group (Table 1). The IR and DRCP groups sustained SRC events of similar peak linear (52.1±41.5 g vs. 40.4±18.0 g) and rotational (4570.2±3941.2 rad/s2 vs. 2833.7±1195.1 rad/s2) accelerations and HITsp (43.8±53.7 vs. 28.5±11.7) head impact variables (P>0.01). Following SRC, IR had a lower plLoad rate than DRCP (0.41±0.33 plLoad/min vs. 2.50±0.77 plLoad/min; P=.002, Cohen's d=.59). However, total plLoad (78.89±73.35 vs. 255.87±111.92), traveled distance (759.38±303.61 meters vs. 2783.90±1504.65 meters), symptom severity (40.7±54.6 vs. 39.8±28.1), and duration until medical clearance (24.3±11.9 days vs. 10.8±10.2 days) were similar (P values >.01). **Conclusions:** Football players that continued participation after SRC experienced greater player load rate—but no increased acute symptoms or protracted clinical recovery—than athletes immediately removed from play. Concomitant head impact measurement and GPS-player monitoring may be an intuitive approach to objectively quantify physical activity burden immediately following an SRC event and may be used to guide tolerance to acute post-injury rehabilitation.

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Table 1. Head impact and physical load exposure among college football players experiencing an immediate removal (IR) or delayed removal/continued participation (DRCP) following sport-related concussion.

Player	Group	Height (cm)	Mass (kg)	Position	Activity	Medical Clearance (days)	HITsp	Pre/Post -SRC Impacts	Post-SRC Observation (min)	Total plLoad	PlLoad Rate[a]	Traveled Distance (m)
1	DRCP	185.42	99.79	LB	Practice	5.00	17.6	2/0	83.90	173.94	2.07	1769.27
2	DRCP	187.96	99.79	LB	Game	7.00	35.5	0/22	221.75	416.25	1.88	4512.62
3	DRCP	195.58	142.88	DL	Game	5.00	41.3	3/16	69.38	248.87	3.59	2069.80
4	DRCP	187.96	95.54	WR	Practice	26.00	19.7	4/5	75.69	184.46	2.44	0.00
5	IR	185.42	90.72	DB	Game	DNR	123.8	1/0	199.10	21.63	0.11	0.00
6	IR	190.50	129.27	OL	Practice	16.00	100.9	20/0	19.33	12.82	0.31	0.00
7	IR	177.80	86.18	DB	Game	38.00	23.6	5/0	87.18	119.43	0.15	0.00
8	IR	190.50	92.99	QB	Game	19.00	18.7	2/0	203.49	161.69	0.59	544.70

[a] plLoad Rate defined as plLoad/min

Abbreviations: DB, Defensive Back; DL, DCRP, delayed removal/continued participation; Defensive Line; DNR, did not return to sport after SRC; HITsp, Head Impact Telemetry severity profile; IR, Immediate Removal; LB, Linebacker; OL, Offensive Line; plLoad, player load; QB, Quarterback; SRC, Sport-related concussion; WR, Wide Receiver

Post-Traumatic Migraine Following Projectile and Surface Contact in National Collegiate Athletic Association Sports: 2009/10-2018/19

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Context: Sport-related concussions (SRCs) are propagated by biotraumatic forces directed to the head/neck which initiate rapid head/neck muscle contractions that disrupt cerebrometabolism. Post-traumatic migraine (PTM), a distinct concussion symptom cluster including headache, nausea, and sensitivity to light or noise, strongly predicts poor post-injury neurocognitive assessment scores and longer symptom resolution time. Given the inherent differences in head impact biomechanics associated with projectile (puck or ball) and surface (cement, grass, etc.) contact, PTM expression may be influenced differently by these injury mechanisms. Thus, we aimed to examine differences and predictors of PTM from SRCs attributed to projectile and surface contact in National Collegiate Athletic Association (NCAA) sports. **Methods:** Exposure data and SRCs with complete symptom inventories reported to the NCAA Injury Surveillance Program by athletic trainers during the 2009/10-2018/19 academic years were examined. PTM was affirmed if the athlete endorsed: headache, nausea, and either sensitivity to light and/or sensitivity to noise. Summary statistics [frequencies (%), median, interquartile range] were used to describe PTM and sample characteristics. A Wilcoxon rank sum test evaluated group differences in total PTM symptom count between projectile and surface contact attributed SRCs. Binary logistic regression assessed differential odds of PTM between projectile (compared to surface) contact SRCs after adjusting for covariates [injury history (new, recurrent), event type (practice, competition), sex (female, male), and helmeted sport (non-helmeted, helmeted)]. Odds ratio estimates with 95% confidence intervals (95% CI) excluding 1.0 were deemed statistically significant. **Results:** Surface (n=398, 55%) or projectile (n=329, 45%) contact attributed to 727 total SRCs were examined (Table 1). Projectile contact SRCs demonstrated higher proportions of nausea (37% vs. 29%), sensitivity to light (56% vs. 46%), and sensitivity to noise (46% vs. 30%) compared to surface contact SRCs. We observed group differences in total PTM symptom count between projectile and surface contact concussions (z=3.49, P<0.001). The PTM prevalence was higher in projectile (29%) than surface (21%) contact attributed SRCs. Projectile (compared to surface) contact was associated with higher odds of PTM (Adjusted OR=1.73; 95% CI=1.14-2.64). **Conclusions:** Post-traumatic migraine in NCAA student-athletes was more prevalent among projectile contact attributed SRCs than surface contact attributed SRCs. Projectile contact (compared to surface contact) was observed to significantly predict PTM expression after adjusting for covariate effects. Clinicians should consider injury mechanisms in their initial SRC evaluations. Targeted studies may consider leveraging head/neck impact biomechanics and migraine-specific tools to assess impairments and to guide clinical management.

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Table 1. Characteristics of projectile and surface contact concussions reported to the National Collegiate Athletic Association Injury Surveillance Program during 2009/10-2018/19

	Overall, N = 727	Projectile Contact, N = 329	Surface Contact, N = 398
Sex, n (%)			
Female	418 (57%)	244 (74%)	174 (44%)
Male	309 (43%)	85 (26%)	224 (56%)
Helmeted Sport, n (%)			
Non-helmeted	366 (64%)	199 (85%)	167 (49%)
Helmeted	207 (36%)	35 (15%)	172 (51%)
Event Type, n (%)			
Competition	353 (49%)	151 (46%)	202 (51%)
Practice	374 (51%)	178 (54%)	196 (49%)
Injury History, n (%)			
Recurrent	47 (6.5%)	18 (5.6%)	29 (7.3%)
New	672 (93%)	304 (94%)	368 (93%)
Total Number of Post-traumatic Migraine Symptoms			
Mean (SD)	2.11 (1.17)	2.28 (1.19)	1.97 (1.15)
Median (IQR)	2.00 (1.00, 3.00)	2.00 (1.00, 3.00)	2.00 (1.00, 3.00)
Post-traumatic Migraine, n (%)			
No	547 (75%)	233 (71%)	314 (79%)
Yes	180 (25%)	96 (29%)	84 (21%)
Headache, n (%)			
No	57 (7.8%)	24 (7.3%)	33 (8.3%)
Yes	670 (92%)	305 (93%)	365 (92%)
Nausea, n (%)			
No	490 (67%)	207 (63%)	283 (71%)
Yes	237 (33%)	122 (37%)	115 (29%)
Sensitivity to Noise, n (%)			
No	464 (64%)	190 (58%)	274 (69%)
Yes	263 (36%)	139 (42%)	124 (31%)
Sensitivity to Light, n (%)			
No	362 (50%)	146 (44%)	216 (54%)
Yes	365 (50%)	183 (56%)	182 (46%)

Notes: Data presented in the order of estimated count. Helmeted sports (HELM) included Men's Football/Lacrosse, Men's/Women's Ice Hockey. Non-helmeted sports (NoHELM) included Men's/Women's Basketball/Cross-Country/Tennis/Track & Field/Soccer, Women's Gymnastics/Volleyball. Number of Post-traumatic Migraine Symptoms refers to the total summed count of headache, nausea, sensitivity to noise, and sensitivity to light endorsement. Post-traumatic Migraine (No/Yes) was affirmed if an athlete endorsed ≥ 3 (of 4) symptoms. Data pooled association-wide are presented overall, and separately for projectile and surface contact. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition, and required medical attention by a team Certified Athletic Trainer or physician (regardless of time loss); no specific definitions were provided to ATs, and the ISP relied on the expertise of participating ATs and team medical staff for concussion diagnosis. Only scheduled team practices and competitions were retained in this analysis.

Sport Related Differences in Baseline Tandem Gait Testing Across NCAA Division I Male Athletics

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Context: The tandem gait (TG) test has been suggested to have clinical utility as a measure of sport concussion (SC). Previous literature has demonstrated that there are no significant sex differences in terms of TG performance, however, it has yet to be determined if TG performance differs by sport. The purpose of our study was to determine if sport-related differences exist in tandem gait performance in male collegiate athletes. We hypothesized that TG performance would be significantly different between one or more collegiate male sports. **Methods:** Our prospective study consisted of 116 male Division I collegiate athletes who were on average 19.5+1.71 years of age and 184.6+7.76 cm tall. Participants consisted of athletes who participated in baseball (n=12), football (n=46), wrestling (n=12), men's soccer (n=16), cross country/track and field (n=18), or men's lacrosse (n=12). All participants were administered the TG without shoes. To complete the TG, all participants were instructed to stand before a 3-meter line created out of athletic tape and then walk heel-to-toe as quickly as possible along the line, perform a 180 degree turn, and then return to the starting point. Participants were administered the TG four times with best time being used in our analyses and time to completion was measured using a handheld stopwatch. If participants did not maintain a heel-to-toe pattern, stepped off of the tape, or broke their gate at any time, that trial was redone. Sport comparisons for height and the best TG time were made using an analysis of variance (ANOVA). Post-hoc analyses were conducted using Tukey's test. All analyses were performed with $\alpha = 0.05$ **Results:** In terms of demographics, a significant main effect was observed for height ($F(5,114)=11.3$, $p<.001$, $\eta 2=.341$) between sports. In terms of height, participants in men's soccer (179.7+6.19 cm) were significantly shorter compared to those in football (188.7+6.67 cm). Likewise, wrestling (174.8+5.31 cm) had athletes significantly shorter than those in men's lacrosse (184.6+7.13 cm), football (188.7+6.67 cm), baseball (186.1+4.85 cm), and cross country/track and field (183.9+7.04 cm). In terms of TG performance, a significant main effect was observed across sports ($F(5,115)= 3.31$, $p=.008$, $\eta 2=.131$). In terms of TG time, post-hoc analyses indicated baseball players had significantly faster baseline TG times (9.3+2.29 seconds) compared to men's soccer (12.3+2.64 seconds; $p=.02$) and wrestling (12.2+2.20 seconds, $p=.05$). **Conclusions:** Our data support sport-specific differences in TG performance. Further research should include additional sport types and determine if differences in TG performance exist across female sports. As sport-related differences exist for TG performance, our data support the clinical utility of the baseline assessment when using the TG assessment in order to have an accurate comparator following a SC.

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Sports Fitness Index Survey for Association With Sport-Related Concussion

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Context: Several surveys have been developed to assess different orthopedic conditions and acquire self-reported ratings of function. The Sports Fitness Index (SFI) is a survey to quantify the persistent effects of past musculoskeletal injuries. Because sport-related concussion (SRC) can affect physical performance it is possible that a self-reported survey of physical limitations may be associated with concussions. Additionally, underreporting or non-disclosure of concussion is a problem across multiple demographics. The purpose of this project was to determine if the Sports Fitness Index could identify those with sports-related concussion history. **Methods:** Two Division I football teams, over 2 seasons, (n=167), completed the 11-item SFI prior to the season. The SFI uses a 6-level response of never, rarely, infrequently, occasionally, frequently, or persistent, scored 5-0, respectively. The first 10 questions are used for the total score by adding question scores and multiplying the sum by 2. Concussion history was attained through a record review of players' medical records and self-reported by the players. All 11-questions and the SFI total score were entered into a backward entry, logistic regression, with concussion history as the dependent variable. **Results:** Good discrimination between concussion history and no concussion history found a 5-factor prediction model included four question (#2 - pain in any body part, #6 - muscle stiffness or aching, #7 - joint instability or pain, and #11 - concussion symptoms) and the SFI total score. The presence of any combination of 3 or more predictors demonstrated 80% sensitivity, 59% specificity, an odds ratio of 6.12 (95% confidence interval (95% CI) = 2.71, 13.79), positive predictive value of 43.7% (95% CI = 37.5%, 50.1%) and a negative predictive value of 88.8% (95% CI = 81.2%, 93.5%). **Conclusions:** These findings signify that concussion history can be detected in Division I football players through the persistent effects of previous musculoskeletal injuries as identified by the SFI. This could be beneficial to clinicians to identify those with a SRC history in order to initiate preventative strategies.

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Static and Dynamic Postural Control Deficits in Individuals With a History of Concussion

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Context: Concussion incurs an increased risk of subsequent lower extremity injury. Residual postural control deficits may contribute to this heightened risk, but there is limited evidence to support this theory. The purpose of this study was to compare dynamic and static postural control between individuals with and without a history of concussion. We hypothesized that these outcomes would be poorer in individuals with a history of concussion. **Methods:** Twenty volunteers (10 with concussion history, 10 healthy controls) completed this laboratory-based observational study. The concussion group reported 2.4±0.6 lifetime concussions with the most recent occurring within the past 13±8 months. Subjects completed the modified Balance Error Scoring System (mBESS) test under eyes-open and eyes-closed conditions in single-leg, double-leg, and tandem stances. Static postural control was assessed via time-to-boundary (TTB) during single-leg stance on a force plate under eyes-open and eyes-closed conditions. TTB represents the time required for the center of pressure to reach the boundary of the base of support, with lower values representing poorer static postural control. Dynamic postural control was assessed via time-to-stabilization (TTS) during single-leg landing on a force plate. TTS represents the time necessary for ground reaction forces to resemble static stance following ground contact during landing, with higher values representing poorer dynamic postural control. Motion of the center of pressure was evaluated during gait initiation to assess preparatory postural adjustments and dynamic balance. Outcomes were compared across groups via one-way ANCOVA controlling for months since the most recent concussion and number of previous concussions. Controls were assigned values equal to the longest time since concussion and greatest number of concussions in the concussion group. **Results:** mBESS errors were greater in the concussion group during the eyes-closed tandem stance condition (concussion: 3.4±0.8 errors vs. healthy: 0.2±0.8 errors; $p = 0.03$). TTB in the medial/lateral direction was shorter in the concussion group during the eyes-open (concussion: 2.6±2.2s vs. healthy: 20.7±2.1s; $p < 0.001$,) and eyes-closed (concussion: 1.1±1.2s vs. healthy: 9.2±1.2s; $p < 0.001$) conditions. TTS was greater in the concussion group in the medial/lateral (concussion: 2.0±0.2s vs. healthy: 0.6±0.2s; $p < 0.001$) and anterior/posterior (concussion: 3.8±0.0s vs. healthy: 3.6±0.0s; $p = 0.027$) directions. Gait initiation outcomes did not differ between the groups. **Conclusions:** Static and dynamic postural control were impaired in those with a history of concussion suggesting that unresolved neuromuscular control deficits exist past the acute phase of concussion. Individuals with chronic ankle instability and anterior cruciate ligament injury display similar deficits in TTB and TTS, thus these deficits may influence lower extremity injury risk following concussion. Future studies should determine if these postural control deficits are associated with lower extremity injury risk and identify objective metrics that are easily implemented in the clinic and effective for making return-to-play decisions.

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The Impact of Concussion Education on Injury Disclosure in High School Athletes: A Critically Appraised Topic

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Context: Sport-related concussions are among the most common injuries in secondary school athletes, but still many of these injuries go unreported. In order to mitigate underreporting, concussion education tools have been implemented to encourage further understanding and recognition of these injuries. Therefore the clinical question posed is does concussion education impact reporting behaviors in high school athletes? **Methods:** A comprehensive search of PubMed and SportDISCUS databases was conducted in January 2020. The search terms utilized included a combination of "concussion", "education", "knowledge", "information", "reporting" and "behavior". Research studies were included if they used secondary school populations, concussion education interventions, and were peer-reviewed studies published in English. Studies were excluded if they were published prior to 2010. All of the studies included large samples in a variety of sports. The outcome of the studies included a questionnaire prior to and after completion of the concussion education program. The Miyashita et al studies from 2014 and 2016 received a score of 15/22 and 16/22 on the STROBE, respectively. The Hunt study received a 17/22. **Results:** A total of 301 studies were identified following elimination of duplicates. After eliminating studies based on title and abstract against exclusion criteria, 36 studies remained. Outcomes of each study were analyzed and 3 were included in the final appraisal. Two studies included in this appraisal provided an educational lecture as an education program while the third utilized an informational video. All three studies found increases in injury history disclosure from pre-education to immediate post-education. The first study saw a significant difference in both males ($p<.001$) and females ($p<.001$) where they reported more sustained concussions following the education intervention. The second study had similar results where the experimental group that received concussion education had a significant difference ($p=.034$) in previous concussions reported after the education was completed. The third study found a significant difference ($p=.000$) in past medical history of concussion reports by participants. There is Level B evidence to support the idea that implementing concussion education will impact concussion reporting behaviors as it pertains to injury history disclosure. **Conclusions:** There is moderate evidence to support that concussion education programs impact reporting behaviors. The studies found immediate changes in injury history disclosure, but no long term change was identified. Clinicians should consider the method of administration of concussion education as well as timing during the season. Education may have more of an impact immediately prior to the start of a sports season, as well as several times throughout the year to keep the information in the forefront.

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The Influence of Corrected Vision on the VOMS Performance in Collegiate Athletes

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Context: The Vestibular-Ocular Motor Screen (VOMS) is commonly used to evaluate athletes following a suspected sport concussion (SC). To date, limited to no data has addressed the influence of corrected vision on VOMS performance. The purpose of this study was to compare VOMS performance between those with and without prescribed corrected vision. A secondary purpose was to compare VOMS performance of athletes who then did or did not wear their prescribed corrective contacts/glasses during their VOMS assessment. **Methods:** Our descriptive laboratory study consisted of 231(109 females, 122 males) Division I collegiate athletes with an average age of 18.6+1.35 years. Participants were initially divided into two groups based if they did (n=165) or did not (n=66) have corrected vision. The corrected vision group was further divided into those who did (n=44) or did not (n=22) wear their prescribed lenses while being administered the VOMS. Mann-Whitney U tests were used to compare the symptom scores of the VOMS Smooth Pursuit, Horizontal and Vertical Saccades, Near Point Convergence (NPC [symptoms and distance]), Horizontal and Vertical Vestibulo-Ocular Reflex, Visual Motion Sensitivity Test, as well as the total symptom score. All analyses were performed with $p<0.05$. **Results:** There were no significant differences observed between athletes with or without corrected vision on any VOMS outcome score (all $p > 0.05$). Of the athletes with prescribed corrective lenses, those who wore their corrective lenses were measured to have a significantly ($z=-2.27, p=0.02$) longer NPC (M=2.83[0.00-7.83]) with a mean rank of 37.27 compared to those who did not wear their corrective lenses (M=1.83[0.00-7.50]) who had a mean rank of 25.95. Approximately 18.2% (8/44) of participants who wore their corrective lenses had a false-positive value for NPC with a value > 5.0 cm while 4.5% (1/22) of individuals who did not wear their corrective lenses exceeded the criterion value. **Conclusions:** Overall, no significant differences were observed between athletes who were or were not prescribed corrective lenses on any VOMS subtest. However, there was a significant difference in terms of distance to NPC between athletes who had corrected vision and did or did not wear their corrective lenses. Participants who wore their corrective lenses while completing the VOMS had a higher false-positive rate for the NPC subtest compared to those who did not wear their prescribed lenses. Our data support the need for athletes with corrected vision to remain consistent in wearing or not wearing prescribed lenses during the baseline and post-injury testing as it may influence the VOMS NPC outcome score.

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Athletic Trainers' Observations of Social Determinants of Health in the Secondary School Setting

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Context: Social determinants of health (SDH), the conditions in the environments where people live, learn, work, and play, affect the health of people and populations more than medical services do. While previous research has assessed ATs' comfort and familiarity with SDH, little is known regarding which SDH ATs observe at the point-of-care. This study aimed to explore the SDH that ATs observe at the point-of-care among patients in the secondary school. **Methods:** We used a validated card study to collect ATs' point-of-care observations of social determinants during meaningful patient encounters in the secondary school setting. Each card included basic instructions for completion and a table to record observations. The first column was pre-filled with 19 social determinants which could be factors affecting health. The other two columns were blank giving the AT space to mark which factors were observed and to indicate which of the observed factors could have negatively impacted the patient's health. A checkbox at the bottom of the card allowed the AT to indicate if they did not observe any of the 19 social factors during the encounter. Cards were designed to be completed in less than 30 seconds. ATs were asked to complete 1 card per patient for 1 week. Descriptive statistics were used to characterize the SDH observed by ATs. **Results:** Observation cards for 211 patients were completed by 8 ATs employed at secondary schools in 5 states (26.4±4.7 cards completed per AT). On average, 1±1.1 social factor (range=0-6) was observed per card. ATs reported no social factors were observed for 37% of patients (n=79/211). In total, ATs observed 195 social factors and reported 42% (n=82/195) of those factors were negatively affecting the patient's health (Table). **Conclusions:** ATs in the secondary school observe SDH in their patients, with a meaningful percentage of the observations perceived as negatively impacting the patient's health. Health literacy, behavioral health issues, and individual/family circumstances were factors more often perceived as negatively impacting the patient's health. When health literacy was observed, it was also reported as negatively impacting patient's health half the time. These data highlight the importance of treating the whole person and not only the injury as these social determinants of health may impact all aspects of their life and health. ATs are in a position to educate and offer support to their patients who may lack health literacy and need to be prepared to do so. Understanding the SDH most commonly observed at the point-of-care may guide secondary school ATs to be prepared with resources to support patients experiencing the negative effect of these social factors.

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Table. Frequency Count of ATs' SDH Observations at the Point-of-Care

	Social Factors	Observed Social Factors	Negative impact on the patient's health?
	Academic stressors	24	6
Most Common Observed	Behavioral health issues	23	10
	Job stressors	22	4
	Individual/family life circumstances	21	10
	Lack of health literacy	19	12
	Poor social support	15	7
	Access to social media/emerging technologies	14	3
	Language barrier	10	3
	Transportation issues	10	2
	Insufficient/lack of health insurance	8	7
	Family care demands	8	3
	Food insecurity	4	3
	Cultural beliefs/values	3	3
	Substance use/abuse	6	5
	Educational limitations	4	0
Least Common Observed	Neighborhood safety	2	1
	Poverty/near poverty	1	1
	Homeless/poor or unstable living conditions	1	1
	Migrant/immigration status	0	0
	I did not observe any of the listed social factors	79	

Athletic Training Students' Attitudes and Skills Following a Transgender Healthcare Curriculum

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Context: Research suggests that athletic training students (ATSs) lack the knowledge and experience providing care to transgender patients. The purpose of this study was to assess how a curriculum, including a standardized patient (SP) encounter, influenced ATSs' attitudes and skills when caring for transgender patients. **Methods:** We conducted a randomized control trial with a cohort of post-baccalaureate professional ATSs (n=20; females=16, males=4; age=23±2 years). The intervention (Figure) focused on a transgender curriculum offered over two courses in the academic year. For assessment, one group (n=10) interacted with a cisgender female while the second group (n=10) engaged with a transgender female. ATSs completed an online post-intervention survey that included the validated 10-item Attitudes Towards Transgender Patients (ATTP) tool. The ATTP is divided into 3 subscales, clinician education (CE), transgender sport participation (TSP), and clinician comfort (CC), with each subscale being scored collectively. Each statement was scored by the ATSs through a 5-point Likert scale, ranging from 3-15 for CE and TSP, and 4-20 for CC. Higher scores indicated a more negative attitude towards transgender individuals. Each SP encounter was evaluated by the course instructor and SP actor on a validated rubric for interpersonal skills, data gathering, patient education, and overall performance. Data were analyzed using a non-parametric Mann-Whitney U test to compare the two groups (cisgender vs transgender encounters) on the two instruments. **Results:** We identified a significant difference between those completing a transgender SP encounter (mean=5.30±2.11) and those completing the cisgender SP encounter (mean=3.50±0.97) on the CE subscale (U=24.000, z=-2.113, p=0.035). There were no differences between groups on the TSP (p=0.70) and CC (p=0.32) subscales. On the SP actor evaluation, we found no significant differences (p=0.08); however, on the SP actor item "encouraged you to ask questions; answered them clearly; never avoiding your questions or lecturing you", we identified a significant difference (U=22.00, Z=-2.342, p=0.019) whereby those that worked with the cisgender SP scored higher (3.20±0.63) than those working with the transgender SP (2.40±0.70). Those working with the transgender SP indicated a lower desire to engage in additional education about transgender patients; however, their performance relative to data gathering, although not statistically different between groups (p=0.201) was 11.25% lower than those working with the cisgender SP. **Conclusions:** The higher score on the CE by ATSs working with the transgender patient shows that they felt they do not need or do not want further training caring for transgender patients. However, they demonstrated less skill in data gathering from the transgender SP. ATSs who received transgender training but did not encounter a transgender patient were more likely to want more learning about transgender education. Even when confidence rises from a single encounter, continued learning may be necessary in working with transgender patients.

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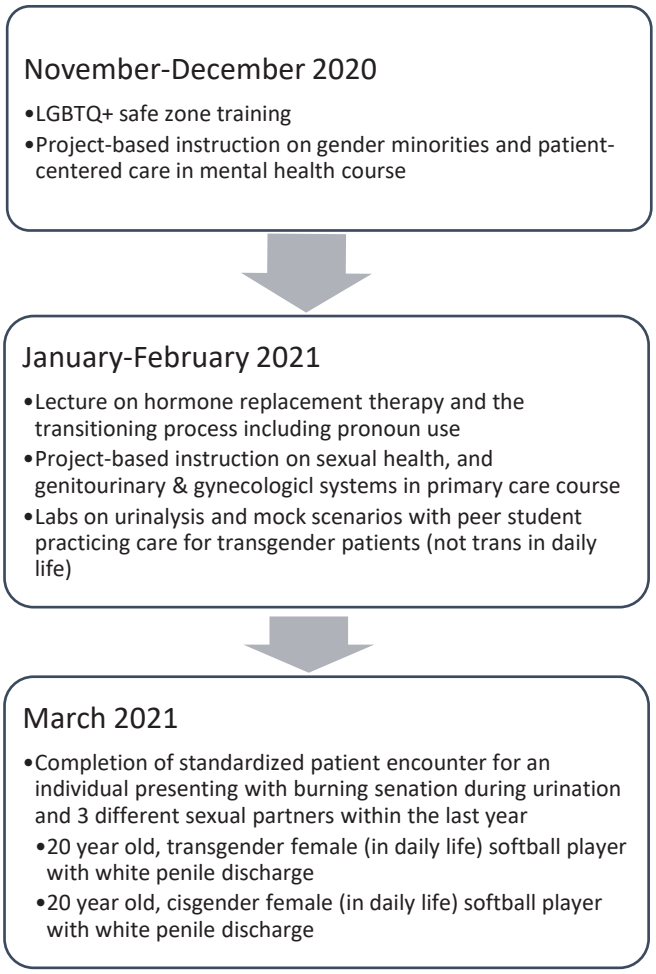

Figure. Overview of Educational Intervention

Examining How Social Justice Education Is Currently Incorporated Into CAATE Accredited Athletic Training Programs

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Context: In 2020, the CAATE released a statement acknowledging the lack of explicit requirements for social justice education (SJE) in the newest standards. Social justice (SJ) in health care is recognizing that equitable care and access to care are fundamental rights that result in fairness and the elimination of disparities. The inclusion of SJE improves AT patient care delivery and patient outcomes. The purpose of this study is to examine athletic training student (ATS) perceptions and exposure to SJE within their ATPs. **Methods:** We used a cross-sectional, web-based survey to explore ATS perceptions and exposures to SJE. This survey consisted of questions on demographic variables (3 personal items, 2 school-related items), SJE delivery methods and effectiveness (12 items) and ATS perceptions on SJE provided by the ATP (6 items). The instrument was content validated by 2 experts in survey design and diversity, equity, and inclusion. The survey was distributed through the BOC and NATA to current or recently graduated ATS. We used criterion sampling to identify ATS enrolled in the final semester of an ATP or credentialed within the last 6 months. 215 participants (age=24±3) were eligible and included in the analysis. The majority of participants identified as women (70.7%, n=152), White/Caucasian (68.4%, n=147), and went to a public state university (56.3%, n=121) in a suburban community (39.5%, n=85). Demographic data and ATS perceptions of SJE were analyzed using descriptive statistics. Chi-square tests of independence were used to examine the relationship between cultural ethnicity and SJE delivery methods and effectiveness. Kruskal-Wallis analyses were used to compare cultural ethnicity and ATS perceptions of SJE and confidence in addressing SJ. **Results:** There was a significant relationship between cultural ethnicity groups and educational experiences from formal instruction (FI), informal instruction (II) and clinical education (CE): FI on access to health care ($p=.011$), FI on human rights ($p=.031$), II on education equity ($p=.12$), II on hunger and food insecurity ($p=.46$), II on immigration ($p=.003$), CE on human rights ($p=.016$). There was a significant relationship between ethnic groupings and perceived effectiveness of SJE in FI ($p<.001$) and SJE in CE ($p=.038$). Significant differences exist between cultural ethnicity groups on perceptions of professors ($p<.001$) and preceptors ($p<.001$) knowledge of SJ as well as their agreement that the ATP prepared them to address SJ issues ($p<.001$). Specifically, Black/African American students indicated significantly lower levels of agreement about professor and preceptor knowledge and whether the program prepared them to address SJ in practice. **Conclusions:** Participants experienced SJE differently. Black/African American students have lower levels of agreement about program personnel knowledge and the ability of the program to prepare them for SJ issues in practice. With the implementation of new CAATE standards, this may change; however, continued focus should be paid to SJE.

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Social Determinants of Health and Access to Athletic Training Services in Pennsylvania Public Secondary Schools

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Context: Health disparities exist in many facets of healthcare. Differences in the provision or access of healthcare based on social determinants of health are inequities. To date, it is unknown if race, geographic locale, school size, free-reduced lunch and title-1 status are social determinants of access to athletic training (AT) services in Pennsylvania public secondary schools. Therefore, the purpose of this study was to compare social determinants of health in schools with adequate and inadequate access to AT services. **Methods:** Data were obtained from the Athletic Training Location and Services (ATLAS) Project, the American Community Survey (ACS), and the National Center for Education Statistics (NCES). Specifically, the ATLAS Project provided employment status of the athletic training services, the ACS provided racial demographics, and the NCES provided locale (suburb, rural, town, and city), school size (< or > 1000 students), free/reduced lunch (< or > 50%), and title-1 status (yes or no). Racial demographics were dichotomized and analyzed by two different methods. First, by < or > 13.4% (national census), and second, by predominantly Black defined as >50% of students were Black. Univariate analyses identified significant variables to include in multivariate analyses. Multivariate analyses included backward stepwise logistic regression to determine the contribution of the independent variables in the prediction of access to AT services. Odds ratios (OR) with 95%CI excluding 1.00 were statistically significant. Access to AT services was dichotomized as adequate (full-time AT services) and inadequate (part-time and none). It was dichotomized in this way because a difference in access or provision of healthcare based on group (school) status is, by definition, a health disparity. **Results:** Six hundred ten public secondary schools with 589 (96.6%) reporting AT employment status were included. Overall, 72% had access to full-time AT services, 18% had part-time access, 6.6% had no access to AT services, and 3.4% (n=21) were unknown. Univariate analyses found suburb, non-title-1, <50% free/reduced lunch, large schools, and predominantly Non-Black schools were significantly (P<0.05) more likely to have adequate access to AT services. In the final model, the multivariate analysis excluded title-1 status and free/reduced lunch status was insignificant (OR=1.67;95%CI:0.95-2.92). City (OR =4.15;95%CI:1.96-8.76); town (OR= 5.21;95%CI:2.98-9.13); rural (OR= 2.51;1.24-5.07); small schools (OR= 1.94;95%CI:1.23-3.33), schools with >13.4% Black (OR= 2.01;95%CI:1.04-3.88), and schools with >50% Black (OR=3.73 (95%CI:1.43-9.78) student populations were all significantly less likely to have adequate access to AT services. **Conclusions:** Our data is consistent with previous research by demonstrating differences in access to AT services in public secondary schools are partly based on social determinants of health. In addition, we found that the racial demographics of schools is a significant factor in determining access to AT services in Pennsylvania public secondary schools.

None of the authors have any financial disclosures.

Social Justice Education: Student Experiences and Perceptions

Young JP, Vaniman AL, Drescher MJ, Edler Nye JR, Mansell JL, Eberman LE: Indiana State University, Terre Haute, IN; Grand View University, Des Moines, IA; Temple University, Philadelphia, PA

Context: Standard DEI 1 of the CAATE 2020 Professional Standards requires that programs demonstrate systematic diversity, equality, inclusion (DEI) and social justice (SJ) efforts into program development, design, and delivery. Although previous standards required the education of patient-centeredness, there was a collective assumption that the PCC standards encompassed DEI and SJ. Student experiences relative to DEI and SJ education are unknown. **Methods:** We used a cross-sectional, web-based survey that was content validated by 2 experts to explore student experiences and perceptions of SJ education in CAATE-accredited, masters-level athletic training programs. Open-ended questions were used to capture participant's understanding of SJ and beliefs about their SJ education during their professional preparation. We used criterion sampling among students in their last semester and recently credentialed ATs within the last 6 months using the NATA and BOC databases. 189 individuals (age=24±3y) responded to the open-ended questions resulting in 410 responses that were included in the analysis. Data from the open-ended responses were analyzed using a 3-member coding team through a modified consensual qualitative research process to identify domains, sub-domains, and categories. We established trustworthiness through multi-analyst triangulation and auditing. **Results:** Two domains were identified through analysis: 1) SJ defined and 2) educational needs (Table 1). Participants described knowing SJ as equality, equity, and justice for minoritized peoples. The majority of respondents described SJ using terms such as equal rights or opportunities, equal distribution of resources, or equality for all. Fewer respondents described equity or justice in their definition of SJ, but those that did identified fairness or described the needed recognition and correction of systems that intentionally marginalized or harmed minoritized peoples. Participants also recognized health care and health care equity as part of SJ but recognized their knowledge was limited on how access and needs affect minoritized patients. In the educational needs domain, participants typically described receiving inadequate or incomplete SJ education. Participants frequently described their SJ education as not occurring at all or being rather limited to one population or being limited to one particular learning experience. Participants expressed a need for active and experiential learning opportunities, specifically practical, applicable and clinically relevant SJ experiences. Participants also desired information from heterogenous and unbiased sources, such as instructors or educational materials. A small portion of participants did not believe their social justice education needed any improvements. **Conclusions:** As programs continue to develop, design, and deliver SJ education, they should consider the value of heterogeneous, unbiased, active and experiential learning opportunities. Programs should expand the depth and breadth of DEI and SJ content to address health literacy, the social determinants of health, cultural competency, cultural humility, and patient-centered care to meet educational standards (Standards 56-60 and DEI 2).

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Table 1. Frequency Counts

Domain, Sub-domain, Category	Frequency N = 189	Commonality
Social Justice Defined		
Known		
Equality	73.5% (n = 139)	General
Equity	22.2% (n = 42)	Rare
Justice	19.6% (n = 37)	Rare
Unknown		
Health & Healthcare Inequities	25.9% (n = 49)	Rare
Educational Needs		
Inadequate or Incomplete	34.4% (n = 65)	Typical
Active & Experiential Learning	13.2% (n = 25)	Rare
Unbiased Education	7.9% (n = 15)	Rare
No need for Improvements	7.4% (n = 14)	Rare

Exploratory Study of Athletic Training Students' Confidence and Knowledge Regarding Suicide Prevention Following Observation of Standardized Patients

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Context: Athletic trainers report lacking confidence managing patients with suicidal ideation (SI). Standardized patient (SP) encounters have increased student confidence and skills time and resources to train actors are commonly reported barriers to implementation. Observation of a pre-recorded SP has been effective to improve clinical skills and could mitigate barriers of traditional SPs. We explored athletic training students' (ATSs) confidence and knowledge following an online suicide prevention lesson with and without observation of an SI management SP encounter. **Methods:** We used a quasi-experimental study design to determine the effects of observation of SP encounters on learner confidence, perceptions, and knowledge pertaining to SI events. Participants were ATSs enrolled in professional masters-level athletic training program recruited through program membership in the Association for Athletic Training Education. Fifteen programs (public=10, private=5; predominantly white institution, n=14, 93.3%) agreed to participate and were sorted into the intervention group (n=28), which received the educational module with SP videos, or the control group (n=43), which received only the educational module. Initial distribution was sent to program faculty and disseminated to students. Pre- and post-assessment were completed through Qualtrics, with links provided to participants within the module. Participants completed assessments immediately before after completing the module. We analyzed results using a repeated measures 2x2 ANOVA. **Results:** Twenty-eight students observed the SP videos (experimental), while 43 students did not (control). Few participants had previous experience with SI prevention training (n=13, 18.3%), but many had previous exposure to SI by knowing someone who had died by suicide or experienced SI (n=45, 73.8%). Both groups demonstrated a significant change over time relative to confidence ($p < 0.001$) identifying risk factors, intervening with patients experiencing SI, utilizing the NATA framework for helping individuals in crisis, and appropriately referring patients experiencing SI. Additionally, there was a significant decrease over time ($p < 0.001$), regardless of group, in perceptions of agreement to statements "it's not my place, "it is offensive," and "talking about suicide increases risk of suicide" and a significant increase in agreement that suicide is preventable ($p=0.003$). There was no significant difference between groups for confidence or perceptions. We identified main effects for time ($p < 0.001$) and group ($p < 0.001$), as well as significant differences between control and experimental groups ($p=0.004$) where the experimental group scored higher overall (11.7±1.44 / 15, 78%) than the control group (10.7±1.55, 71%) at the post-test. Both groups improved (mean change=1.7±1.8, 11.3%) from their educational experience. **Conclusions:** Observing SP videos may be effective to increase student knowledge pertaining to SI prevention. All participants significantly increased their confidence and knowledge, while appropriately adjusting the perceptions to best address SI after participating in a learning module. Future research should compare observations to in-person SP encounters to train for SI prevention.

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High Fidelity Simulation to Teach Cardiac Assessment Among Athletic Training Students

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Context: Sudden cardiac death is a well-documented event that occurs in athletes and physically active individuals. This devastating event typically occurs in young, high school and college-aged individuals with the first sign of the condition being death. The athletic trainer (ATC) plays a key role in prevention strategies in this population. Detecting abnormalities in patient history and auscultation of the cardiac system are a vital role in preventing sudden cardiac death. High-fidelity simulation represents a modern technology that will allow better education of ATCs in the identification of cardiac abnormalities or risk factors. The purpose of this Doctor of Nursing Practice (DNP) was to utilize high-fidelity simulation to teach cardiac assessment and auscultation to athletic training students (ATS) in the Bachelors of Science in Athletic Training program at Northern Kentucky University (NKU). **Methods:** The study was completed in a pre-test/post-test experimental design. Twenty-seven ATS were recruited and consented. During the pre-test session, ATC students were assessed on both self-confidence and competency regarding their ability to perform cardiac history examination and cardiac physical examination using a Visual Analog Scale. Students then took part in a 1 hour didactic presentation. The students were instructed by doctoral students in the Nurse Anesthesia Program. This included past medical history and family history risk factors. Anatomical considerations of the cardiac system were reviewed and the practical skills of cardiac auscultation were reviewed. Practice time was allotted to familiarize the ATS with landmarks for auscultation. Students then completed a series of assessments using high-fidelity mannequins. The mannequins have the capacity to change cardiac sounds digitally from a remote location while the students assess the patient in a controlled environment. Students were evaluated on their ability to accurately normal versus abnormal cardiac findings using the Observed Structured Clinical Examination (OSCE). Post-test questionnaires were then completed to assess confidence and competence. **Results:** All students had significant increases in both confidence and competence when performing a cardiac assessment using a paired t-test of the visual analog scale. (mean difference and 95% confidence interval: 12.26 (10.51, 14.00), p-value<0.00). Additionally, all ATS had an increase in Cardiac History Assessment (Table 01) and OSCE results (Table 02). **Conclusions:** Cardiac assessment plays a key role in the prevention of sudden cardiac death. Athletic Training education programs have barriers to educating patients on these skills, including time and experience in the instructors. An inter-professional strategy showed statistical improvements in confidence and competence in their cardiac assessment. The limited sample size did not allow for statistical comparisons in the validity of the physical examinations, however, all subjects had improvements in these areas.

None of the authors have any financial disclosures.

Question	Pre-Correct	Post- Correct	Estimated Difference	Confidence Interval	
				Lower	Upper
1	3.70%	96.30%	0.4815	0.256	0.707
2	3.70%	96.30%	0.704	0.466	0.941
3	3.70%	96.30%	0.5926	0.3702	0.815
4	11.11%	88.89%	0.7407	0.5384	0.9431
5	3.70%	96.30%	0.8148	0.6313	0.9984
6	3.70%	96.30%	0.8519	0.6808	1
7	3.70%	96.30%	0.7778	0.5839	0.9716
8	14.81%	85.19%	0.7778	0.5839	0.9716
9	0.00%	96%	0.9047	0.810294	0.999063
10	0%	96%	0.9047	0.810294	0.999063

Table 1Pre and Post Focused Cardiac History Assessment

n = 27	Pre-Correct	Post-Correct	Sample P	Confidence Interval	
Scenario				Lower	Upper
1	0	21	0.777778	0.577417	0.913783
2	0	23	0.851852	0.662689	0.958113
3	0	23	0.851852	0.662689	0.958113
4	0	25	0.925926	0.757102	0.9909
Average	0	**25**	**0.851852**	**0.757102**	**0.9909**

Table 2OSCE Results with Pre and Post Comparison

Longitudinal Impact of Mental Health Emergency Standardized Patient Encounter

Neil ER, Winkelmann ZK, Granger KC, Eberman LE: Temple University, Philadelphia, PA; University of South Carolina, Columbia, SC; Indiana State University, Terre Haute, IN

Context: Due to the practice gap of psychosocial interventions in clinical education, athletic training students and athletic trainers alike must ensure collaborative and effective management of mental health conditions in alignment with the NCAA Sport Science Institute Mental Health Best Practices. The use of hands-on instruction and assessment, such as practical exams, increase the confidence in a student's psychosocial intervention abilities. Standardized patient (SP) encounters have been effective in improving communication, psychosocial interventions, and role execution. Previous research within ATPs has identified the long-term benefits with skill translation from the SP encounter. Therefore, the purpose of our study was to describe how a SP encounter for a mental health emergency influenced the clinical practice of athletic trainers enrolled in a post-professional athletic training program. **Methods:** This qualitative study used a phenomenological approach to explore the lived experiences and clinical practices following a mental health emergency SP encounter. The study included those who had completed the educational experience at least one year ago as part of their post-professional athletic training education experience. Twelve individuals (male=6, female=6; age 32+/-7y, experience 8+/-6y) participated in the study. A semi-structured interview protocol was created and externally reviewed for content validity. The interview protocol asked the participant to reflect on the SP encounter itself and describe how it influenced their practice as a clinician. Participants completed an individual, audio-recorded interview and transcriptions were deidentified for data analysis. Data analysis occurred following the consensual qualitative research (CQR) approach. A 3-member coding team analyzed the data for domains and categories through four rounds of cross-analysis. To ensure credibility and trustworthiness, we used member checking, multi-analyst triangulation, and auditing. **Results:** Two emergent domains characterized the data: learning experiences and patient approach. The participants noted the SP encounter was emotionally realistic. The level of realness allowed the learners to suspend reality and be able to truly treat the encounter like they would in a real-life scenario. Participants also noted the SP encounter allowed for both application to their future practice as well as transformation from error. The learners shared there were areas in which they did not perform as they felt they should have in the encounter, however the experience allowed them to fail in a safe environment and then ensured their future clinical practices were adapted based on reflective debriefing. Some learners noted the SP encounter provided reassurance about skills, as they knew what to do, but were encouraged to receive positive feedback. Finally, some learners said the experience allowed them to then teach others, typically through creating SP encounters for students in the classroom or as a preceptor. From the patient approach standpoint, learners expressed the behavioral health SP encounter allowed them to provide empathetic patient care. Learners also said this encounter allowed them to practice direct questioning and active listening. For some learners, the SP encounter encouraged emergency action planning at their current site to improve continuity of care. The associated table contains the CQR counts for the codebook. **Conclusions:** Similar to other research about the longitudinal impacts of SP encounters, participants applied the learning outcomes from the SP encounter in their clinical practice one to three years later. Specifically, they were able to transform their practice from the errors they made during the SP encounter. The learning environment created an emotionally realistic space with reassurance and collaborative learning, which resulted in personal and professional development. We suggest mental health SP encounters be used to prepare athletic trainers, regardless of academic level, and especially when there are substantial consequences to the health and wellbeing of the patients, like in the case of an emergency mental health crisis.

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Perceptions of Professional Graduate Versus Undergraduate Athletic Training Students' Clinical Readiness

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Context: As athletic training nears the deadline for existing programs to transition to a professional graduate degree, recognition of athletic trainers' current perceptions of the 2 student levels must occur. We must be equipped to best prepare our stakeholders to fully support the growth and development of future clinicians and the profession as a whole. **Methods:** A cross-sectional study was designed and approved by the institutional review board in order to gain athletic trainers' perceptions on athletic training students' clinical readiness. A web-based survey with questions was developed based on previous literature, accreditation, and practice standards. The instrument underwent 2 rounds of pilot-testing for question clarity and relevance before being distributed to a convenience sample. The 15-item survey sought 5-point Likert scale responses (ranging from strongly agree to strongly disagree) to statements related to students' clinical knowledge and professional characteristics. Open-ended questions to support participants' answers were obtained to provide qualitative data for triangulation. Inclusion criteria consisted of athletic trainers responsible for evaluating professional undergraduate or graduate students within the past 5 years. The survey was deployed to 1000 professional members using the NATA Research Survey Service. A total of 87 participants between the ages of 21-70 years old completed the survey. Tests to determine significance were completed when appropriate as well as qualitative analysis of the open-ended responses. **Results:** With respect to quantitative analysis, descriptive statistics indicated 71/87 participants perceived differences between graduate and undergraduate athletic training students. A Mann-Whitney U analysis was performed with a P value set at <.05. The Mann-Whitney U test found significance with knowledge based questions for graduate students being better prepared to start a program (P<.001), graduate students having better overall knowledge (P<.001), and better clinical performance (P<.001). Significance was also found as it related to graduate students wanting more control and responsibility during patient care (P<.019). Open, axial, and selective qualitative coding methods were applied to the 2 open-ended questions to identify consistent relationships. Three main findings emerged from the data: 1) improved soft skills, 2) curricular design, and 3) irrelevance of degree earned. **Conclusions:** As the transition to a professional graduate degree levels out, we must be open to the perceptions that exist among preceptors and educators regarding clinical readiness of future clinicians. Improved soft skills like confidence, maturity, and dedication support quantitative results and align with previous researchers findings; however, other qualitative findings resulted in divergence from the statistical results. The expectation that foundational knowledge is transferred to graduate coursework must continue to be analyzed as well as overall program design since there is a perception that students have less time to become proficient in clinical skills.

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Preceptors' Perceptions of Clinical Reasoning in Athletic Training Practice

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Context: Clinical reasoning (CR) is defined as the multi-factorial and complex mental processes used for establishing a clinical diagnosis. Clinical reasoning, which takes shape during athletic training clinical education, is a vital skill for athletic trainers (ATs) to accurately evaluate and diagnose injury and illness. Preceptors are the role models that foster an athletic training student's CR development. However, the CR ability that preceptors are expected to foster in students has not been investigated. Therefore, the purpose of this study was to explore athletic training preceptors' perceptions of their CR processes. **Methods:** This study used a consensual qualitative research approach to interview a total of nine ATs, recruited using a social media and snowball sampling method, that were CAATE-accredited, professional program preceptors. Participants were individually interviewed through Zoom and participant numbers were guided by data saturation. A semi-structured interview protocol was developed, which consisted of 12 open-ended questions guided by three research questions: (1) How do athletic training preceptors organize their thoughts while making clinical decisions during patient encounters? (2) What are the changes in preceptors' evaluation techniques based on the perceived difficulty of the case? (3) Do preceptors identify a preference in CR models when evaluating patients? To achieve the purpose of this study, the questions were structured around how preceptors perceived their reasoning through the context of a simple and complex clinical case that they have managed. The content validity index demonstrated a high level of agreement between the four raters that the instrument was valid (S-CVI/UA = 88%). To ensure face validity, the interview protocol was pilot tested with a preceptor that met the inclusion criteria. The pilot interview did not yield any additional changes to the instrument and was included for final analysis. Three researchers used a consensus process to analyze data, identify emergent themes, and independently create a codebook. A consensual codebook was developed using identified themes and subgroups. Frequency counting was used to provide a sense of representativeness to determine how often each category was applied to the entire sample. Trustworthiness was established using member-checking, multiple researchers, and an internal auditor. **Results:** Preceptors' perceptions of CR revealed four main themes, 12 categories, and 20 sub-categories (Figure 1) that emerged from the semi-structured interviews. The main themes were (1) Diagnostic Reasoning, (2) Therapeutic Reasoning, (3) Metacognition, and (4) Influences. Preceptors reported that when clinical cases aligned with their previous clinical experience, they preferred a non-analytical diagnostic approach. Complex cases, or less habituated cases, resulted in an analytical approach to diagnostic reasoning. Preceptors mostly used a combination of the two approaches based on the situational context of the presenting injury/illness and metacognitive processing. Preceptors described using metacognitive processes for the growth and development of their clinical skills. Metacognition took place both in the moment and while reflecting on clinical scenarios. Situational factors such as training, clinical experiences, and the environment in which preceptors practiced influenced CR. Controllable factors such as stakeholder involvement could be mitigated through essential skills such as effective communication, conflict resolution, adaptability, and problem-solving. Factors outside of the preceptors' control could be mitigated through social support and professional networking with external support systems such as coaches and supervising physicians. **Conclusions:** Clinical reasoning is complex and nuanced and preceptors serve as the link for students to develop and apply CR in clinical practice. Therefore, preceptors should foster a culture of self-reflection on clinical experiences to improve CR and include students in learning activities that similarly foster CR skills. Athletic training programs should use preceptor development opportunities to help educate preceptors on their CR ability as well as how to purposefully teach skills to improve students' CR.

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Relationship of Anxiety and Depression in Athletic Training Students During COVID-19

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Context: Current estimates state that approximately 35% of college students have been diagnosed with a mental health disorder. Studies have found the general population reporting increased levels of anxiety and depression during the COVID-19 pandemic. The purpose of this study was to examine the effect COVID-19 had on the mental health of athletic training students (ATS) and what factors contribute to feelings of depression and anxiety. **Methods:** A Qualtrics-based 36-item questionnaire, about academics and mental health of ATS during the Spring 2020 semester, was sent to the 322 active CAATE accredited athletic training program directors with a link to forward the questionnaire to current students. The presence of anxiety and depression-related symptoms in ATS was examined based on gender (male, female, other), race/ethnicity (White, Black, American Indian or Alaska native, Asian, Native Hawaiian/Pacific Islander, Latino/Hispanic, multi-race, other), ATP status (year in school), GPA, BOC exam worry (not at all worried to extremely worried), and the Depression, Anxiety, and Stress Scale (DASS-21) scores for depression, anxiety, and stress-related symptoms. Separate linear regression models using a backward selection method with removal of variables greater than 0.10 predicted the presence of anxiety and depression-related symptoms from our independent variables. **Results:** Three hundred sixty-two ATS completed the survey (undergraduate: n=185, 51.1%; female: n=225, 62.2%; white: n=229, 63.3%). Based on DASS frequencies, 51.2% of ATS reported some level of depression, 69.1% of ATS reported some level of anxiety, and 32.5% of ATS reported some level of stress as indicated on the DASS-21. Our model was able to account for 51.5% of the variability in predicting depression. Anxiety ($B = 0.41$; $p < 0.001$), Stress ($B = 0.39$; $p < 0.001$), and GPA ($B = 0.80$; $p = 0.047$), as measured by the DASS-21, showed the greatest level of predictability for depression in athletic training students. Our second model was able to account for 69.0% of the variability in predicting the presence of anxiety-related symptoms. Specifically, stress ($B=0.51$, $p<0.001$) and depression-related symptoms ($B=0.18$, $p<0.001$) significantly predicted anxiety-related symptoms for students in this study. While not statistically significant, gender ($B=0.70$, $p=0.051$) and ATP status ($B=-0.14$, $p = 0.088$) were also included in this model. **Conclusions:** Results demonstrate that anxiety and depression exist at high levels in ATS in relation to the COVID-19 pandemic. Both depression and anxiety were significant in relation to the alternate dependent variable, with stress also playing an important role. GPA had a positive relationship with depression, suggesting that as GPA increased, so did depression scores. Teaching methods may have had students worried about maintaining grades during the early portion of the COVID-19 pandemic. Program requirements need to be examined and the mental health of ATS needs to be monitored as the pandemic continues.

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Cancer in Sport – The Diagnosis and Return of a Division I Track & Field Athlete With Stage II Hodgkin's Lymphoma: Level 4 Case Study

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Background: An otherwise healthy 23 y/o male Division I collegiate hammer thrower presented with a repeat meniscal injury to the left knee. After further imaging and evaluation, the orthopedic surgeon recommended an arthroscopic intervention. On the day of surgery, the patient was admitted to the surgical outpatient clinic and due to the COVID-19 global pandemic, a chest X-ray was ordered in addition to the hospital's traditional preoperative checklist. The X-ray showed a mass in the left supraclavicular region. **Differential Diagnosis:** Lung cancer. **Intervention & Treatment:** The knee arthroscopy was not conducted, and the patient was released and readmitted for a biopsy of the left supraclavicular lymph node. The results of the biopsy were consistent with Hodgkin's Lymphoma and a subsequent positron emission tomography (PET) scan with contrast was conducted and ultimately the diagnosis of stage II Hodgkin's Lymphoma was established. The patient underwent treatment with both chemotherapy and targeted radiation therapy. The chemotherapy was administered via a chest port-a-cath that was surgically inserted into the right side of the patient's chest. The patient received two cycles of chemotherapy and three weeks of daily targeted radiation therapy. The outcome was successful, and the patient was able to resume competitive activity without restrictions. His season ended successfully with an NCAA first round appearance as well as a personal best throw. **Uniqueness:** Minimal literature exists regarding the treatment of cancer and return to activity in a young, athletic population. Even fewer studies with male patients as the focal point have been produced. Hodgkin's Lymphoma is also a rare form of cancer of the lymphatic system compared to non-Hodgkin's Lymphoma. Additionally, this student athlete has no previous personal or familial medical history with cancer of any type. **Conclusions:** The diagnosis and treatment of lymphatic cancers remain an uncommon occurrence. There is nominal literature regarding this specific diagnosis in a male athletic population returning to competitive activity. Stage II Hodgkin's Lymphoma has an expected 95% survival rate. The introduction of this treatment and return to athletic competition may serve as a framework for other similar instances of cancer diagnosis in a young adult population.

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COVID-19 Long Term Effects on Football High School Athlete: Level 3 Exploration Case Series

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Background: COVID-19 is a new virus that appeared in the US in March of 2020. The effects are reported in non-athletes' months after the initial diagnosis. There are instances of athletes having cardiac and respiratory effects long after the initial contraction of the disease. **Patient:** Patient is a 17-year-old male high school football player, who contracted COVID-19 in July of 2021. He is a year-round athlete (football-fall; wrestling-winter; track-spring). The individual was unvaccinated prior to contracting Coronavirus and has no prior history of respiratory problems. His symptoms included headaches, fever, body aches, back pain, and loss of taste and smell. Per county guidelines, he was to quarantine for 14 days; however, he was in quarantine for 3 weeks because of multiple positive tests. Once he tested negative, he was allowed to return to pre-season practice. **Intervention & Treatment:** Before returning to play the athlete had to get an EKG per the county athletic guidelines. His results were normal and he began the acclimatization process. However, acclimatization was slightly different for this athlete than the other athletes without COVID-19. The athlete complained of pectoral pain and fatigue and stated that when he takes deep breaths, he feels like his chest is ''locking." The athlete takes longer breaks or sits out of practice due to his symptoms, and also states that he constantly feels out of shape more than normal. Therefore, his acclimatization program focused more on endurance exercises for conditioning than usual. Exercises included running laps on the track while increasing the amount of equipment he wears. The Athletic Trainer used recovery pain relief gel on his back and chest to open it up, which assisted his respiratory issues. To date, the athlete has lost 25 pounds. **Outcomes or Other Comparisons:** This athlete is the only one who has come in for treatment regarding COVID-19 aftereffects even though there have been reported cases of COVID-19 from other players. The athlete missed the first week of preseason but was able to start conditioning in the middle of the second week. The athlete has been able to fully return to play but does come to the Athletic Trainer for treatment for respiratory symptoms. At the midpoint of the season, the athlete began to complain more about his symptoms including shortness of breath and chest tightness. He even had to be removed from play for the second half of a game. The Athletic Trainer may refer the athlete to a pulmonologist. **Conclusions:** In conclusion, while this athlete has returned to full play, he still complains of respiratory problems long after receiving a negative test for COVID-19. This case was a challenge due to COVID-19 being a new virus that has affected millions of people globally and has led to long term effects that are hard to predict especially in high school athletes. **Clinical Bottom Line:** This case study was important because COVID-19 is a new virus that has caused global issues for all age types. Since an athlete's body must be at peak levels of fitness the long-term effects of COVID can adversely affect the body's response to injury.

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Ehlers-Danlos Syndrome in a Female High School Lacrosse Goalie: Type IV CASE Study

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Background: Patient is a 15 year old Caucasian female that plays goalie for her high school's lacrosse team. This athlete has a long history of fractures and ligamentous injuries. In January 2017, the patient stepped in a hole in her yard causing a left calcaneofibular ligament sprain and a Salter Harris Type I fracture of the distal fibula. The patient experienced a 10ft fall from a tree in April 2017, following which she went to the emergency department (ED) where she was diagnosed with a closed nondisplaced right acetabular fracture and pubic ramus fracture. Despite rehabilitation to strengthen her hip and pelvic musculature, she experienced continued pain in her right hip. It was later determined that she had torn her right acetabular labrum from the fall. This injury was surgically repaired in April 2019. In October 2019, she had her left acetabular labrum repaired. The mechanism of injury is unknown but was thought to be from swimming or overuse from the recovery of her right pelvic fracture. In June 2020, the patient went to the ED for episodes of syncope at which time it was noted that there was a family history of mitral valve prolapse. She received an echocardiogram and EKG; all cardiac results returned normal. She was referred to Rheumatology for further evaluation. In the meantime, she sustained a SLAP tear from falling while water tubing. This injury was surgically repaired in July 2020. Finally, in September of 2020, she fell while hiking and sustained a right distal radius closed buckle fracture. **Differential Diagnosis:** Hypermobility, low calcium levels, mitral valve prolapse, dysautonomia, and low vitamin D levels. **Intervention & Treatment:** In September 2020, a Rheumatologist diagnosed her with Ehlers-Danlos Syndrome (EDS) due to her joint hypermobility, increased rates of injuries and family history of EDS in a younger sibling. Since her diagnosis, she sustained a torn right glenohumeral labrum by picking up a barbell in weight lifting class in April 2021 and a left ankle sprain by missing a step while going down stairs in May 2021. Her injuries are being treated as they happen. **Uniqueness:** EDS is a group of genetic disorders that affects fewer than 200,000 people in the United States every year. The skin can become more elastic, thin, or velvety, joints can become hypermobile, and heart valves can become weakened, particularly the mitral valve.[1] An annual cardiac evaluation is encouraged to monitor the function of the heart. During an athlete's pre participation exam (PPE), standard body ROM should be assessed and compared to normative values. This information could be key when combined with a thorough personal and familial medical history to recognize the need for further evaluation. There is currently no treatment or cure for EDS. One way to decrease the amount of injuries sustained by those with EDS is by limiting participation in contact sports. Sports such as tennis, golf, and swimming could reduce the likelihood of contact-based injuries. **Conclusions:** The athlete was warned of the risks of participating in contact sports. The family decided that if the patient wanted to play she could. At this time, her injuries will continue to be treated by the school athletic trainer, as long as they can be tolerated or until her parents remove her from participation. Athletic trainers are an integral part of an athlete's medical care team. Athletic trainers need to be aware of conditions other than musculoskeletal injuries since we are often the gatekeeper for medical care referrals. During a PPE, it is important that a complete patient history is obtained not just a musculoskeletal injury history in hopes of early recognition of red flags that warrant referral.

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Mediastinal Grey Zone Lymphoma, a Form of Non-Hodgkins Lymphoma: A Patient-Centered Case Study

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Background: Decongestants relieved symptoms until he received the second dose of the Pfizer COVID-19 vaccination at the end of January 2021. He proceeded to observe increasing swelling of his left subclavian lymph node, severe fatigue, chest congestion, dry cough, and trouble breathing while laying down and with exertion. The patient had a consult with his primary care physician in the beginning of February due to his over-the-counter treatment not relieving his symptoms. **Patient:** The patient is a 26-year-old male certified athletic trainer who presented with chest congestion, fatigue, and weakness in December of 2020. **Intervention & Treatment:** The patient was referred for an ultrasound of the lymph node and prescribed bactram to take for one week, twice a day to treat the present infection. When symptoms did not resolve, he was referred to an Ear, Nose and Throat specialist. A chest radiograph revealed multiple swollen lymph nodes within his chest indicating the need for a computed tomography (CAT) scan of his chest and abdomen. Results of the CAT scan indicated needle biopsy of the left subclavian lymph node. The biopsy lacerated his jugular vein, putting pressure on his trachea, leading to inability to breathe and requiring a trip to the emergency department. The oncology department at the hospital removed his left subclavian lymph node and sent the lymph node to the National Institution of Health (NIH) for further testing. The NIH ultimately diagnosed the patient with Mediastinal Grey Zone Lymphoma stage 2b. The oncologist recommended chemotherapy for treatment, which began at the end of March 2021. The chemotherapy treatment plan (R-EPOCH) included rigorous treatment every three weeks for five days, repeating this process six times. Treatment included prednisone 250mg a day, rituximab, IV fluids, and Decadron daily. He was then given a continuous pump for etoposide, doxrubin and vincristine to decrease the growth of cancer cells and Zofran to treat nausea. **Outcomes or Other Comparisons:** Once the treatment was concluded, the patient oncologist repeated scans to show that the Mediastinal Grey Zone lymphoma was absent. The patients treatment then changed to getting repeat scans every six months. **Conclusions:** There is limited research on Mediastinal Grey Zone lymphoma which can make it difficult to diagnose based on signs and symptoms. This case of Grey Zone lymphoma was diagnosed early. As a healthcare provider, the patient was able to understand the severity of his signs and symptoms progressing over time. Additionally, the COVID-19 vaccine played a big role in this case; the lymph node reacted to the vaccine was because the patient's body was already fighting off the non-Hodgkins lymphoma. This allowed his body to show signs on the lymphoma quickly, giving him the ability to have a better survival rate for this lymphoma. **Clinical Bottom Line:** It is important as an athletic trainer (AT) to be able to recognize if signs and symptoms are being treated and not improving. ATs must advocate on the behalf of the patient for further investigation until a correct diagnosis is found. With lymphoma, early diagnosis will increase survival rate, making it important to be able to recognize major signs and symptoms to refer to the correct clinician. Being able to talk to the patient about the steps that will be taken through this process can make things easier, along with education on different coping strategies that will be safe for them during this time. ATs must build good relationships with their patients to allow them to be comfortable enough to ask for help outside of physical demands. These relationships will help the AT be able to advocate on behalf of their patients.

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Post-COVID "Long-Haulers" Syndrome in a Female Recreational Athlete

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Background: Our subject is a 33 y/o recreational athlete who contracted COVID-19 in March of 2020. Her initial COVID-19 symptoms were quite severe. She "toughed" out the acute phase of the illness in her apartment due to hospital overcrowding. However, even weeks later when the acute phase had passed, she was left with several lingering issues. The patient developed new symptoms as well as worsening residual symptoms. These included: food intolerances (foods that trigger a histamine reaction- dairy, gluten, caffeine, alcohol, legumes, acidic foods, processed foods, etc.), gait disturbances, paresthesias, vestibular issues, anxiety, depression, brain fog/memory/cognitive issues, insomnia, chronic pain/fatigue, hypotension, weight loss, among others. **Differential Diagnosis:** There are many sub-diagnosis for Post-COVID "Long-haulers" syndrome because it is a multi-system condition. Several additional tests have ruled out other pathologies including: multiple sclerosis, lyme disease, lupus, sleep apnea, and COPD. **Intervention & Treatment:** Her team consists of a coordinating family practice physician, physiatrist, psychiatrist, gastroenterologist, neurologist, physical therapist, behavioral health therapist, sleep therapist, and speech pathologist. She takes a variety of medications including ramelteon [insomnia] , citalopram [depression], amitriptyline [low dose for gastric sensorimotor dysfunction], aripiprazole [depression/anxiety], and clonazepam [anxiety]. A stomach biopsy revealed inflammation of the stomach lining, however, no ulcerations were found. Uterine inflammation coupled with severe dysmenorrhea resulted in a hysterectomy procedure. To improve her gait and physical state, our subject has gradually increased her activity level to 30 minutes a day on a recumbent stationary bicycle. As a result of the limitations in what she can eat and lack of appetite, the patient had lost 70 pounds since contracting COVID-19. With the guidance from her healthcare team, she gradually increased her daily caloric intake to 1600 calories and has been slowly regaining weight. The neurological issues caused by COVID-19 have affected her gait, speech, and have given her involuntary tics (mostly associated with anxiety). Her balance has become severely compromised by the combination of neurological issues and gait impairments. To assist with ambulation, the subject uses trekking poles. **Uniqueness:** Despite COVID being primarily considered a respiratory illness, our subject now faces a plethora of other issues including gastrointestinal tract issues and neurological issues that have lasted over 20 months following her contracting COVID-19. For her entire team of medical specialists, COVID is new, uncharted territory with a unique virus that offers outcomes ranging anywhere from zero symptoms to death. It has been estimated that 27-33% of COVID patients will develop some form of "long-haulers" sequelae. The severity of the initial symptoms are not indicative of the development and/or severity of "long-haulers." In our subject's case, her symptoms were severe, but did not require hospitalization or a ventilator. Yet, she still developed significant "long-hauler" symptoms. With her March 2020 contraction of COVID, she was in the first wave of patients. With millions of people contracting COVID since then, this is an ominous foreshadowing as to the potential wave of future 'long-hauler" cases. **Conclusions:** Our subject still suffers from gait, coordination, gastrointestinal tract, and neurological issues. She has made tremendous improvement on her neurological impairments, but still deals with tics and speech problems associated with anxiety. She has had severely decreased cognitive communication, including her attention span, immediate memory, and delayed memory. Overall, she has made considerable progress, but still has a long path of healing and recovery before she will be considered functional for her activities of daily living. She now lives with her parents, since she is presently unable to fully live on her own. Post-COVID "Long-Haulers" syndrome still needs considerable research in order to learn the etiologies and preferred treatments.

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Pulmonary Embolism in a Female Athlete

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Background: An 18-year-old female collegiate volleyball player who presented with symptoms of a SLAP tear of the right shoulder. After having surgery on Oct. 16th, 2020, she complained of back spasms in her left Rhomboid area the Sunday after surgery. On the morning of Oct. 20th, 2020, she complained of a cough she had had for a few days. Later that night, she began to cough up blood. The athlete was then sent to the ER and was later admitted when doctors discovered a large blood clot in her right lung. It was suspected that this young athlete had a blood clotting disorder that caused the two blood clots in her lungs. There was no family history of clotting disorders; however, the history was significant as the patient was taking oral contraceptives. For an accurate diagnosis, the athlete was tested for a blood clotting disorder twice. Her second test was six months following the event. **Differential Diagnosis:** Differential diagnoses include back spasms, pneumonia, and Chronic obstructive pulmonary disease. **Intervention & Treatment:** Treatment of athlete's back spasms following a SLAP lesion surgery consisted of electrical stimulation, ice, heat, use of massage ball, and trigger point release therapy. Treatment for athletes' lung blood clots consisted of having two catheters directly distributing medicine to each blood clot. **Uniqueness:** This case is unique since this athlete has no family history of blood clotting disorders. However, Estrogen-containing contraceptive methods raise the chances of pulmonary embolism by about three or four times compared to females who are not on the medications. **Conclusions:** This athlete's second test came back normal, and it was ruled that she does not have a blood clotting disorder. She is no longer on daily blood thinners, however, if she must undergo surgery again, she will have to be prescribed blood thinners afterward. All sports medicine professionals should be aware of blood clotting conditions that may be present among student-athletes. Prescreening should include questions about history or family history of blood clotting disorders. Early diagnosis of Pulmonary Embolisms is essential to appropriate treatment and increases chances of continued athletic participation.

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Athletic Trainers Working With Athletes With Intellectual Disabilities

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Context: Intellectual disability is defined as any disability characterized by significant limitations in both intellectual functioning and adaptive behavior. In the United States, there are an estimated 3 million athletes experiencing some form of intellectual disability. Previous literature shows individuals with disabilities have unequal access to healthcare professionals. As medical professionals with a focus on active populations, athletic trainers are well poised to provide high-quality medical care to athletes with intellectual disabilities. However, previous research shows athletic trainers do not feel prepared to provide care to athletes with intellectual disabilities. The purpose of this study was to explore the experiences and perceptions of athletic trainers who work with athletes with intellectual disabilities. **Methods:** We used a consensual qualitative research approach to guide this study. Using criterion sampling, we identified athletic trainers who have worked with patients with an intellectual disability within the last 3 years. Fifty-two potential participants completed the preliminary Qualtrics survey to consent, confirm they met the inclusion criteria, and provide demographic information. Following survey completion, 10 participants completed a semi-structured interview regarding their experiences. The research team developed the interview script using the limited research that is available, and three content experts skilled in qualitative research design reviewed it and made grammatical and structural modifications. We focused the interview on the athletic trainers' experiences, preparation, and perceived competency. Following the interview, we sent transcripts to each participant for accuracy member checking. In the consensual qualitative approach, we coded the qualitative data as a team and established a consensus codebook over a multi-step process using multi-analyst triangulation. **Results:** Participants were experienced athletic trainers (14±12 y of experience, range 4-39 y) from various settings (setting: secondary school=4, college/university=2, other=2, clinic=1, retired=1) with varied training (highest degree earned: professional bachelors=2, post-professional masters=2, academic doctorate=3, clinical doctorate=3). We identified three domains within the data: preparation/resources, knowledge/skills gained, and communication (Figure 1). During the interviews, participations noted they had little formal education related to providing care for athletes with intellectual disabilities and learned largely through doing because there are very few formal professional preparation or continuing education opportunities focusing on this topic. As they practiced, clinicians gained knowledge and skills related to situational awareness and understanding whole-person health. Participants noted the importance of clear and patient-centered communication with the patient and that they developed new communication patterns specific to providing care to patients with intellectual disabilities. **Conclusions:** Athletic trainers are providing care to patients with various intellectual disabilities but have had little preparation specific to this population. For that reason, athletic trainers are often left to learn on their own. As the profession focuses on providing high-quality, patient-centered care and expanding diversity, equity, and inclusion efforts, we must be intentional about including training and resources related to care with all types of patients. We should create educational opportunities related to intellectual disability and the ways in which we can provide great care.

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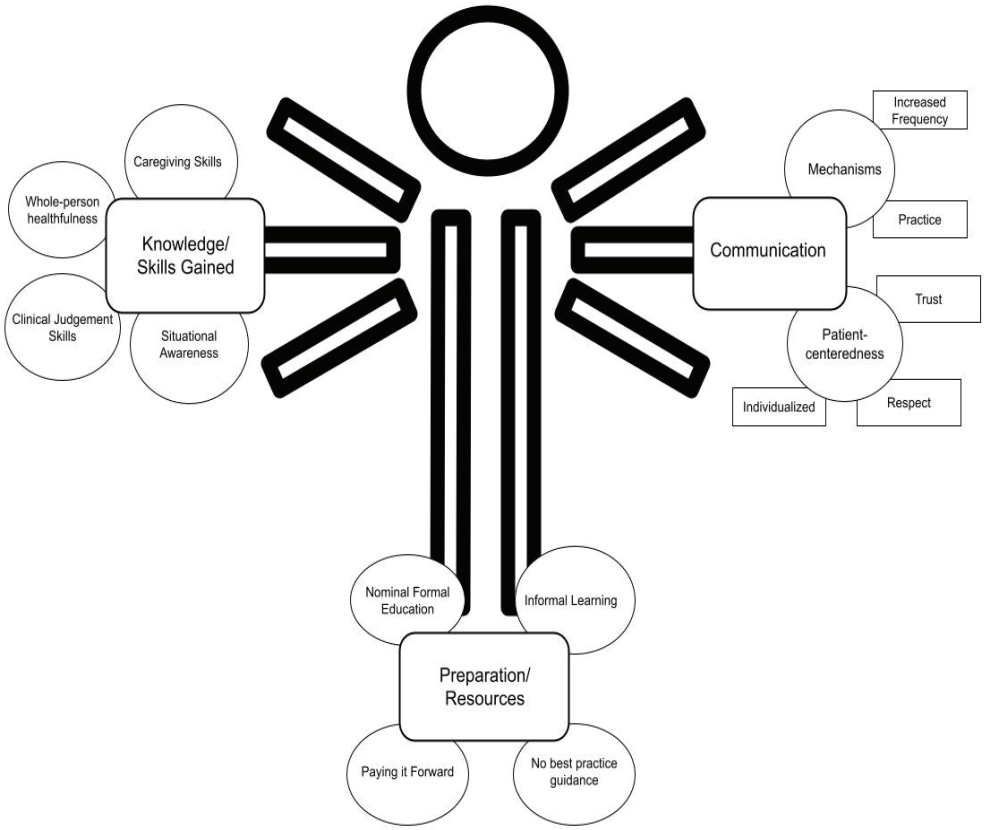

College Football Players' Perceptions of Athletic Trainer's Patient-Centered Care as Measured by Trust and Empathy

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Context: Football athletes make up 16.7% of NCAA participants and over half of collegiate football athletes identify as Black/African American. Little is known about this population's perceptions of their athletic trainer's (AT) delivery of patient-centered care and how that might differ across racial identities. Therefore, the purpose of this research was to assess college football player's perceptions of patient-centered care in the form of trust and empathy with their AT and compare differences of trust of their AT by race. **Methods:** This cross-sectional study included a convenience sample of collegiate football players from a single NCAA institution (n=101 [Black/African American=49, White=52] age=20.41 + 1.6, response=97.4%). Participants completed a web-based survey including demographic information and the assessment of perceptions of trust and empathy with their AT; testing was completed following a team meeting. Example questions of this Likert Scale can be seen below in Table 1. The instrument was adapted from an instrument validated with physicians and then pilot-tested with collegiate athletes. Only athletes identifying as Black/African American and White were included. Descriptive statistics including means, standard deviations, frequencies, and percentages were used. Comparison of survey items regarding trust of their AT by race was calculated using a Mann-Whitney U test. Statistical significance was set at $p < 0.05$. **Results:** Most football players (n=92, 91.1%) reported having seen their AT for an injury in college with an average of 1.88 + 2.84 injuries reported. Overall, players indicated positive feelings of trust and empathy with their AT (Table 1). There was no difference between racial identities and trusting their AT if they were the same race ($U = 1230.5$, $p = .74$) and trusting their AT if they were a different race ($U = 1446.5$, $p = .16$). A higher percentage of White football players indicated they were very likely to trust their AT if they were a different race than Black/African American athletes (40.4% vs. 24.5%) with most football players indicating it does not matter (White=55.8% vs. Black/African American=71.4%). **Conclusions:** Collegiate football players indicated positive feelings of trust and empathy with their AT. There were no differences between racial identities and trusting their AT if they were the same race or a different race. However, a higher percentage of White football players reported they were very likely to trust their AT if they were a different race compared to Black/African American football players. In addition, most football players had no opinion regarding their AT's race, suggesting football players subjectively feel as though they are being provided adequate medical care from their ATs regardless of social identities related to race. This is important as previous research in other medical professionals/medical fields show a lack of racial diversity could be contributing to disparities and inequities in healthcare.

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Table 1. Athletes Perceptions of Trust and Empathy of their Athletic Trainer

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
AT(s) provide me with the best care	49, 48.5%	33, 32.7%	15, 14.9%	3, 3%	1, 1%
AT(s) care about me	55, 54.5%	31, 30.7%	14, 13.9%	1, 1%	0, 0%
AT(s) committed to keeping me healthy	53, 52.5%	30, 29.7%	16, 15.8%	2, 2%	0, 0%
AT(s) advocate on my behalf to coaches	45, 44.6%	26, 25.7%	24, 23.8%	3, 3%	3, 3%
AT(s) considerate of needs and put me first	25, 24.8%	38, 37.6%	25, 24.8%	12, 11.9%	1, 1%
Distrust AT(s) opinions and want a second one	7, 6.9%	13, 12.9%	33, 32.7%	32, 31.7%	16, 15.8%
Trust AT(s) judgements about care	32, 31.7%	40, 39.6%	26, 25.7%	3, 3%	0, 0%
AT(s) involve me in treatment decisions	28, 27.7%	34, 33.7%	37, 36.6%	1, 1%	1, 1%

The Association Between Access to Athletic Trainers and Emergency Medical Services Activations for Sport-Related Injuries

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Context: The presence of an athletic trainer (AT) in secondary schools is associated with improved preparedness for sport-related emergencies. Utilization of emergency medical services (EMS) with different access to athletic training services remains unknown. This study compared the incidence of EMS activations for sport-related injuries between zip-codes by athletic training service level and employment model. **Methods:** Data were obtained from the National EMS Information System and the Athletic Training Location and Services Project for 2017-18. Cases were limited to 9-1-1 EMS activations for sport-related injuries among individuals 13-18 years. An aggregate score was created for each zip-code by athletic training service level, ranging from 0 (no schools within zip-code have access to athletic training services) to 1 (all schools within zip-code have access to full-time athletic training services). Service level was categorized as NONE (0.00), PART (0.01-0.99), and FULL (1.00). Employment models within each zip-code were categorized as independent contractor (IC), medical or university facility (MUF), school district (SD), or mixed employment models (MIX). The incidence of EMS activations within each zip-code were determined. Separate negative binomial regressions were performed with incidence of EMS activations as the dependent variable. The predictor variables were athletic training service level and employment model. Incidence rate ratios (IRRs) with 95% CIs excluding 1.00 and $p<0.05$ were considered significant. **Results:** On average, there were 2.8±3.5 EMS activations per zip-code (range 1-81, n=4,923). The number of ATs employed within zip-codes ranged from 0-9 (mean 1.4±1.3). Among zip-codes where at least 1 AT was employed (n=2,228), 3.73% (n=83) were IC, 30.83% (n=687) were MIX, 27.24% (n=607) were SD, and 38.20% (n=851) were MUF. Compared to SD, MUF had a 10.8% lower incidence of EMS activations (95%CI: 0.817, 0.974, p=0.010). IC (IRR: 0.920, 95%CI: 0.758, 1.118, p=0.403) and MIX (IRR: 0.996, 95% CI: 0.909, 1.091, p=0.932) did not have a significant difference in EMS activations compared to SD. Service level was calculated for 3,834 zip-codes, with 19.5% (n=746) NONE, 46.2% (n=1,771) PART, and 34.4% (n=1,317) FULL. Compared to NONE, FULL (IRR: 1.416, 95%CI: 1.308, 1.532, $p<0.001$) and PART (IRR: 1.368, 95%CI: 1.268, 1.476, $p<0.001$) had higher incidences of EMS activations. **Conclusions:** The presence of an AT within a zip-code where at least one EMS activation occurred is associated with an increased utilization of EMS for sport-related injuries among secondary school aged individuals. The incidence of EMS activations was significantly lower for MUF compared to SD, but there was no difference between IC and MIX compared to SD. These findings may indicate improved identification and triage of sport-related emergencies in areas with access to ATs. The difference in EMS utilization between employment models may represent the presence of different policies and procedures for sport-related emergencies.

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Use of the Emergency Department Among Secondary School Student-Athletes in an Urban School District

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Context: Athletic trainers (ATs) in secondary schools can reduce visits to hospital-based health care providers (HCPs) by managing injuries and other medical conditions on-site at school and by triaging patients to appropriate outpatient HCPs. This study aims to describe emergency department (ED) use by student-athletes (SAs) in an urban setting, by analysis of ED visits and the presence of an AT onsite. **Methods:** The database was acquired from a pediatric academic medical center as part of a larger retrospective study of student athlete (SA) injury and illness care in secondary schools in an urban city. The dataset tracked and compared ED use by SAs with various levels of AT access across three academic years; however, only one year is included in this dataset. SAs attending public schools who presented to the ED were included. Reasons for visits were coded by two sports medicine physicians as related to: sports, mental health, other. Interrater reliability was confirmed by subsample of coded visits (i.e., agreed > 95% on 100 visits). Schools had either full-time AT (≥30 hours/week at school), part-time AT (15 hours per week), or no AT. School socioeconomic status (SES) was categorized as low, middle, or high, based on percentage of free or reduced lunch eligibility. Exploratory descriptive and inferential statistics were calculated to investigate whether AT presence or school SES impacted SA ED use. **Results:** There were 2776 ED encounters among SAs from 19 schools. Per SA, there were a total of 0.14 sports-related, 0.02 mental-health-related, and 0.15 other-type encounters in the ED. There were no significant differences for sports-related or other-type encounters among the SES of schools or presence of an AT (all P>.05). There was significant difference in mental-health-related ED visits between full-time AT schools (mean=0.030 ± 0.022) and combined data of no and part-time AT schools (mean=0.012 ± 0.016), t17=2.07, P=.027, d=0.98. There was significant difference in mental-health-related ED visits between high SES schools (mean=0.008 ± 0.011) and combined data of low and middle SES schools (mean=0.025 ± 0.022), t17=1.88, P=.039, d=0.89). **Conclusions:** In schools with full time ATs or low/middle SES, SA mental health encounters in the ED were higher. Possible causes include less ability to access outpatient mental health services, as well as a higher level of ED use for any cause by a low/middle SES population compared to a high SES population. It is possible that full-time ATs had more contact with SAs and referred them at a higher frequency than part-time ATs. The study highlights the need for AT awareness of mental health issues in the secondary school population. This aspect of SA care by ATs deserves future research, to clarify causes for mental health referral and barriers to outpatient care access.

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Battery of Testing in an Athlete With Recurrent Exercise Associated Muscle Cramp Episodes: A Case Study

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Background: The athlete was a 21-year-old African-American male from the southeastern US. He was in his 4th year at a Midwest FBS football program. The athlete had a history of heat illness and exercise associated muscle cramps (EAMC) since middle school. His father also had a history of muscle cramping during activity. Since arriving on campus, the athlete had 9 documented cramping episodes and received an IV twice. The initial episode occurred on August 7th. Muscle cramps occurred in multiple locations and he was unable to complete practice. The average heat index during the month of August was 82.1 degrees F, and the average WBGT was 68.44. He only completed 13 of the 20 August practices due to cramping limitations. Symptoms occurred in proximal lower limbs before moving to distal upper limbs, and sometimes involved abdominals **Differential Diagnosis:** Two widely accepted causes of muscle cramping are disturbances of hydration and electrolyte balance, and altered neuromuscular control1. Differential diagnoses in this case included EAMC, hypothyroidism, mitochondrial disorders, glycogen storage diseases, fatty acid oxidation disorders, Issac's syndrome, and stiff person syndrome. **Intervention & Treatment:** Pre / post participation hydration testing, weigh-ins, and food intake recording were completed, but cramping episodes remained. The athlete was initially trialed on Propranolol 10mg prior to activity. Supplements were suggested, such as arginine, L-carnitine, quinine and Vit E, to decrease the risk of cramping or provide supplementation of treatable neuromuscular conditions. Neurologists were consulted and lab tests performed beginning in Mid-August of 2021. Labs came back with a moderate elevated serum myoglobin, creatine kinase, creatinine, and Aspartate transaminase which suggest muscle breakdown. The rest of his comprehensive metabolic panel, aldolase, carnitine, pyruvic acid, and lactic acid were normal. EMG was then performed and showed increased insertional activity in the vastus lateralis, anterior tibialis, and thoracic paraspinal muscles. This did not point toward any specific disease but showed that he had a propensity for cramping. Genetic metabolic and mitochondrial panels were ordered. The results found a variant of undetermined significance in the ALDOA gene suggestive of Aldolase A deficiency. Further testing will be required to make a final diagnosis. He was offered to have genetic testing of his parents or a muscle biopsy. He decided to pursue a biopsy after the season. Gabapentin was offered to trial making the muscles less excitable but was declined due to possible drowsiness side effects while in season. Lastly, arginine supplementation was recommended. **Uniqueness:** Aldolase A deficiency is an ultra-rare genetically inherited disorder found in red blood cells and muscle tissue that is associated with exercise intolerance, and possible rhabdomyolysis2. The athlete had a typical EAMC history before August 2021, sporadically experiencing muscle cramps when weather was very warm or athlete wasn't sufficiently hydrated or fueled. August 2021 cramping episodes occurred early during practice with a decrease in playing time compared to previous years. He was not losing irregular amounts of weight during activity and had adequate hydration levels prior to exertion. This required an interdisciplinary approach in order to gain further insight in cramping etiology and possible genetic involvement. **Conclusions:** Something had been predisposing this athlete to suffer from EAMC. There were no environmental changes from high school to college football that placed the athlete at a greater risk; athlete also didn't have any cramp related issues during summer conditioning of 2021. Cramps occurred early in practice and appropriate muscle cramp management approaches failed. Typical medicine and treatment were not mitigating cramp occurrences. A multidisciplinary approach was needed to further investigate the cause of his cramping.

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Cold Intravenous Fluids Are Inadequate for Whole-Body Cooling Rates Required for Exertional Heat Stroke Treatment

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Context: Despite recommendations to utilize whole-body cooling via cold-water immersion or tarp-assisted cooling, some military and emergency medicine protocols perpetuate use of chilled intravenous (IV) saline to cool patients with exertional heat stroke. Our purpose was to determine whole-body cooling rate of cold IV fluids following exercise hyperthermia in a field setting. **Methods:** We utilized a randomized, crossover field study design. Eight volunteers (27 +/- 5y, 171.1 +/- 8.95cm, 72.9 +/- 10.9kg) completed two trials. Participants arrived euhydrated (urine specific gravity <1.020). If assigned cold IV, they had an IV catheter (18G) inserted into an antecubital vein and taped. They were instrumented with a GPS/HR watch (TIMEX Ironman®) and self-inserted a rectal thermistor ~15cm past the anal sphincter. Baseline data were recorded. Then, participants completed a ¼-mile warm-up followed by self-selected stretching. They ran 1-mile as fast as they desired. Times were recorded and matched between trials. Following the 1-mile run, they completed sets of 5 sprints (50yd out; 50yd return) with 30s rest between sprints. Participants were allowed a 3min rest between sets. Following exercise to safety cut Tre (40ºC) or exhaustion, participants transferred (within 5min) to our cooling station where they sat in the shade and either received cold IV fluids (normal saline stored in a cooler covered in ice) or did not for our passive cooling condition for 30min. Rectal temperature (Tre) and HR were recorded throughout exercise and cooling. Every 10min during cooling, participants were asked their thermal sensation. Cooling rate was calculated as pre- minus post-cooling Tre divided by time. Participants completed both trials, in random order and trials were separated by >4 days to prevent acclimatization. Paired samples t-tests were utilized to compare trial differences for maximum Tre, overall cooling rate and WBGT (mean +/- SD). Repeated measures ANOVA was used to compare trial, time and interaction differences throughout cooling. Significance was accepted when P<0.05 (Jamovi, v.2.0). **Results:** Mean WBGT (28.2 +/- .9ºC) was not different between trials (p=.082). Maximum Tre was not different between cold IV (38.88 +/- 0.30ºC) and passive cooling (38.76 +/- 0.28ºC; p=.200). Overall cooling rate was significantly greater in cold IV (0.0391 +/- 0.005ºC/min) compared to passive cooling (0.0282 +/- 0.006ºC/min; p=.002). Tre throughout cooling was not different between trials (p=.610), but did decrease throughout the trial (p<.001). HR decreased over time (p<.001), but did not differ between cold IV and passive cooling throughout recovery (p=.236). Thermal sensation decreased throughout cooling (P<.001), but was not different between trials (p=.536). **Conclusions:** Athletic trainers should continue to use emergency action plans that employ documented effective treatments for exertional heat stroke. In isolation, cold IV saline infusion provided inadequate whole-body cooling and should not be used for exertional heat stroke treatment.

The study was conducted with internal funds from the University of Arkansas and the Department of Health, Human Performance and Recreation.

High School Coaches' Knowledge, Perception, and Current Practices Regarding Exertional Heat Illness in the United States

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Context: Exertional Heat Illness (EHI) is a dangerous, but preventable condition that affects approximately 9,000 athletes each year in the United States. 30% of public schools don't have access to an Athletic Trainer, leaving coaches as the sole adult responsible for the safety of athletes during activity. The purpose was to evaluate what knowledge, perception, and current procedures high school coaches have regarding EHI recognition and prevention. **Methods:** This cross-sectional study was completed using an online survey. The original survey used to evaluate NCAA strength and conditioning coaches was modified so the language was transferable to high school coaches, and pilot tested by Ohio University's Coaching Education Department. The survey had 9 demographic questions, 24 Likert items, and 8 yes or no questions followed by an open-ended opportunity to explain their answer. The survey was sent to 54,711 coaches from 16 states. Coaches were included if their contact information was on their state athletic association website. 2,126 coaches responded, for an overall response rate of 3.9%. Descriptive statistics were obtained and mean, and standard deviation values were calculated for the number of correct answers for total score and each of the 4 subfactors. To compare knowledge scores between degree, coaching experience, state, age, and heat illness certification, a Kruskal-Wallis one-way ANOVA was conducted. To compare knowledge scores between experience with heat illness, gender, and general coaching certification a Mann-Whitney U test was conducted. Where significant differences were found, post hoc tests were used for pairwise comparisons. Alpha level was set at 0.05. Qualitative data from open ended questions were examined to identify general themes among the responses. **Results:** The average knowledge score was found to be 74%. There was a significant difference in scores between coaches that had experience handling EHI and those that did not ($P < .001$), between genders with men scoring higher than women ($P = .004$), and coaches with more years of experience ($P < .001$), and older age ($P < .001$). There was also found to be a statistically significant relationship between state and knowledge score ($P = .002$), and those that had a coaching certification ($P = .02$). When evaluating the open-ended section of the survey the results revealed that many coaches are not abiding by published prevention strategies, and state mandates regarding practice safety. **Conclusions:** Major findings indicate more education and training is needed. Coaches with experience handling or witnessing EHI, more years of coaching experience, older age, and the completion of a coaching certification had significantly higher level of knowledge than others. More training in prevention, recognition, and treatment of EHI is necessary for all high school coaches to prevent avoidable deaths.

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Hypohidrotic Ectodermal Dysplasia in a Soccer Player - Level 4 Case Study

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Background: A 13-year-old male high school soccer player reported tryouts with the jayvee soccer team at his high school. As instructed by the coach he began to run two laps around the soccer field as a warm-up. After the two laps the athlete was in apparent distress and the coach notified the athletic trainer on the football field to come to the athlete's aid. The athlete presented with shortness of breath and initially had difficulty with communication. The athlete's skin was hot, pale. and dry. The athlete reported tingling sensations to his mouth and extremities. Vital signs revealed an elevated HR with a normal pulse oximetry, and a slightly elevated BP. He was immediately placed in the cold tub for cooling. As the athletic trainer was prepping to take a rectal temperature, the athletes stood up effortlessly on his own accord and asked lucidly that his parents be notified to explain his inherent condition. **Differential Diagnosis:** Fatigue, dehydration, heat exhaustion, heat stroke, hypohidrotic ectodermal dysplasia (HED). **Intervention & Treatment:** The athlete cleared of his current distress within two minutes or less with cold water immersion. A core temperature was never obtained as the athlete attempted removing himself from the cold tub. Vital signs were reassessed and were WNL. The athlete noted the tingling sensations ceased around his mouth and extremities. He responded to questions and commands coherently. Because the athlete's vital signs never veered into the extremes as with heat stroke, the athlete was removed from the cold tub and rested on the sidelines. Parents arrived on-site and assumed care for their son. They explained that their son has hypohidrotic ectodermal dysplasia since birth. Parents noted they use cold towels and rest previously when a similar situation occurs. The athletic trainer recommended the student-athlete seek follow-up appointment with his primary care physician regarding continued sports participation. It was noted that the athlete in-question had little organized soccer playing experience and limited knowledge of physical conditioning activities. Additionally, the coach permitted the athlete to engage in the team tryout without the state required medical PPE forms on-file with the athletic trainer. **Uniqueness:** Hypohidrotic ectodermal dysplasia (HED) is an uncommon genetic disorder in athletes. These individuals lack normal sweat gland functions or have an absence of sweat glands, thus are at risk to develop rapid onset heat exhaustion or heat stroke with exercise. Caution should be taken with these individuals regarding exertional activities. Patients with HED should have physician clearance to participate in sports and maybe able to engage in low intensity athletic activities. This case illustrates the appropriate evaluation, treatment, and care of patient with hypohidrotic ectodermal dysplasia (HED). The athlete is currently asymptomatic and has decided to forego scholastic athletic participation. **Conclusions:** Hypohidrotic ectodermal dysplasia (HED) is an uncommon genetic disorder in athletes. Because these individuals are lacking normal sweat gland functions or have an absence of sweat glands, they are at an extreme risk developing rapid onset heat exhaustion and/or heat stroke with exercise. Extreme caution should be taken with these individuals regarding exertional activities. Patients with HED should have physician clearance to participate in sports and maybe able to engage in low intensity athletic activities. This case illustrates the appropriate evaluation, treatment, and care of patient with hypohidrotic ectodermal dysplasia (HED). The athlete is currently asymptomatic and has decided to forego scholastic athletic participation at this time.

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State High School Sports Safety Policies: Cold Water Immersion and Cool First, Transport Second Requirements

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Context: Exertional heat stroke is 100 percent survivable with appropriate care, which includes aggressive whole-body cooling and lowering core body temperature to less than 38.9C (102F) within 30 minutes of collapse. Circulated cold water (2 degrees) has been shown to have the fastest cooling rate and it is essential to lower core temperature to appropriate ranges before transport. Previous research has determined that state policy mandates increase local policy adoption specific to exertional heat illness. The purpose of this study was to identify which states require cold water immersion (CWI) and cool first, transport second (CFTS) policies for the treatment of suspected exertional heat stroke for high school athletics. **Methods:** Since 2017, a 100-point rubric comprised of 5 evenly weighted sections (sudden cardiac arrest, traumatic head injuries, exertional heat stroke, appropriate medical coverage, and emergency preparedness) has been used to assess high school sports safety policy mandates in all 50 states and the District of Columbia. State legislation, state high school athletic association (SHSAA) policies, and any additional requirements (board of education, department of health, etc.) are extensively reviewed via a 3-tier process annually: 1) independent review by research assistants, 2) independent audit of tier 1 findings by a senior research assistant, and 3) final audit by 3 senior researchers. Only policies that are publicly available and mandated by all SHSAA member schools are credited. For this study, results specific to CWI and CFTS are reported. **Results:** As of August 2021, 16 states require that CWI tubs be available for all warm weather practices and 13 states require onsite cooling using CWI before transport to a hospital. Table 1 identifies each state with a mandated policy and whether the policy is required through state legislation or SHSAA policies. **Conclusions:** Less than a quarter of states require all high schools to have a CWI tub onsite and available to treat exertional heat stroke. Of those that require CWI tubs at all warm weather practices, not all require onsite cooling prior to transport to a hospital. It is important to note that lack of state mandates does not mean individual schools are not implementing these best practice treatments for exertional heat stroke, but results reveal there is a large gap in CWI and CFTS policies. These results idenfity an opportunity to push for best-practice policy mandates, which is one way to influence adoption of sports safety best practices. Further exploration is needed to identify the factors that prompted these states to implement policy requirements and barriers that have prevented other states from making similar mandates.

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Table 1: State HS Sports Safety CWI and CFTS Mandates

	"CWI tubs for onsite cooling for all warm weather practices"	**"If exertional heat stroke is suspected, onsite cooling using CWI before transport to the hospital"**
Leg[1]	1 (*LA*[a])	1 (*LA*[a])
SHSAA[2]	14 (*AR, DC, GA, HI, ID, KY, MA, MS, NJ, NC, OR, TN, UT, VT*)	11 (*AR, DC, GA, HI, ID, NJ, NC, OR, TN, UT, VT*)
Both[3]	1 (*FL*)	1 (*FL*)

1. Policy is mandated through state legislation
    a. Law mandated Board of Elementary and Secondary Education write policy
2. Policy is mandated through state high school athletic association policy
3. Policy is mandated through state legislation and state high school athletic association policy

BMI – Not a Risk Factor for Medial Tibial Stress Syndrome? A Critically Appraised Topic

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Context: Prevention and treatment of medial tibial stress syndrome (MTSS) remains elusive; the cause of MTSS is likely multifactorial. Few modifiable risk factors have been directly linked to the development of MTSS. In recent critical reviews, body mass index (BMI) has been identified as a risk factor for MTSS. However, BMI, while considered a modifiable risk factor, may not be easily changed for some athletes. The importance of BMI as a risk factor for MTSS must be quantified. Our objective was to summarize and calculate the 1) pooled effect of BMI on the presence of MTSS. In athletes [P], with MTSS [E] vs no MTSS [C], is there a difference in BMI [O]? **Methods:** PubMed and EBSCOHost (Academic Premier, CINAHL, Medline, SportDiscus) were searched through September 2021. Search terms included iterations of "medial tibial stress syndrome", "shin splints", "risk factors", "leg pain". Studies were limited to those published within the last 5 years in English. Selection criteria required that studies 1) investigated participants with MTSS 2) were etiologic in design (prospective or retrospective). Included studies were critiqued using the modified Levine Scale for Harm Studies (mLevine). The mLevine is scored out of 6 with higher scores indicating fewer threats to validity. Extracted data included sample sizes, and participant height, and mass. A sample-size adjusted weighted BMI (wtBMI), weighted SD (wtSD), and weighted 95%CI (wt95%CI) around BMI was calculated for MTSS and control. These weighted values were used to calculate Hedges' g effect sizes[95%CI] (ES) to determine the magnitude of the difference in BMI between MTSS and control groups. ES were interpreted as weak (<0.4), moderate (0.4-0.8), and strong (>0.8). **Results:** Seven studies met selection criteria and were analyzed. Four were retrospective (case-control) and 3 were prospective (cohort). Scores from the mLevine ranged from 4 to 6. The most commonly missed criteria were lack of blinding of assessors and inadequate reporting of the duration between exposure and MTSS. Descriptively, the wtBMI [95%C] for each group was within the normal range for adults and similar between groups (MTSS = 23.0 [22.8, 23.3] vs. control = 22.8 [22.5, 23.1]). There was no difference in the weighted BMI between MTSS (n=168) and control (n=277) participants (ES = 0.10 [-0.09, 0.29]). **Conclusions:** The role of BMI as a risk factor for MTSS is unclear. Based on the current analysis, BMI is not a risk factor for MTSS, contradicting previously published evidence. Clinicians should continue to address other modifiable risk factors, before encouraging an athlete to "lose weight" to combat or prevent MTSS, particularly if the athlete is within a normal BMI range. Threat to internal validity was likely minimal due to the standard procedures used to objectively determine participant height, weight, and presence of MTSS.

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Characterization of Risk Classification Using the Relative Energy Deficiency in Sport Clinical Assessment Tool

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Context: The Relative Energy Deficiency in Sport (RED-S) consensus statement includes a risk assessment tool to help guide clinicians' decision making on athlete's eligibility and return to play (RTP); however, scarce evidence exists demonstrating the feasibility of the tool used among female sports. The purpose of this study was to determine the risk classification for female collegiate athletes and dancers using the RED-S Clinical Assessment Tool (CAT). A secondary purpose examined differences between risk classification and sport. **Methods:** We conducted a secondary analysis on a cross-sectional field study data set to examine low energy availability (LEA) with or without eating disorder (ED) risk. Investigators combined secondary analysis data with retrospective data from medical records (e.g., medical history, injury type, menstrual cycle background, etc.). The full data set consisted of 125 female collegiate athletes (age:19.8±2years; weight:63.6±9.2kg; height:167.8±15.3cm) in the disciplines of equestrian (n=29), volleyball (n=13), softball (n=17), beach volleyball (n=18), soccer (n=20), and ballet (n=28). Data related to ED risk and pathogenic behaviors (e.g., vomiting, laxative use, etc.), weight, body mass index, body fat percentage, LEA, menstrual cycle history, bone mineral density, and stress fracture history were used to identify RED-S risk. The RED-S CAT was used to identify classification risk and RTP recommendations (High Risk=Red-Light, Moderate Risk=Yellow-Light, Low Risk=Green-Light). Basic descriptive statistics examined the proportion of participants in each risk classification, cross tabulation and Chi-square analyses examined differences across classification and sport. **Results:** Overall, 13.6% (n=17) of athletes were classified in the Red-Light category (no competition/training and recommended use of written treatment contract), 74.4% (n=93) in the Yellow-Light category (may train if following a treatment plan and can compete once medically cleared under supervision), and 12.0% (n=15) in the Green-Light category (full sport participation). All Red-Light risk participants engaged in extreme weight loss technique(s) (i.e., vomiting, diuretics, and/or laxative use). Most common Yellow-Light risks were 80% (n=100) for LEA, 67.2% (n=84) high risk for perfectionism, 29.6% (n=37) high risk for interpersonal problems composite, and 28.8% (n=36) missed ≥ 3 months of their menstrual cycle. No significant differences were found between risk classification and sport [$\chi 210,125=17.7$, p=.06]; however, ballet displayed the highest Red- and Yellow-Light risks (5.6%, n=7 and 15.2%, n=19). Of the 15 Green-Light risk participants, none were from softball and beach volleyball, whereas equestrian: n=4, volleyball: n=3, soccer n=6, and ballet: n=2. **Conclusions:** It is imperative patients and medical providers understand the complexity and consequences of energy deficiency and its potential effects on athlete's overall wellbeing and performance. Female collegiate athletes in our study were primarily classified in the Yellow-Light category, while almost 14% were Red-Light. By understanding and utilizing risk classification tools, like the RED-S CAT, clinicians can treat and implement appropriate RTP strategies.

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Descriptive Injury Epidemiology of Reserve Officers' Training Corps Cadets at a Large Southeastern US University

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Context: Reserve Officers' Training Corps (ROTC) cadets are a physically active student population who, similar to traditional student-athletes, complete rigorous physical training making them susceptible to injury. There is ample research relating to injury epidemiology in student-athlete populations; however, a gap in literature exists relating to injury in ROTC cadets and midshipmen. The purpose of this study is to describe injury-related information that can improve patient-centered care through Athletic Training for ROTC cadets across the United States. **Methods:** This longitudinal cohort study was completed over one academic year (August 2019-May 2020), cut short due to the COVID-19 pandemic. An electronic medical record-keeping system managed the by the athletic trainers for the ROTC program was used to examine injury incidence, incidence proportion, and specifics, including extremity-involved, mechanism of injury and common injury diagnoses trends across all four ROTC branches. All medical information was deidentified prior to analysis. Participants included male and female cadets and midshipmen, at least 18 years of age representative of all military branches enrolled in an ROTC program at a large southeastern university. Participants were considered injured if 1) they sustained a musculoskeletal injury and sought treatment by the athletic trainer and 2) the injury occurred during a ROTC sanctioned event (i.e., Physical Training (PT), fitness tests, ruck marches, etc.) with recorded accountability to determine athlete-exposure (A-E). Descriptive statistics were used for all demographic and injury data. Incidence rate was calculated as the number of new injuries over total exposure time. Incidence proportion (i.e., probability of injury) was calculated as the number of newly injured participants over the number of total participants. **Results:** From 202 Army cadets, 96 Air Force cadets, and 110 Navy / Marine midshipmen, there was a total of 87 injuries over the academic year, with 70% classified as lower extremity injuries. Acute and chronic injuries occurred approximately 50% of the time. The most common injuries treated across all participants were muscle strains (12.64%), ankle sprains (10.34%), and tendinitis / osis (10.3%). Incidence rates were 1.8, 2.73, and 7.11 per 1000 A-E for Army, Air Force, and Navy / Marines, respectively. The probability of a participant being treated for an injury that occurred due to PT across the 2019-2020 academic year was 11.9% for Army cadets, 9.42% for Air Force cadets, and 23.7% for Navy / Marine midshipmen. **Conclusions:** Overall, injuries occur in ROTC cadets and midshipmen due in part to physical training and physical assessment testing, similar to their intercollegiate student-athlete peers. These findings identify a need for an increased investment into patient-centered care for ROTC cadets at a rate similar to that made for student-athletes. Further research is needed increase understanding of injury trends and injury prevention strategies for the betterment of health for ROTC cadets.

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Dietary Habits, Injury History, and Psychosocial Status Associations Among College Athletes

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Context: Energy intake patterns of all athletes are subject to numerous internal and external factors, such as time, cultural expectations, nutrition knowledge, food availability, psychological dysfunction, and sleep quality. While bone and metabolic disorders that accompany low energy availability (LEA) in athletes have been widely reported, its influences on musculoskeletal function, cognitive performance, and overall wellness have not been confirmed. **Methods:** A cross-sectional study was conducted utilizing 38 Division I student-athletes (age = 20.7 ± 1.7 yrs) consisting of 14 males (mass = 187.69 ± 8.84 kg, height = 104.51 ± 31.3 cm) and 24 females (mass = 171.55 ± 9.15 kg, height = 65.25 ± 12.0 cm). Sports played included football (11), softball (11), volleyball (4), tennis (4), soccer (3), and track/cross country (3). Participants completed an electronic survey that included the Sports Fitness Index (SFI), Overall Wellness Index (OWI), 10 categories of Self-Reported Problems (SRPs), Pittsburgh Sleep Quality Index (PSQI), Depression, Anxiety, and Stress Scale (DASS), Eating Attitudes Test (EAT-26). Upon completion, participants were dichotomized into "high" and "low" risk groups based on EAT-26 median score as a surrogate measure of LEA. Discriminatory strength for the remaining survey scores were examined using receiver operating characteristic analysis to identify optimal cut-points for identifying LEA risk categorization. Cross-tabulation and logistic regression analysis was then used to quantify associations with risk category, represented by odds ratio (OR) and 95% confidence interval (CI). **Results:** Univariable associations between survey results and LEA risk category are presented in the table. The number of SRPs had the greatest association with LEA risk (cut-point: ≥10 symptoms; OR = 8.00; CI: 1.45 - 44.3). Specifically, high LEA risk was associated with symptoms relating to muscle control (cut-point: ≥2, OR = 11.33; CI: 1.25 – 102.8) and behavior (cut-point: ≥ 2, OR = 13.91, CI: 1.54 – 125.8). Other significant associations included OWI total score (cut-point: ≥33; OR = 4.09, CI: 0.89 - 18.72) and DASS Depression Subscore (cut-point: ≥ 3; OR = 3.18, CI: 0.82 – 12.34). **Conclusions:** Associations between athletes with high EAT-26 scores and those who reported behavioral and motor control problems were identified. Our results suggest that the OWI and its 10 categories of Self-Reported Problems might be an effective screening tool for identifying student-athletes who may be at risk of low energy availability. It should be noted, however, that EAT-26 scores are surrogate measures of energy availability and does not directly measure energy availability. Future research should seek to utilize direct measurement of energy availability.

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Musculoskeletal Injury Concealment in the Reserve Officer's Training Corps

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Context: Underreporting of musculoskeletal injuries is common in military populations; however, injury concealment may be higher in the Reserve Officers' Training Corps (ROTC), where injury surveillance is often inadequate, and trainees do not have direct access to health care. The purpose of this study was to evaluate injury reporting in ROTC trainees at universities in the United States. **Methods:** This study used a survey originally developed by researchers from the United States Army Research Institute of Environmental Medicine that has been previously used to describe underreporting of musculoskeletal injuries in US Army personnel. The survey was adapted for the ROTC population by modifying questions to better represent ROTC trainees. Survey data were collected from five Army ROTC programs, two Air Force ROTC programs, and one Naval ROTC program. These nine ROTC programs represented approximately 925 ROTC trainees. Trainees who agreed to participate accessed the survey online via the Qualtrics experience management platform. Trainees answered questions about musculoskeletal injuries sustained during ROTC regarding injury onset, injury severity, and whether the injuries were reported to either medical providers or military cadre. **Results:** Of the 184 trainees who initiated the survey, 158 finished, including 99 male and 59 female ROTC trainees. This sample included 120 Army cadets, 25 Air Force cadets, and 13 Naval midshipmen. Data from incomplete surveys were not included for analysis. 74 trainees reported having not been injured during their time in the ROTC. 84 ROTC trainees described 220 injuries including 75 (34%) that were reported. No trainees reported exaggerating injuries or symptoms. The most common reasons cited for seeking care were that the injury affected performance (32%), fear that training would worsen symptoms (21%), and concern due to symptoms (19%). The most common reasons for not reporting injuries were fear of negative career repercussions (28%), to avoid negative social perceptions (25%), and difficulty accessing medical care (22%). **Conclusions:** Approximately two-thirds of musculoskeletal injuries in ROTC trainees were not reported. This rate of underreporting is higher than active duty Army personnel but similar to the rate of Initial Entry Training recruits. Untreated injuries can lead to chronic pain, recurrent injuries, and long-term performance deficits. Unreported injuries may undermine efforts to reduce musculoskeletal injuries in the military. Our findings suggest that military instructors should encourage ROTC trainees to report musculoskeletal injuries early for effective treatment and reconditioning. Military leadership in ROTC programs may also need to alter their organizational culture to foster a more positive environment for reporting and seeking care for musculoskeletal injuries. In addition, a lack of access to medical care may be a significant barrier to help-seeking behavior in ROTC trainees.

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Oral Contraceptive Use and Operatively Treated Anterior Cruciate Ligament Injury: A Critically Appraised Topic

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Context: Female athletes experience anterior cruciate ligament (ACL) injuries at 2-8x the rate of their male counterparts. Limited evidence suggests that oral contractive (OC) use may protect against ACL injures. In women, is there a lower risk of sustaining an operatively treated ACL injury if using oral contraceptives? **Methods:** PubMed was searched in Fall 2021 using the Boolean phrase "((Female) AND (ACL AND Surger*)) AND ((Oral OR homon*) AND contraceptive)) AND Risk". Article titles, abstracts, and text were screened on their ability to answer the clinical question. Studies were included if they compared surgical ACL reconstruction in women who did not use OC to those who did. Studies more than 10 years old were excluded. The outcome measures were odds ratios, including 95% confidence intervals, comparing OC use and surgical ACL repair rates. The STROBE checklist for case-control studies were used to assess the validity of each study. **Results:** The search revealed a total of 12 studies and 3 met all search criteria. All studies used a case-control design. The first study used the Danish Knee Ligament Reconstruction Register to age match 4,497 women who underwent surgical ACL repair (no OC use=54.45%; OC use=45.5%) to 8,858 controls (no OC use=52.4%; OC use=47.6%;) with no ACL injury. There was a lower likelihood of surgical ACL reconstruction in OC users compared to non-users (adjusted OR = 0.82 [95% CI, 0.75-0.90]). The second study used a commercial insurance database to identify 12,819 women with operative ACL repair (no OC use=76.61%; OC use=23.39%) and matched them with 38,457 age-matched controls without ACL injury (no OC use=77.18%; OC use=22.82%). The adjusted OR was 0.99 (95% CI, 0.94-1.04), indicating no difference in likelihood of ACL repair between groups. The final study used the PearlDiver database to identify a matched group of 87,874 no OC and OC patients. Females undergoing ACL surgery in the OCP group (n=569) were identified and compared to an age and Charleston comorbidity score matched group that underwent ACL surgery, but not on OCPs (n=465). The odds ratio for ACL reconstruction while using OC compared to not using OC was 0.82 (95% CI, 0.72-0.92). The STROBE scores were 21/22, 22,22, and 22/22. **Conclusions:** There are mixed results regarding the protective effects of OC on operatively treated ACL injuries. Overall, there was a 1–18 % reduction in ACL operative interventions associated with oral contraceptive use. Emerging evidence demonstrates a protective effect from OC, but should they not be used to mitigate risk at this time. Future research should focus on prospective studies on a more physically active population to further examine this relationship, as well as identify the possibility protective mechanism of OC use. SORT: B.

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The Female Athlete Triad Coalition and RED-S Risk Assessment Tools in Collegiate Ballet Dancers

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Context: Due to the pressure to maintain the "ideal body image", ballet dancers may be at increased risk for the Female Athlete Triad (Triad) and Relative Energy Deficiency in Sport (RED-S). Awareness and recognition of Triad and RED-S symptoms are important as early intervention may prevent worsening of symptoms and potential for further health complications. The Triad and RED-S developed clinical assessment tools to assess the risk among physically active populations. This study examined the risk for Triad and RED-S among collegiate ballet dancers using the Triad Cumulative Risk Assessment (CRA) and RED-S Clinical Assessment Tool (CAT) and identified at-risk dancers and subsequent return to play (RTP) status. **Methods:** A secondary analysis was conducted on a cross-sectional field study data set to examine low energy availability (LEA) with or without eating disorder (ED) risk on collegiate ballet dancers. Investigators combined secondary analysis data with retrospective data from medical records (e.g., medical history, injury type, menstrual cycle background, etc.). Data consisted of 26 female collegiate ballet dancers (age: 20.5±3years; weight: 56.4±7.0kg; height:165.3±6.9cm). Data related to ED risk and pathogenic behaviors (e.g., vomiting, laxative use, etc.), weight, body mass index, body fat percentage, LEA, menstrual cycle history, bone mineral density, and stress fracture history were used to identify Triad and RED-S risk. The CRA was scored for RTP as: Low Risk=full clearance, Moderate Risk=provisional/limited clearance, or High Risk=restricted from training and competition. The RED-S CAT identified classification risk and RTP recommendations by: Low Risk=Green-Light (full clearance), Moderate Risk=Yellow-Light (may train with treatment plan), and High Risk=Red-Light (no competition/training). Basic descriptive statistics examined the proportion of participants in each risk classification and RTP eligibility. **Results:** The CRA identified 11.5% (n=3) ballet dancers as high risk (restricted from training) compared to the RED-S CAT at 23.1% (n=6). Most ballet dancers were categorized by the CRA as moderate risk) at 88.5% (n=23), with no dancers categorized in the low risk. The RED-S CAT revealed 73.1% (n=19) as moderate risk=Yellow-Light and 3.8% (n=1) as low risk=Green-Light. **Conclusions:** The RED-S CAT categorized more ballet dancers as high risk compared to the CRA; however, regardless of assessment tool used, majority of ballet dancers were categorized in the moderate risk=Yellow-Light category for RTP. Female ballet dancers are more inclined to have concerns with their body image and alter dietary behaviors to uphold standards placed on them by their environment. Therefore, ballet dancers classified as moderate or high risk warrant greater surveillance and further assessments before healthcare providers can confidently give them full clearance on training and competition.

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Time-Loss After Musculoskeletal Injuries Sustained by Women's and Men's Collegiate Basketball Players: Findings From the NCAA-Injury Surveillance Program Between 2009/10-2018/19

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Context: Basketball players sustain a variety of injuries, many affecting the musculoskeletal (MSK) system, which may affect their ability to participate in the sport. Previous research has identified the types of injuries most commonly sustained by basketball players but injury-related factors associated with the odds of sustaining time-loss (TL) have not yet been described. Therefore, the purpose of this study was two-fold: 1) to describe distribution of TL injuries in basketball players and 2) identify predictors of MSK TL injury. **Methods:** Men's and women's basketball-related exposure and injury data were collected as part of the National Collegiate Athletic Association Injury Surveillance Program (NCAA ISP) during 2009/10 through 2018/19. The NCAA ISP uses a convenience sampling scheme with a rolling recruitment model, in which athletic trainers (ATs) at participating institutions contribute data via their respective electronic medical record systems. Injuries were characterized by TL (≥ 1 day), and the distribution of TL and non-TL injuries (by body part, mechanism of injury, player position, and injury diagnosis) were examined using frequencies (%s) in the pooled sample, as well as separately for men's and women's basketball injuries. For MSK injuries specifically, differential odds of TL between men's and women's basketball were examined using multivariable logistic regression models parametrized to adjust for body part, mechanism of injury, and injury diagnosis; effect estimates with 95% Confidence Intervals (CI) excluding 1.00 were considered statistically significant. **Results:** Overall, 9,615 injuries were reported, of which 75.0% were MSK (men: 75.98%; women: 73.81%). Thirty-nine percent of all injuries reported resulted in TL. Comparable proportions of TL injuries were reported in men's (n=2,055; 38.6%) and women's (n=1,695; 39.5%) basketball. Additionally, 37.5% of MSK injuries resulted in TL (men: 37.5%; women: 37.4%). Among TL injuries in men's and women's basketball, sprains were the most common injury diagnosis (men=726, 35.3%; women=506, 29.9%), more injuries affected the lower extremity (men=731, 35.6%; women=599, 35.3%), and approximately half were attributed to player contact (men=974, 47.4%; women=735, 43.4%). TL injuries were most prevalently reported in Guards (men=981, 47.7%; women=835, 49.3%). Mechanism of injury, body part, and injury diagnosis were significant predictors of MSK TL injury, while sex was not (Table 1). **Conclusions:** TL injuries are common among both men's and women's basketball players. Additionally, mechanism of injury, body part, and injury diagnosis were associated with MSK TL injury while sex was not. ATs caring for basketball players should understand factors that may put their athletes at risk of losing playing time. Furthermore, ATs should prioritize injury prevention (e.g., neuromuscular training) based on the identified predictors to MSK TL injury, to minimize time loss and maintain and promote athlete physical and mental health.

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Table 1. Multivariable Logistic Regression of Musculoskeletal Time Loss Injuries in Men's and Women's National Collegiate Athletic Association Basketball Athletes, 2009/10-2018/19

Comparisons	Odds Ratio (OR)	95% CI
Sex		
Women	1.09	0.98-1.22
Men	1.0	Referent
Mechanism of Injury		
Other contact	0.77	0.66-0.90*
Non-contact	0.79	0.68-0.92*
Overuse	0.49	0.40-0.60*
Other	0.56	0.43-0.73*
Player contact	1.0	Referent
Body Region		
Head/Neck	0.61	0.43-0.88*
Upper extremity	0.53	0.39-0.71*
Lower extremity	1.02	0.81-1.28
Other	0.89	0.69-1.14
Core	1.0	Referent
Diagnosis		
Dislocation	1.36	1.00-1.85
Fracture	2.52	1.87-3.38*
Other	0.44	0.37-0.50*
Sprain/Strain	1.0	Referent

*Effect estimates with 95% CIs excluding 1.00 were deemed statistically significant.

A Swollen and Unstable Knee: What Could It Be?

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Background: A 15 year old female softball athlete was playing in a game over the weekend when she was rounding third base and tried to stop but felt her left knee buckle. She immediately fell to the ground and was unable to get up or walk on the affected leg. She was evaluated by her High School athletic trainer and found to have decreased range of motion in flexion and extension due to pain at the knee, strength limited due to pain, laxity with varus stress at 0 degrees, but no laxity at 0 and 30 degrees with varus stress testing as well as a negative anterior and posterior drawer test. Sensation was intact throughout. **Differential Diagnosis:** Lateral collateral ligament injury, Posterior lateral corner injury, Posterior collateral ligament injury, Patellar subluxation/dislocation injury, Anterior collateral ligament injury **Intervention & Treatment:** Athlete was evaluated the next week by a Primary Care Sports Medicine physician who did an exam which showed large effusion, negative bruising or warmth. Decreased range of motion in flexion and extension due to pain at the knee, strength limited due to pain, laxity with varus stress at 0 degrees, but no laxity at 0 and 30 degrees with varus stress testing as well as a negative anterior and posterior drawer test. Positive dial test at 30 degrees. Normal strength and range of motion at the ankle. Sensation was intact throughout. She was sent for an MRI which showed posterior lateral corner injury with a tear of the lateral collateral ligament, and injury to the popliteal fibular ligament and the popliteus tendon. She was sent for evaluation by the orthopedic surgeon who performed a repair of the posterior lateral corner and left common peroneal nerve neurolysis. **Uniqueness:** Injuries of the posterior lateral corner of the knee remain under-reported, and with a low incidence of 5-9% of all knee injuries. Time to diagnosis ranges from 0-30 months in some studies especially in cases not involving other ligament injuries. Due to this low incidence, the majority of these injuries are being treated by surgeons who are performed less than 4 cases per year which drastically increases the chance for post-operative complications. With concomitant popliteal nerve injury being a common but often missed finding, posterior lateral corner injuries can lead to significant morbidity for the patient if this is not recognized early. The most common mechanism for this is hyper-extension, either contact or non-contact. It is important for athletic trainers to recognize this injury due to the possibility of a missed peroneal nerve injury which could result in a life-long foot drop. **Conclusions:** Posterior lateral corner injuries are being increasingly recognized and treated appropriately over the past few decades. Isolated posterior lateral corner injuries are currently accounting for less than 30% of all posterior lateral corner injuries which make up less than 10% of all ligamentous knee injuries. It is very important for all athletic trainers to remember to assess neurovascular status in all injuries to not miss possible life altering nerve injuries one of which, peroneal nerve injury, could be easily missed when focused on evaluating the stability of what appears to be a ligamentous knee injury. Having these patients seen as soon as possible for further diagnostic work up could be life altering.

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Acetabulum Fracture and Labral Tear in a High School Football Player: A Level 3 CASE Study

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Background: Acetabulum fractures are commonly caused by motor vehicle accidents, falls greater than 10-feet, and extreme sports. The prevalence of acetabulum fractures is fewer than 3 in 100,000 cases, and femoroacetabular fractures commonly present in the anatomical or surgical neck of the femur.1,2 The purpose of this Level 3 CASE study is to share the case of a unique presentation of an acetabular labral tear and acetabulum fracture. **Patient:** Patient is a 16-year-old high school male football tight end. He presented with pain originating from the right posterior medial thigh at the ischial tuberosity, to pes anserine. He reported being tackled during football practice 3 days prior and "landed weird" on his leg, but he could not remember the position he landed. Pain was described as aching and sharp. Pain aggravated by active and passive hip and knee flexion/extension, and palpating on or near the areas of pain. Visual inspection was unremarkable. Passive immobilization of the leg at 30° of knee flexion alleviated most of the pain. The pain had increased over the 3 days since the injury, so he began using crutches to avoid weight bearing. Chief complaints consisted of pain in the posteromedial thigh, limited weight bearing, and restricted motion in both hip and knee flexion/extension. No strength tests or special tests were performed due to pain. At this time the diagnosis was a semitendinosus sprain, with suspicion of a possible avulsion fracture due to point tenderness at the ischial tuberosity. Two days after the initial evaluation the patient self-referred to a chiropractor and was not seen by the athletic training staff for 3 weeks; he performed range of motion and strength exercises at that time, while weight-bearing as tolerated. The patient returned to the athletic training clinic after 3 weeks with new imaging ordered by his family physician that showed a labral tear and acetabulum fracture. The patient was diagnosed with septic arthritis as a result of the delayed diagnosis. **Intervention & Treatment:** By the time the proper diagnosis was determined to be a labral tear and acetabulum fracture, the athlete developed septic arthritis that required emergency surgery and antibiotics. The patient is currently still undergoing treatment with several different antibiotics to manage the septic arthritis. He is meeting with a hip specialist to discuss options for his fracture and labral tear. **Outcomes or Other Comparisons:** Typical treatment for labral tear and acetabulum fractures is surgical repair to restore smooth function of the acetabulum surface and increase stability of the joint. The extent of the surgical repair depends on how many structures were injured and how severely. A conservative treatment for more stable fractures with minor labral tears would be immobilization with crutches for several months. 1,2 **Conclusions:** Acetabular labral tears and acetabulum fractures are rare but possible in high school football given the high intensity of the sport. Overdiagnosis of hamstring strains could lead to the oversight of other pathologies. A challenge associated with this case due to the atypical presentation is that the mechanism of injury did not directly correlate to a fracture or labral tear. This atypical presentation of an acetabulum fracture and labral tear should be considered when evaluating hamstring injuries, in order to rule out pathologies above and below the injury. **Clinical Bottom Line:** Labral tears and acetabulum fractures must be ruled out when evaluating hip pathologies caused by a high energy mechanism of injury. Although the injury presented with tenderness to palpation at the typical locations for a semitendinosus hamstring sprain, a more thorough evaluation should have been conducted and imaging should have been ordered sooner.

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An Open Quadriceps Repair in a College Basketball Coach: Type IV Case Study

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Background: A 64 year old male collegiate basketball coach complains of bilateral leg pain after falling during a deceleration sprint. Patient complains of right posterior leg pain, left anterior leg pain, and left elbow pain due to collision with the basketball court as he lost his balance. A certified athletic trainer's initial evaluation revealed 1/5 MMT for L Knee Extension. Patient was placed in knee immobilizer and transported to the orthopedic clinic. Previous medical history included sleep apnea, hypertension, hyperlipidemia, and a history of DVTs. **Differential Diagnosis:** Left patella contusion, bursitis, or fracture. Left olecranon contusion, bursitis, or fracture. Right hamstring strain 2 or 3 degree, ischial tendon avulsion. Left quadriceps 2 or 3 degree strain, proximal patella tendon avulsion. **Intervention & Treatment:** During the orthopedic evaluation x-rays revealed no fractures. Patient was lacking last 20 degrees of knee extension. Valgus and Varus stress tests were negative. Swelling was moderate in the left elbow and anterior knee. A palpated defect was noted proximal to patella in the quadriceps. A right knee MRI revealed a hamstring proximal avulsion. The grade three rectus femoris rupture approximately 2 inches above the patella was obvious during the assessment. The rupture was repaired within 6 days. This repair involved 3 drilled holes in the patella to pass fiberwire sutures into proximal mid-rectus femoris fibers, lateral retinaculum, and reattachment of VMO tendon to VMO muscle fascia. Physical therapy began 14 days post-surgery via a telehealth conference (COVID related). Due to PMH patient was taking aspirin BID since surgery prophylaxically, however, he was diagnosed by the cardiologist with a DVT in the left posterior tibial and peroneal veins. Resulting in taking Xarelto 20 mg QD. Rehab focus entailed hamstring flexibility on the right and limited AROM of the rectus femoris (0-45 for 1st 6 weeks; 0-70 for the next 6 weeks, and finally 0-90 at week 14). At 2 months the patient was allowed to weight bear PRN therefore the wheelchair/rolling walker were discontinued. At 6 weeks underwater treadmill was initiated. Full flexion and discontinuation of hinged post-op brace was achieved at 16 weeks. PT visits always included an element of manual therapy related to massage for edema, hamstrings, IT band tightness, patella joint mobilization, and knee PROM for the first 5 months. Strength, endurance, and proprioception training were gradually progressed with purposeful variety and difficulty. After 7 months of rehabilitation the quadriceps strength at full extension reached 5/5 however mid-range strength remained 4/5, as well as, Lower Extremity Functional Scale equaled 47/80 which was an improvement from 16/80 at week 2. At 10 months the patient stated "he felt stronger on injured quadriceps than the non-injured." However, the patient's primary complaint was bilateral hamstring, calf, and quadriceps tightness therefore a new PT order was provided for once a week until patient reaches his goal of hunting, fishing, and hiking without discomfort. **Uniqueness:** Patellar tendon ruptures are extremely rare (0.5% of the general population) usually in patients under 40, making this case unique because of the patient's age and injury type. **Conclusions:** This workman's compensation case entailed no work for 3 weeks, followed with 3 months of partial work, and return to full work within 4 months of injury. Early success was accomplished by regular healthcare appointments including multiple specialties (orthopedics, cardiology, athletic training, and physical therapy). At 10 months complete recovery was not reached based on complexity of rectus femoris repair with bilateral leg injuries, age, DVT, BMI > 30, COVID quarantine, and pronounced swelling. The prognosis for full recovery is likely within 1.5 years from the injury based of patient's tenacity, determination, and desire to RTP.

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Atraumatic Acute Compartment Syndrome of the Lower Leg in a Collegiate Football Player: A Case Study

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Background: Compartment syndrome is characterized by an increase in pressure resulting in ischemia to one or more closed fascial compartments, typically seen in the upper or lower extremity. This increase in pressure can occur in two contrasting ways, acute and chronic. Chronic compartment syndrome occurs as reversible ischemic events, typically seen in running athletes. Once activity ends, compartment pressure and symptoms decrease back to baseline. Acute compartment syndrome of the lower leg is an emergent medical condition caused by an increase in pressure that does not subside with rest, which compromises motor and sensory function. 75% of these injuries are typically seen following fractures, usually of the tibia. Other causes include soft tissue, vascular or crush injuries, other lower extremity surgery, penetrating trauma or infection. The purpose of this Level 3 case study is to present and discuss an atypical presentation of a 19-year-old football player who suffered acute compartment syndrome of the lower leg without acute injury. **Patient:** While playing defensive lineman during a collegiate football practice, a 19-year-old, 6-foot 3-inch, 224-pound male began complaining of nondescript right lower leg tightness, specifically in the lateral compartment. No neurological symptoms were present, and the patient was able to finish practice following treatment by the ATC, which consisted of stretching and soft tissue mobilization. The following day during practice warm-up, the patient began to experience tingling in his right foot. He was removed from activity immediately, which did result in a decrease in symptoms. Two days post his initial complaint, he stated his numbness had returned while he was walking. He was given crutches and was seen by the team physician, who advised that if his symptoms got any worse, he was to go to the emergency department immediately. Three days post initial complaint, the athlete presented to the athletic training room with increased numbness and tingling in his right foot over the superficial peroneal nerve distribution, palpable hardness in his peroneal musculature and visible muscle fasciculations. He was immediately referred to the emergency department. Following bloodwork and bilateral lower leg doppler ultrasound, the patient was sent home with instructions to hydrate and stretch. Five days post initial complaint, the patient followed up in a sports medicine clinic for compartment pressure testing. The patient's symptoms had worsened significantly since the emergency department visit. Following evaluation that did not include pressure testing, the physician referred the patient back to the emergency department with the insistence that his condition required immediate surgery for acute compartment syndrome of the right lower leg. **Intervention & Treatment:** Five days post his initial complaint, the patient underwent emergency fasciotomies to release all four compartments of his right lower leg. He was placed in a wound vacuum following surgery and underwent subsequent surgery for wound closure two days later. **Outcomes or Other Comparisons:** Acute compartment syndrome typically results from traumatic injury and requires emergency surgical intervention. Patients who develop acute compartment syndrome without traumatic fracture or injury are more likely to have delayed treatment and complications. **Conclusions:** Acute compartment syndrome is a condition that requires immediate referral for surgical intervention. Emergent referral can be complicated by patients who present without a history of trauma to the lower leg as the treatment of chronic compartment syndrome includes rest until pressure testing can be obtained. Patient advocacy is also always critical when referral is needed as delayed referral can lead to severe complications and tissue necrosis. **Clinical Bottom Line:** Although rare, ATCs must urgently refer patients who present with severe compartment syndrome symptoms with or without a history of acute trauma.

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Bicruciate Ligament Reconstruction for Anterior Knee Dislocation in Collegiate Football

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Background: Knee dislocations are uncommon in athletics, and most are seen in young men due to motor vehicle collisions, so the mechanism of a low-energy fall in football practice is especially rare (Chowdhry et al). The injuries associated with a knee dislocation are extensive, including damage to the cruciate and collateral ligaments, meniscus, popliteal fossa, neurovascular structures, and fracture. These can lead to further complications like permanent neurological injury, compartment syndrome, or even amputation. Post-stabilization of emergent conditions, it is crucial to reconstruct the damaged anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) as they are primary stabilizers of the knee. This Level 2 Case explores the treatment of a football player who underwent bicruciate ligament construction. **Patient:** A 19 year-old football player suffered a left knee dislocation while decelerating after being hit in the opposite leg. This patient was predisposed to injury due to a natural hyperextension range of motion (ROM) of -15°. Computerized tomography angiography imaging revealed a grade IV anterior knee dislocation, damage to the lateral collateral ligament (LCL), PCL, ACL, and medial meniscus, rupture of the popliteus, and a small inner wall tear of the popliteal artery. **Intervention & Treatment:** Post-assessment, the physician's goals were 1) save the limb, 2) regain normal gait, and 3) return-to-play (RTP) in 2 years. Initial surgery included repair of the popliteal complex, popliteal artery, and medial meniscus. Because the patient hadn't gained full ROM, reconstruction of the cruciate ligaments was postponed. For 4 months, the patient improved quadriceps and hip strength, proprioception, and gait while progressing ROM. A non-operative treatment for the ligaments was considered, but to achieve RTP the ACL and PCL were reconstructed with allografts. Non-operative treatment was sufficient for the LCL (Jokela et al). Following the 2nd surgery, the patient progressed through standard protocols and was cleared to play 8 months later. **Outcomes or Other Comparisons:** Chowdhry et al have found that there has been an increase in the probability of knee dislocations specifically in men. Additionally, vascular damage now occurs at a higher rate compared to studies done before 2019, likely due to an increase in high-energy mechanisms. This is significant to football as two predisposing risk factors are present - the male population and the high-contact nature of the sport, so though dislocations have been uncommon in the past, we may see an increase. This athlete received 2 surgeries to separately repair the neurovascular damage and reconstruct the cruciate ligaments. The decision to reconstruct versus repair is in line with literature which states reconstruction on average had a 7% failure rate while repair averaged 38% failure. In addition, the RTP probability of an athlete who sustains injuries to the ACL + PCL/LCL is at a much lower percentage in comparison to that of isolated ACL and ACL/medial collateral ligament (MCL) tears (Bakshi et al 2018). This is significant because this athlete did RTP after sustaining injury to the ACL, PCL, and LCL. **Conclusions:** Knee dislocations result in multi-ligament damage and risk of further complications like neurovascular damage and compartment syndrome. This patient underwent one surgery to save the neurovascular function and once full ROM was gained, had another operation to reconstruct the damaged primary knee stabilizers. Both surgeries were successful and the patient now has full strength and ROM, no neurological deficits, and is functional enough to compete in Division 1 (D1) football. **Clinical Bottom Line:** Delaying bicruciate ligament reconstruction of the knee for the sake of range of motion resulted in successful, timely rehabilitation and RTP for a D1 football athlete post-knee dislocation.

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Collegiate Track Athlete With Tenosynovial Giant Cell Tumor and Labral Tear of the Hip: A Level 1 CASE Study

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Background: Tenosynovial Giant cell Tumors (TGCT), also known as Pigmented Villonodular Synovitis (PVS), are rare benign tumors, accumulated in a defect of a joint's lining. This overproduction of synovial tissue is caused by a protein, Colony Stimulating Factor-1, which attracts surrounding cells, forming a mass. This diagnosis is rare only occurring in 1.8 per one-million individuals and has no known etiology. TGCT's commonly affect the knee, hip, and talocrural joint and present with reduced ROM, painful loading of the joint, and recurrent, painful episodes that subside with rest. This Level 1 CASE Study presents a patient with TGCT and labral tear of the hip compared with a retrospective case series involving 5 adolescent patients with TGCT in the hip managed surgically. This article was chosen due to similarity of operative procedure performed. **Patient:** The patient was a 19-year-old, female, collegiate track athlete who struggled with recurrent, transient, bilateral hip pain beginning at age 13. There was no reported history of trauma and she had negative radiographic imaging while in high school. She developed the same left hip pain during her first collegiate pre-season training that was successfully managed by conservative treatment. However, following an audible pop during athletic activity with a subsequent increase in pain, the patient was referred to a sports medicine physician. Diagnostic imaging from this referral indicated synovial tissue protruding anteriorly (TGCT) as well as a labral tear of the left hip and surgery was recommended. **Intervention & Treatment:** Upon diagnosis, the patient opted for surgical repair. She underwent an arthroscopic labral repair with proximal femoral osteoplasty and removal of excess synovial tissue. Post-surgery, patient was non-weight bearing (NWB) for one-week. She progressed from NWB to WB with no antalgic gait and began ROM restoration during phase one. Low-level leg strength activities and quadriceps muscle stimulation were performed for the next eight weeks to begin strengthening. At week 10, exercises were progressed to 50% bodyweight in the AlterG®. As overall strength improved, functional exercises were progressed and along with time in the AlterG® at increasing bodyweight each week. A full return to team activities occurred three months following the surgery. This progression resembles a standard response post labral tear repair, and no noted setbacks from removal of the TGCT were noted. **Outcomes or Other Comparisons:** The patients of the comparison case series presented with similar initial onset symptoms of vague anterior hip pain in the groin/inguinal ligament region; with two patients displaying similar chronic pain of the patient in this case with no traumatic mechanism. Each of the five patients in the reference study received an arthroscopic synovectomy and had a 0% recurrence rate at 32 months with asymptomatic, restored preinjury level activity. The athlete of this case study has been able to return to full, unrestricted activities and has been asymptomatic without recurrence for 32 weeks. **Conclusions:** The case study partially validates the existing literature as far as management of a TGCT through arthroscopic debridement. However, the patient shared that she had a family history of TGCT after she received her diagnosis; this contradicts the history obtained from patients in the reference study. Therefore, further investigation should be undertaken to determine if family history predisposes an individual for TGCT or if they may be at a higher risk for reoccurrence. **Clinical Bottom Line:** TGCT has the potential to cause detrimental implications for the involved individual if left untreated. It can cause permanent necrosis of the joint and alter lower extremity biomechanics, possibly predisposing an individual to further injury. By learning the predisposing red flags of a TGCT, health care providers can treat the patient better holistically and potentially decrease a prolonged treatment.

None of the authors have any financial disclosures.

Concurrent ACL and MPFL Tear: Type 3 Uncommon Case Study/Series

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Background: The focus of this case study is a simultaneous tear of the anterior cruciate ligament (ACL) and the medial patellofemoral ligament (MPFL). Injury to the ACL is a very common entity and causes anteroposterior and rotational instability of an injured knee. Injury to the MPFL is less frequent, and its insufficiency causes patellar instability. A tear to both ligaments at the same time is rare. This case would require a single step procedure using the quadriceps tendon autograft for the reconstruction of both. **Patient:** The patient is a 22-year-old male who was playing soccer on the beach at the time of the injury. Their chief complaints included, left knee pain, swelling, episodes of instability, and in terms of range of motion they were not able to fully flex at the knee. The mechanism of injury was that the patient was playing soccer on the beach when he planted in the sand and pivoted. The patient was first seen at an emergency room. When examined at the sports medicine clinic, there was noticeable effusion and skin bruising along the medial hamstrings. The diagnosis was an anterior cruciate ligament tear, a medial meniscus tear, a medial patellofemoral ligament tear, and patellar instability all in his left knee. **Intervention & Treatment:** In this case, the patient required surgery. The surgical intervention involved a combination of MPFL and ACL reconstruction utilizing quadriceps tendon autograft. The combination of ACL and MPFL tear is rare with few cases reported in the literature. The outcomes of simultaneous ACL reconstruction and patellar stabilization are unclear due to limited data available on these injuries. Non-surgical options, such as bracing, would not be a viable option for several reasons which include, his age, activity level, the instability of knee and patella, and the fact that bracing won't prevent further injury especially as the sole form of treatment. Physical therapy was implemented immediately post-surgery to focus on ROM and then slowly progress to strengthening of the surrounding structures in the knee. **Outcomes or Other Comparisons:** The decision to use an autograft versus an allograft is dependent upon multiple factors. These factors include age, activity level, and work demand. Autografts are recommended for patients under 25 years of age while allografts are suggested for patients 25 years and over. This is because there is only a 9.6% chance of failure in a young active population of patients younger than 25. **Conclusions:** Concurrent ACL and MPFL tear is a rare injury combination. Physical examination and diagnostic imaging, such as an MRI, is essential in patients with an ACL tear and patellar instability. Simultaneous reconstruction of both the ACL and MPFL in a single sitting is suggested because it offers better results in terms of the healing process. Identifying and treating MPFL tear is imperative to avoid instability of the knee post ACL reconstruction. Failure to address this can be one of the reasons for ACL graft failure. **Clinical Bottom Line:** Although the simultaneous tearing of the ACL and MPFL are a rare occurrence, to provide the patient with proper care the physician should be knowledgeable of both ligaments anatomically and functionally. The treatment of this injury is dependent on the correct diagnosis and severity or grade of the injury. Failure to address both may put excessive strain on the graft, leading to a rupture of the graft.

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Femur Fracture in a High School Baseball Player

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Background: This case involves a 17-year-old male baseball player with 6+ years of competitive baseball experience. This individual had no previous injury to either the involved or contralateral femur. The only pre-existing injury was bilateral femoroacetabular impingement with resulting labral tears. He had bilateral osteochondroplasty and inferior spine iliac spine decompression performed on 12/20/2019 (right) and 1/31/2020 (left). The athlete was cleared for participation in athletics by his surgeon after going through physical therapy. The injury happened in May of 2021 while participating in a game with his high school baseball team. The athlete was up to bat, after getting a hit he was running to first when his right foot got caught in the dirt and he fell forward just before reaching base. Upon arrival to the athlete he was C/O significant thigh pain and was grasping the posterior lateral thigh. He reported no numbness or tingling distal to the site on injury and was neurovascularly intact. **Differential Diagnosis:** Hamstring strain, hamstring avulsion, femur fracture **Intervention & Treatment:** Basic observation and palpation revealed a mid-shaft femur fracture with deformity and EMS was activated. The athlete's neurovascular status was monitored prior to and upon EMS arrival. He was then placed in a leg traction splint, given IV pain medication, and transported to a level 1 trauma center. Radiographic imaging at the hospital confirmed a comminuted mid-shaft fracture of the femur with lateral displacement of the distal fragment. The athlete was admitted to the hospital and an intramedullary fixation was performed the next morning. **Uniqueness:** A non-contact, non-traumatic femur fracture in a healthy 17-year-old athlete is extremely rare in occurrence. Most femur fractures in adolescent males is a result of an auto-accident (40%) or fall from a height (32%).1 Only 6% of femur fractures in this study1 were spontaneous or result of stress or pathological mechanisms. Non-traumatic femur fractures are typically a result of one of the following causes, fatigue, insufficiency of bone or minerals, incremental fractures (as seen in Paget's disease), pathological factors.2 **Conclusions:** In this case, blood work and labs were obtained and previous radiographs were further reviewed to assess for any underlying tumors, bone cancer, or bone disease. There was no family history of bone cancer and nothing abnormal was seen on his radiographs from January 2021. The athlete was continuing to work with physical therapy and had been having no thigh pain or difficulty performing exercises to indicate a potential stress fracture. It is uncertain what exactly lead to the fracture in this case but we can rule out any pathological cause. A basic metabolic panel also showed calcium levels from 8.3-9, which is slightly low but not below normative values. Its plausible that this fracture was caused by a fatigue/ stress mechanism which is at times seen following a lower extremity surgery that affects normal walking gait for a period of time following surgery. It is important as athletic trainers to keep in mind the risk of lowered calcium levels in our athletic populations we work with. However, without regular blood panels is may be difficult to ascertain the risk level in each athlete. Also it is vital to emphasize normal gait walking and running before returning to a high level of activity.

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Medial Closing Wedge Distal Femoral Osteotomy for Genu Valgum Deformity With ACL Revision Reconstruction and Lateral Extraarticular Tenodesis: Type 3 Case Study

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Background: For quite some time there were no good solutions for young, healthy, active individuals who had early onset post-traumatic arthritis causing a genu valgus/varus deformity. It was not until recently a greater understanding of alignment restoration procedures has come to light, specifically distal femoral osteotomies (DFO). These techniques have been shown to correct the deformity and restore neutral alignment for joint preservation. There are also many options to pair these techniques with concomitate cartilage, ligament, and meniscal procedures. This type 3 case study will review the multiple treatment options available for active individuals with unilateral compartment arthritis resulting in a genu valgus deformity. It will also discuss potential reasons for primary ACL reconstruction failures and different surgical techniques to help restore normal anatomy. **Patient:** A 24-year-old female presents with lateral sided left knee pain and instability. She had a history of a bone patella bone (BTB) autograft ACL reconstruction in 2015. The patient had an uneventful recovery and was able to return to all activities with no issues. It was not until 2021 when her pain gradually returned over the last year, as well as feelings of instability. Conservative treatment of a custom ACL brace and physical therapy was not sufficient in relieving her symptoms. She was in the process of training for the fire academy and needed to return to a high level of physical activity. Her physical exam findings were consistent with ACL insufficiency with a grade 3 pivot shift and 3B Lachman's test. She also measured -10°of genu recurvatum and 140° of knee flexion. Long standing x-rays reveal a 5.4° valgus deformity when compared to the contralateral side of 3.4°. An MRI confirmed an attenuated ACL graft, advanced chondral degeneration of the lateral femoral condyle with bone marrow edema changes and a 6mm loose body. **Intervention & Treatment:** Due to failed conservative treatment measures, it was decided an ACL revision reconstruction would be performed with the contralateral BTB autograft along with a medial closing wedge distal femoral osteotomy to correct her genu valgum deformity. A lateral extraarticular tenodesis was also performed correct biomechanics and decrease the chance of retears in the future. **Outcomes or Other Comparisons:** The patient in this case study underwent what is currently known to be a successful medial closing wedge distal femoral osteotomy, ACL revision and lateral extraarticular tenodesis. She is 3 months status post and reports no pain, swelling, or feelings of instability. She continues to work with physical therapy to regain full range of motion and strength. She has some tightness and soreness in the posterior knee and is lacking 2-3° of active terminal extension, but is able to achieve full extension passively. She has a grade 1A Lachman's test and radiographs demonstrate complete union of the osteotomy site with no evidence of hardware failure. It is expected she will have a full recovery by 9 months post operatively and is well on her way to successfully completing the firefighter academy. **Conclusions:** Asymmetric joint wear is a serious issue in the process of degenerative joint disease. Recent research has shown there are good options for young, active individuals, but an abundance of preoperative planning and thorough understanding is imperative when discussing these various interventions. DFO is a viable solution along with cartilage, meniscus and ligamentous procedures, as seen presented in this case study. **Clinical Bottom Line:** Unfortunately, ACL re-tears happen in approximately 5.8% of the population within 5 years, but more research needs to be done to find out biomechanical causes of this. When evaluating young athletes, especially following an ACL reconstruction failure, it is imperative to keep these parameters in mind for proper management and surgical planning.

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Osteochondral Defect in Collegiate Football Player Results in MACI Implant: Level 3

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Background: Osteochondral Defect Lesions (OCDs) are localized areas of joint damage that occur when part of the bone and cartilage separate from the rest of the joint. Most commonly occurring in the talus, affecting the ankle joint. OCDs are typically treated with debridement and osteochondral grafting. Due to his age and potential outcome, the Matrix-Induced Autologous Chondrocyte Implantation (MACI) was chosen by the physician in this case. **Patient:** The patient is an 18 year old freshman male collegiate football athlete. The patient reports no prior medical history. At the start of his high school senior season, he reported to the Athletic Trainer with chronic pain, swelling, instability, and decreased range of motion in his right knee. The original differential diagnosis was a hairline fracture or tendonitis. He continued playing but the pain increased, and he decided to get a second opinion. X-Ray, MRI, and CT were used to confirm the presence of an OCD. The surgeon suggested the two-part MACI technique. Although the first part of the procedure was not covered by insurance, the second part was covered. The financial impact was a deciding factor for the patient to go through with the procedure. The patient's goal was to return to football. **Intervention & Treatment:** The MACI procedure consists of two parts. The first part is a cartilage biopsy to harvest a sample of the patient's cartilage to be grown in the lab for 1 month. The patient was walking the next day and did therapy focused on balance. Six weeks later, the second part was the cartilage implantation; the surgeon cuts the MACI implant to the correct size for the defect and glues it into place. The implanted cartilage will continue to grow and strengthen. Following surgery, the patient was on bed rest for 1 week, then non-weight bearing for 6 weeks. The patient completed physical therapy with a focus on water therapy and progressed to weights to strengthen the surrounding structures. The patient started college where he was recruited to play football. He notified the Athletic Trainer of the procedure during preparticipation physicals.. The Athletic Trainer collected history regarding his condition and surgery and put together a care plan. He was not able to be cleared for football until the required rehabilitation time set by his physician had passed so he redshirted. The Athletic Trainer put him on a non contact strength and conditioning program while incorporating therapeutic modalities. The plan included exercises and drills that would help with cutting, jumping, acceleration, and deceleration needed for his position. The plan improved his agility, strength, and range of motion and decreased muscular atrophy. **Outcomes or Other Comparisons:** After the implant was completed, the patient wore a straight-locked brace for 6 weeks that was unlocked while sitting. The patient used a continuous passive motion machine to minimize scar tissue, encourage even cartilage growth, and keep the joint moving without muscle activity. The patient progressed as expected and met all goals set. There were no surprise complications or deviations from expectations, he is expected to return to play 9 months post operation. Compared to other OCD treatments, the MACI technique is less invasive, does not require internal suture fixation as the implant is adhered using a fibrin sealant, and provides better outcomes with less downtime. **Conclusions:** The use of the MACI technique for treating OCDs in the knee is a viable option for youth patients wanting to return to activity due to its long term results. **Clinical Bottom Line:** The MACI technique is useful for treatment of OCDs and it is important for Athletic Trainers to be aware of this option.

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Rehabilitation and Return to Sport in an In-Season Division 1 Quarterback Following Surgical Management for a High Ankle Sprain

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Background: This case presents a Division 1 football student athlete that received a closed reduction and internal fixation with TightRope following a high ankle sprain. Surgical intervention was chosen over a non-operative approach due to the nature of the injury and the timeline for return to play. **Patient:** Patient is a 22-year old Division 1 male football student athlete, playing quarterback. The patient was tackled and suffered an inversion mechanism to his left ankle during a game. Initial evaluation on the sideline revealed lateral ankle pain and laxity of the lateral ligaments. Patient was re-taped and was able to return to participation. Patient presented with increased pain over the lateral and medial aspect of the ankle with significant swelling and ecchymosis the following day. An MRI was obtained and revealed a grade 3 Anterior Inferior Tibiofibular Ligament (AITFL) tear and a grade 2 sprain to the Anterior Superficial Deltoid, Anterior Talofibular Ligament (ATFL) and Calcaneofibular Ligament (CFL). **Intervention & Treatment:** Initial treatment goals were to decrease pain, swelling, and inflammation. The patient completed a rehabilitation program 3 times per day, consisting of joint and soft tissue mobilizations, isometric foot and ankle strengthening, proximal lower extremity strengthening, and modalities including an H-wave, neuromuscular electrical stimulation (NMES), laser therapy, HIVAMAT® therapy, and a Game Ready. Gait training and therapeutic exercises designed to increase range of motion (ROM) and strength began at one week post-op. When ROM, strength, and mobility were restored, the patient started a jogging progression and functional on-field training. The patient was cleared to return to unrestricted participation after performing all sport-specific movements at full speed without an increase in inflammation and no subjective reports of instability. Throughout the rehabilitation process, the patient worked on contralateral leg and upper body strengthening with the Strength and Conditioning Coach. Due to the injury occurring in-season, the treatment approach aimed to restore musculoskeletal impairments and neuromuscular control to return to participation faster than standard rehabilitation timeframes. **Outcomes or Other Comparisons:** The patient was able to ambulate in an Alter-G on day 9 and by day 11 progressed to jogging in the Alter-G. Patient performed on-field sprinting and position specific drills on day 14. The patient returned to practice for individual drills and controlled team drills on day 16. The patient returned to play in a game on day 28. The patient was able to return to his prior level of sports participation without reinjury in a faster time period compared to standard post-operative guidelines. **Conclusions:** Operative versus non-operative management following high ankle sprains and syndesmotic injuries remains controversial. Currently, there is not a universally agreed upon post-operative rehabilitation plan with return to sport testing criteria for high ankle sprains. The patient was able to complete a rehabilitation program that addressed all musculoskeletal impairments to allow him to safely return to a high level of sports competition. **Clinical Bottom Line:** This case highlights the benefits of a surgical approach and sport-specific rehabilitation plan following a high and lateral ankle sprain in an in-season collegiate football player. The criterion-based rehabilitation program following surgical management of a high ankle sprain with a concurrent lateral ankle sprain can serve as a template for future Athletic Trainers to use for in-season athletes wishing to return to sport faster than standard post-operative timeframes.

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Reoccurring Peroneal Tendon Subluxation Repair and Peroneus Quartus Excision in a Physically Active Athletic Trainer: A Type 3 Case Study

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Background: Subluxation of the peroneal tendons are common among patients with chronic posterolateral ankle pain and instability. Peroneal tendon tears are generally repaired surgically by reattaching the superior peroneal retinaculum, debriding or repairing the torn peroneal tendon(s), and a groove deepening procedure. During treatment, a small percentage of patients discover an accessory muscle, peroneal quartus. The purpose of this case study is to present and discuss the management of a 27-year-old physically active athletic trainer (AT) who suffered from chronic subluxating peroneal tendons and a peroneus longus tear with presence of accessory peroneal muscle. **Patient:** The patient began experiencing pain on the lateral aspect of the ankle while running and discovered the subluxating peroneal tendons during an evaluation course in 2006. The patient does not recall any specific mechanism of injury, only pain with running long distance. The pain continued for approximately 1 year. The patient continued to run using a tape application with pad to assist in preventing subluxation and decreasing pain. The patient began experiencing pain on the lateral aspect of the lower leg with daily activities, such as walking. As pain increased the patient was seen by a foot and ankle physician in October 2007. The clinical exam revealed obvious peroneal tendon subluxation with AROM of inversion and plantarflexion, and MMT. An x-ray was performed and a possible tear of the peroneal tendon(s) was suspected due to location of pain. The patient was scheduled for a groove deepening technique and tendon repair surgery in May 2008. **Intervention & Treatment:** During surgery, the physician discovered and excised the peroneus quartus in the peroneal groove to eliminate overcrowding of the space available for the peroneal longus and brevis tendons. After excision, the realignment of the tendons was successful within the groove and no osteotomy was needed. The superior retinaculum was torn from the posterior fibula allowing the peroneus longus to dislocate. The retinaculum was realigned with a 2.4mm suture anchor and a 2-0 fiber wire was used to hold the retinaculum to the fibula. The peroneus brevis tendon was located with no damage, but hypertrophic in nature. However, the peroneus longus tendon revealed a 2cm tear involving less than 10% of the tendon with no deep degeneration and it was repaired. The standard post-operative protocol for immobilization and physical therapy was followed. **Outcomes or Other Comparisons:** The initial surgery revealed the accessory muscle present within the peroneal groove. The surgeon felt there was no need for the groove deepening technique once the peroneal quartus was excised. In addition, the peroneus longus tendon was torn without the presence of an os peroneum. The calcaneofibular ligament was also found to be structurally normal. The patient was 4 months post-surgery when a clicking sensation was felt with straight line running. The patient returned to the surgeon and the groove deepening surgical technique was recommended in order to better hold the tendons in the groove. **Conclusions:** It is uncommon to find the peroneus quartus residing in the peroneal groove. Tearing of the longus tendon from chronic subluxations is more often due to anatomical factors, such as the presence of an os peroneum. A thorough clinical exam, followed by appropriate imaging should be performed to determine the potential causes of the peroneal subluxations when no history of lateral ankle sprains or instability is present. **Clinical Bottom Line:** Although uncommon, ATs should be aware that peroneal tendon subluxations can be caused by an accessary peroneal muscle overcrowding the peroneal groove and resulting in uncommon peroneal longus tears.

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Tibial Plateau Fracture of Division 1 Football Player

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Background: Level 3 case reports of a 23-year-old male collegiate football player who sustained a tibial plateau fracture with Grade 1 Lateral collateral ligament (LCL), medial collateral ligament (MCL), and posterior cruciate ligament (PCL). Tibial plateau fractures are usually caused by a direct force to the lower leg when the leg is in a varus or valgus position or simultaneous vertical stress of flexion of the knee. **Patient:** A male student-athlete aged 23 years old participating in NCAA Division I Football served as our case. Our student-athlete has 17 years of experience. MOI occurred during a non-contact warm-up drill. Upon clinical evaluation, the patient complained of right knee pain. Special testing included the Lachman's test, varus/valgus test, which was positive for pain. The posterior drawer test was negative, with a positive finding with the McMurray's test. The patient was tender to palpation along both the medial and lateral joint lines. The patient expressed discomfort through active range of motion in flexion and extension. Initial diagnosis included grade 1 ACL and LCL sprain. Magnetic resonance imaging revealed a tibial plateau fracture with grade 1 sprain of the LCL, MCL, and PCL. **Intervention & Treatment:** The patient's recovery was a total of 6 weeks. Surgery was not elected. Weeks 1-2 focused on control of swelling, specifically pitting edema. The patient was 50% weight-bearing and was assigned crutches for two weeks, along with wearing a DonJoy Total Range of Motion brace. After the first 1-2 weeks, attention was on strengthening and increasing the range of motion. On weeks 3-6, the patient was 100% weight-bearing. In weeks 3-6, sport-specific exercises were emphasized to return to play. The patient received blood flow restriction (BFR) treatment throughout his recovery process. Specific strengthening exercises included squats and knee extensions, as well as isometric and isotonic exercises. Manual therapy included lymphatic draining to reduce the influx of edema. **Outcomes or Other Comparisons:** Surgery was not elected for the patient, and he returned to full play within six weeks. Barriers in recovery included complications with gait assessment and correction. The patient was cleared for progression to play but did not fully participate due to gait abnormalities. **Conclusions:** On initial examination, common signs and symptoms of a tibial plateau fracture did not present. With no surgery needed, after a six-week recovery period, the patient is cleared to compete and progress in his recovery protocol. **Clinical Bottom Line:** Common tibial plateau fractures are sustained by a strong force on the lower leg when the leg is in varus or valgus position or simultaneous vertical stress and flexion of the knee. Though tibial plateau fractures are common amongst football players, hyperextension stresses are uncommon as a mechanism of injury.

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A Buford Complex in a Division I Collegiate Beach Volleyball Athlete: A Type 4 Clinical CASE Study

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Background: The patient is a 19-year-old Division I collegiate beach volleyball player. In April of 2021, the patient started experiencing pain and discomfort in her right shoulder when bench pressing during team lifts. The pain and discomfort were located on the anterior aspect of her right shoulder. The pain then began to increase and bother her when playing beach volleyball, specifically with overhead serving. The patient has no previous history of right shoulder injury. The patient was evaluated by an athletic trainer and was deemed to have a rotator cuff pathology. The patient received manual therapy to reduce pain at the joint and finished out the competition season. The patient returned home for the summer and attended physical therapy from May through August, 2021. The patient did not perform sport specific motions with her right arm during this period. While strength improved with physical therapy, pain persisted so an MRI with contrast was ordered in August. **Differential Diagnosis:** The patient was initially diagnosed and treated as having a rotator cuff pathology in her right shoulder due to her pain with bench pressing and overhead movements. When the patient began physical therapy at home after the conclusion of her season, the physical therapist began to treat her instead for a shoulder labrum pathology. When the patient's pain had not improved after two months of physical therapy, further imaging was ordered. The patient received an x-ray and an MRI with contrast of her right shoulder. **Intervention & Treatment:** The ordered diagnostic imaging revealed a Buford complex as a normal variant in the right shoulder. The radiologist also noted a minuscule amount of fluid in the subacromial/subdeltoid bursa. There was no rotator cuff pathology noted. The MRI was reviewed, and the patient was examined by the team orthopedic surgeon. The orthopedic surgeon cleared the patient for full participation with limitations in the weight room to avoid putting unnecessary strain on the joint. Athletic training rehabilitation began at the end of August of 2021 with a plan focused on shoulder stabilization, rotator cuff strengthening, and posterior shoulder girdle strengthening. The patient began a slow return to hitting progression with her right shoulder. The patient returned to full practice in October of 2021 using her right arm to hit, without pain, two months after the rehabilitation and return to play program began with the ATC. **Uniqueness:** The anatomical labral variant known as the Buford complex occurs in about 1.5% of shoulders. Following a literature search, only one case was reported of successful identification and management of this variant in a Division I collegiate patient. Additionally, this is the only known successful management of a Buford complex in a Division I overhead athlete. As an overhead athlete, predisposition to shoulder injury exists due to the stresses of hitting a volleyball at a high velocity. The Buford complex increases this risk due to the susceptibility of sustaining a SLAP lesion. **Conclusions:** While there was no secondary injury in this case, the patient is at an increased risk for shoulder injury, specifically a SLAP lesion due to the irregular attachment of the middle glenohumeral ligament. This creates a greater challenge within rehabilitation efforts to strengthen and stabilize the glenohumeral joint without reducing hitting velocity or making modifications to her swing that would decrease overall athletic ability. While rare, this is a condition clinicians need to be aware of because it may present as other shoulder pathologies. Successful management can occur if the ATC and patient are diligent in their rehabilitation efforts.

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Abnormal Scarring Found in Shoulder Scope of Overhead Sport Athlete: Type 3 CASE Study

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Background: A softball athlete underwent a shoulder arthroscopy for a humeral avulsion of the glenohumeral (GH) ligament (HAGL lesion). While performing the shoulder scope, the surgeon found no HAGL lesion but found excess scarring of the proximal head of the patient's biceps tendon and rotator cuff, as well as a thickened subacromial bursa. This is believed to be due to an overbearing response to overuse of the patient's shoulder when performing repetitive throwing motions (Santavirta, et al., 1992). **Patient:** The patient is a female softball athlete in her sophomore year of college who began experiencing pain in her left shoulder superiorly and anteriorly in 2018 and sought out general pain management from her previous athletic trainer. By 2019, this became worsened, "sharp" pain and a lack of mobility began restricting her ability to throw. **Intervention & Treatment:** The patient was initially treated for pain using various modalities such as ice pack application and interferential current therapy (IFC) in 2018. A shoulder scope was performed in December 2020 to repair a suspected HAGL lesion. Upon finding excessive scarring, adhesions were removed from the patient's shoulder. Two weeks post-operatively, this patient began one month of general range of motion (ROM) exercises in physical therapy before returning to her athletic trainer for light strengthening and continued ROM exercises for the next two and a half months. This was followed by a gradual throwing and hitting progression to return her to normal softball activities. She successfully returned to full strength and range of motion six months post-surgery. However, she is still experiencing unimproved pain with throwing. She was given a biceps tendon injection at the end of September 2021 and a GH joint injection at the beginning of October 2021. The biceps tendon injection was unsuccessful for pain relief. The GH joint injection has been successful for mild pain relief accompanied by rest due to an unrelated hamstrings strain. **Outcomes or Other Comparisons:** A HAGL lesion occurs when the inferior GH ligament tears away from the neck of the humerus (Bui-Mansfield, et al., 2007). This can result from shoulder instability, which can often be seen in throwing athletes and may have led this patient's doctor to this diagnosis initially upon examination and viewing her MRI (Cools, et al., 2015). This patient's symptoms appeared to match those of a HAGL lesion but were caused by her body's abnormally excessive scarring reaction to GH joint overuse. **Conclusions:** This case highlights an atypical reaction of excessive scarring for GH joint overuse in overhead athletes. The gradual decrease in mobility due to tightness rather than pain could indicate adhesions. Consistent rest and stretching could be recommended for this type of patient experiencing early stages of these symptoms. Surgical intervention will be necessary to remove adhesions causing immobility, but pain may not decrease. If pain does not subside, injections to the GH joint may offer temporary pain relief. The patient's excessive scarring response may continue naturally, necessitating another surgery to remove adhesions. **Clinical Bottom Line:** Clinical Bottom Line: Excessive scarring as a natural response to shoulder overuse may create difficulties in preventing joint adhesions. The patient in this case is expected to undergo surgery for future adhesions due to this reaction. Educating and cautioning athletes on potential results of overtraining and detailed strengthening programs that focus on gradually conditioning the deltoid and rotator cuff muscles may be key in prevention (Cools, et al., 2015).

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Aneurysmal Bone Cyst and Internal Fixation Using Olecranon Autogenous Graft on a 34-Year-Old Male: A Rare Events CASE Study

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Background: Patient is a 34-year-old male who presented with right index finger pain. The patient's finger was smashed by a rock at work nine months prior to his initial clinical visit. After the initial injury, he experienced ongoing pain and swelling in his index finger but deferred medical attention in attempt to manage his symptoms on his own. Upon clinical examination, the index finger displayed significant tenderness to palpation and substantial swelling with notable range of motion deficits. Of note, the patient recalled no symptom improvement over the course of nine months regarding his pain and swelling. **Differential Diagnosis:** Based on the patient's mechanism of injury and clinical presentation, fracture to the proximal phalanx of the right index finger was initially the leading differential diagnosis. The patient still had the ability to activate flexor and extensor tendons, ruling out flexor or extensor tendon rupture. Other differential diagnoses included collateral ligamentous injury or a bone mass. **Intervention & Treatment:** To examine the extent of the suspected fracture, radiographic imaging was conducted. Immediately upon observation of x-rays, it was apparent that a large tumor-like mass was encompassing almost the entire proximal phalanx; consequently, differential diagnoses drastically changed. Because a biopsy of the mass is necessary to diagnose what type of lesion was present, differential diagnoses rely largely on radiographic imaging. These included: Giant cell tumor, granuloma, chondral sarcoma, and Ewing sarcoma. Due to the narrow zone of transition and presence of internal septations and lobulations, the physician and radiologist concurred on the lesion most likely being an aneurysmal bone cyst (ABC). Conservative versus surgical treatment options were discussed with the patient. After conversation pertaining to the risks and benefits of both, the patient elected to proceed with surgical intervention. Curettage of the lesion with reconstruction utilizing olecranon bone graft was then performed. The lesion was curetted, removing all evidence of cyst, and tissue from this lesion was sent to pathology which confirmed the presurgical diagnosis of an ABC. A graft from the patient's olecranon was then harvested at the posterior ulna. The graft was taken back to the finger and fixated with a Synthes plate to reconstruct the entire radial aspect of the proximal phalanx. The bone graft was then fixated with Synthes Hand Mod screws. The patient followed-up at two-and-five weeks postoperatively; patient consent for this case study was obtained at the five-week clinical visit. He had no pain, minimal swelling, and appropriate healing of incisions. Radiographs were obtained during each of these visits and demonstrated excellent hardware positioning with no evidence of loosening and early incorporation of the graft across the cyst site. **Uniqueness:** ABCs are defined as benign, expansile tumor-like bone lesions that can be locally aggressive with relevant potential for local recurrence The nature, character, and optimal treatment of ABCs has been studied over the course of the past 75 years; yet, definitive answers to each of these characteristics remains obscure. The patient in this case was 34 years old, which is especially unique considering 90% of ABCs are found in patients younger than 30 years old. Additionally, a trauma-induced mechanism has relevant clinical applicability especially in the field of sports medicine. In this respective case, curettage and reconstruction using an olecranon autograft led to excellent patient-reported and surgeon-based outcomes, serving as validation measures in the efficacy of this surgical procedure. **Conclusions:** Trauma-induced bone lesions can be common among young-athlete populations, demonstrated by high incidence rates in children and adolescents. If a contact-sport athlete presents with an uncharacteristically swollen and painful bony segment which has persisted for an extended period of time, including a trauma-induced lesion on the list of differential diagnoses should be considered.

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Complex Scapular Body Fracture Resulting in a Floating Shoulder: Type 4 CASE Study

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Background: A 34-year-old male right-hand-dominant recreational mountain biker presented to the emergency department after traumatic downhill mountain bike crash. The patient flew over the handlebars landing on a rock with direct impact to his left scapula. Pain, swelling, loss of function, and parethesias of his left arm and upper back were present immediately after the injury. He was referred to an orthopaedic surgeon for further evaluation of his injuries. He was seen in clinic four days after injury where he was diagnosed with a displaced scapular body fracture resulting in a floating shoulder. **Differential Diagnosis:** Scapular fracture, clavicle fracture, rib fracture, pneumothorax, AC ligament sprain, CC ligament sprain, AC joint separation. **Intervention & Treatment:** During evaluation, patient reported 7/10 pain at rest, increasing to 10/10 with use of the left arm. The pain was described as sharp and did not radiate. Patient reported feeling general shoulder instability with weakness, swelling, and pain. Upon physical examination, ecchymosis and a visible deformity over the posterior shoulder were noted. Patient reported tenderness along superior scapula, he denied any cervical spine tenderness and was neurovascularly intact. ROM deferred secondary to pain, but the deltoid, pectoralis, and lower trapezius muscles showed strong motor function. Plain radiographs and CT showed a transverse scapular body fracture with approximately 1.5-inch displacement inferiorly and widening superiorly with acromial extension. Given the patient's limitations, dysfunction, and mechanical pathology, including a floating shoulder surgical intervention of a left scapula open reduction internal fixation (ORIF) and left acromion ORIF would result in best outcome for this injury. At his 2-week post-operative appointment, the patient reported he was doing well. His posture was better, and he would continue to wear the sling for another 3 weeks. Plain radiographs showed appropriate positioning of the scapular and acromion ORIF plates along with well-placed screws. He progressed out of the sling and through ROM and strength in formal physical therapy. **Uniqueness:** Approximately 3-5% of shoulder girdle fractures and only 0.7% of all fractures occur at the scapula.1 Scapular fractures typically occur as a result of high-energy direct traumas often seen during motor vehicle accidents.2 While not often seen in traditional athletic training settings, acute and stress fractures of the scapula have been reported. Mechanisms of injury have been reported in football players, wrestlers, and water-skiers to include a forceful shoulder internal or external contraction against resistance.3 Other mechanisms included overuse from pitching in baseball players resulting in a stress fracture.3 Each of these cases obtained plain radiographs, as well as CT scans and all were treated non-operatively. Due to the fracture pattern, this case was classified as a floating shoulder and treated operatively due to the inherent instability of the shoulder. **Conclusions:** A recreational mountain biker presented after traumatic downhill crash with a displaced scapular body fracture. Literature reporting on scapular fractures has shown the most common mechanism to be motor vehicle accidents.2 Limited case study reports on athletic scapular fractures describe mechanisms including direct blows from football tackles while the shoulder is in terminal internal or external rotation, forceful shots from a hockey player, and a jogger running with weights in each hand.3 Each of these fractures were treated non-surgically and the athletes were able to return to sport. While non-surgical treatment is a viable option, this can lead to chronic pain, decreased shoulder range of motion, and decreased shoulder function later in life.4 Given the patient's goals, activity level, and inherent shoulder instability a scapular ORIF and acromion ORIF had a better chance of returning the patient to pre-injury function, profession, and everyday activities. Scapular fractures are rare but should be suspected after direct impacts and overuse mechanisms in the athletic population.

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Distal Clavicular Epiphyseal Avulsion in an NCAA Division II Intercollegiate Baseball Player: Type 4: Rare Events CASE Study

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Background: A 22-year-old baseball pitcher was pitching during a game on 3/6/2021 when the patient complained of extreme pain over the clavicle and upper fibers of the trapezius following a sensation he described as a "pop". The patient reported this occurred during the deceleration phase of throwing and claimed that he was able to manually relocate the clavicle with his non-throwing hand immediately after completing the pitch. At the time of the injury and during the reevaluation on 3/8/21 the patient refused passive and active ROM due to extreme pain. The patient was scheduled an X-ray for 3/10/2021. Those films were evaluated as normal and an MRI was scheduled for 3/22/2021. At this time the patient was instructed to begin initial rehabilitation with the athletic trainer. The MRI revealed findings consistent with a distal clavicular epiphyseal avulsion with extension into the superior periosteal sleeve. It was determined that an injury of this nature should have been detected on the X-ray. **Differential Diagnosis:** SLAP lesion, glenohumeral instability, acromioclavicular sprain, clavicular fracture **Intervention & Treatment:** Since the patient's subjective pain severely limited ROM the shoulder was immobilized with a standard ACE wrap to brace the arm to the torso. The patient was given ice and was instructed to be on a regimented dose of OTC NSAIDs to decrease pain. Upon receiving the initial X-ray results the patient began pain management and AAROM rehabilitation techniques with athletic trainer and athletic training student 3 times per week. The patient began to show an increase in pain free ROM throughout the course of a week and progressed to the use of overhead pulleys on 3/17/2021 to achieve full ROM. The MRI revealed the true diagnosis on 3/23/2021 and the conventional treatment plan is non-operative with immobilization. However, by this time the patient had already been participating in active rehabilitation for approximately 3 weeks. Continuation of the rehab plan with the athletic trainer was prescribed by the advanced nurse practitioner with an emphasis on continuing to increase pain free ROM and beginning strength improvement as tolerated. During a follow-up appointment 4/5/2021 the nurse believed a grade 2 sternoclavicular (SC) separation coupled with the distal clavicular epiphyseal avulsion was present and instructed that the patient should cease all active rehabilitation until an additional follow-up appointment in May 2021. The patient did not report to athletic trainer again until 4/20/2021 where he complained of significant tightness in the upper and middle fibers of the trapezius. The athletic trainer then began frequent sessions of passive and active neck stretches with education on a home stretching plan. **Uniqueness:** This injury is rare and typically occurs in young children as the epiphyseal plate is still ossifying. In addition, the mechanism of a baseball pitch is uncharacteristic as the typical mechanism of injury for this pathology is direct contact. This patient experienced a non-contact injury that happened when the epiphyseal plate was fully ossified. The available literature on this type of pathology is considerably limited and bereft of this mechanism in this population. **Conclusions:** The patient graduated in May 2021 and elected to transfer all care to his home physician. The new medical team ruled out the SC separation and the patient began a rehabilitation plan with a physical therapist. He is making progress with pain free motion but continues to report pain with overhead motions 7 months post-injury. This uncommon diagnosis was not fully understood even after imaging and physical rehabilitation was prescribed before repair of the clavicle could occur. Athletic Trainers and other clinicians need to ensure an accurate diagnosis and assess the current phase of healing to avoid applying inappropriate stresses to injured tissue.

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Erb's Palsy and the Effects on Normal Gait: Uncommon CASE

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Background: Erb's Palsy is a congenital injury sustained to a child's brachial plexus during birth. It can occur due to a large baby, a breech presentation, or prolonged labor, resulting in difficulty in delivering the newborn (Orthoinfo, 2019). The complication can also arise if the doctor assisting the delivery attempts to deliver the baby quickly and applies a traction force that causes a stretching or rupturing of the brachial plexus. On average, 1 or 2 babies out of every 1000 babies are born with the condition (Orthoinfo, 2019). The degree of this condition varies vastly on the extent of the injury, with some having minor loss of function to complete paralysis of the affected arm. This study is on a patient who has sustained this injury at birth but is currently competing as a division one soccer player. **Patient:** The patient observed is a 21-year-old female soccer player diagnosed with Erb's Palsy in her right arm. Since the condition was present at birth, she has grown up dealing with and managing the condition. She has worked with a physical therapist throughout her childhood to optimize the functionality of the affected arm. The remaining characteristic of her condition is a sloping of her right shoulder compared to the unaffected side. Her right arm has a noticeable developmental delay, with the right arm's musculature more atrophied than the left. There is no decrease in either gross or fine motor skills compared bilaterally. No pain is presented but there is decreased range of motion of the affected side when compared bilaterally. When relaxed, the affected arm does not go into a neutral position but stays in slight flexion of approximately 45 degrees. While watching her gait during activity, there is minimal use of the affected arm. It remains in a neutral position at the shoulder with flexion at the elbow. This action results in her tucking the elbow against her body and does not allow for proper gait. **Intervention & Treatment:** With Erb's Palsy, there is no treatment that guarantees the full functionality of the affected arm. Surgery is optional to reattach the brachial plexus for severe cases, allowing for the appendage's function but does not mean a full recovery. The patient in the CASE study has full function of her arm but has diminished range of motion that has improved but will never be complete. During her first year in the division one soccer program, she had minimal movement during running. With muscle strengthening and range of motion work, she now has improved movement while running. Also, there have been improvements in her range of motion in all plains. **Outcomes or Other Comparisons:** The damage to the nerve is irreparable, and the outcome is to maximize the functionality of her affected arm to optimize her activities of daily living. **Conclusions:** Erb's Palsy is not a common condition, so it can be challenging to know what to do for patients with this issue. Since it occurs at birth, there is an excellent likelihood that the patient has been undergoing rehabilitation. The main goal as the athletic trainer is to continue to help optimize range of motion and standard day-to-day functionality. **Clinical Bottom Line:** If presented with a patient who has Erb's Palsy, the goal is to help them have a better quality of life. Improving range of motion, strength, and gross and fine motor movements of the hand can result in more effortless day-to-day functioning.

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Presence of a Madelung Deformity in a Female Collegiate Volleyball Player

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Background: This Level 4 CASE study presents a 21-year-old female collegiate volleyball player with 4 years of experience as a Setter and Defensive Specialist. Patient had a brief history of recurrent wrist pain dating back to Spring 2020; however, athlete had not been active in her sport since this time due to the Covid-19 pandemic. Upon her return to activity in Fall 2020, the pain resumed. No specific event initiated the injury, the patient only complained of increasing idiopathic discomfort over time. Clinical examination revealed obvious, diffuse swelling. Athlete was tender to palpation over the medial and dorsal aspect of the wrist and exhibited decreased range of motion in wrist extension. Phalen test was performed and determined to be negative. A positive Finkelstein test was observed as well as a positive Triangular Fibrocartilage Complex (TFCC) compression test. **Differential Diagnosis:** The Athletic Trainer diagnosed the condition as TFCC pathology. **Intervention & Treatment:** Athlete was referred to an orthopedic hand specialist. Radiographs revealed a Madelung Deformity and confirmed grade 3 tear of the TFCC. Athlete was instructed to sleep in a rigid brace and to cease activity for 1 week. Activity after this period was with the brace as tolerated. She received a cortisone injection and was also prescribed an anti-inflammatory. Athlete opted for a more conservative treatment to complete her final season of volleyball. Subsequent treatment utilized a trial-and-error approach as little research has been conducted on this injury in athletes. The most successful therapeutic intervention for controlling the pain and swelling was the use of Hivamat 200. The electrical current of this device was set to a frequency of 150 Hz with an output of 100% for 30 minutes. Treatment was completed one day prior to, or the morning of competition and was coupled with forearm strengthening, allowing the athlete to compete with minimal to no pain. As of today, the athlete is 5-months post-cession of athletic activity. She received an ulnar shortening osteotomy to correct the deformity. **Uniqueness:** The Madelung Deformity is a congenital condition affecting the distal radius. Though the defect is present at birth, symptoms often don't appear until ages 6-13. Its clinical presentation includes but is not limited to, pain and decreased range of motion. During the pre-adolescent growth spurt, the premature closure of the radial epiphysis leaves a malalignment at the radioulnar articulation. The exact cause is unknown but factors such as presence of a hypertrophic Vickers' ligament, which connects the carpals and radius, and/or a mutation in the X chromosome known as the SHOX gene, make it more common in females. Accounting for less than 2% of hand deformities in children, Madelung Deformity is often misdiagnosed. **Conclusions:** The basis of this case study is to describe the potential presentation of a Madelung Deformity in an adult athlete. Athletic trainers should refer for radiographs and a genetic workup to rule out the possibility of a Madelung Deformity when a female patient is suspected of having sustained a TFCC injury coupled with decreased ROM and consistent diffuse pain. Though it is more common in the adolescent population between the ages 6 and 13, it is possible for the condition to go undiagnosed into adulthood.

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Trabecular Fracture of the Ulnar Styloid in a Collegiate Baseball Player: A Case Report

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Background: An otherwise healthy 23-year-old male collegiate baseball player reported to the athletic training room complaining of sharp pain on the ulnar aspect of his wrist following a swing. The patient had reported discomfort in the area previously, but stated the new pain was a different sensation. Patient had decreased grip strength, pain with ulnar deviation, pronation, and supination, and decreased range of motion with wrist extension. When the patient attempted to take another swing, he stated that he felt too much pain to attempt to continue. **Differential Diagnosis:** Triangular fibrocartilage complex injury, extensor carpi ulnaris tendinopathy, wrist sprain. **Intervention & Treatment:** Given the intensity of the patient's pain, he was placed in a volar wrist brace and referred to the team physician. Diagnostic ultrasound did not reveal any inflammation or damage to the extensor carpi ulnaris tendon. After examination, the physician injected the patient's ulnar aspect with cortisone to attempt to relieve any inflammation and recommended the patient remain in the volar brace. Over the next week, the patient reported no decrease in symptoms with the conservative treatment plan, and an MRI was ordered. The MRI revealed that the patient had suffered a trabecular fracture of the ulnar styloid with no cortical involvement. Additional findings of the MRI included spurring at the pisiform and triquetrum, a small volar ganglia formation, and a small focal defect of the TFCC. Following review of the MRI, the team physician referred the patient to a wrist and hand orthopedic surgeon. After further evaluation, the surgeon determined the majority of the patient's symptoms were a result of trabecular fracture. By this time the patient had been immobilized for two weeks, and the surgeon recommended immobilization for an additional four weeks to allow for adequate healing. The patient began adjunct treatment at this time including blood flow restriction therapy and oral vitamin D3 supplementation. Following removal of the splint, the patient began wrist and forearm strengthening along with range of motion exercises. Within one week, the patient demonstrated adequate wrist and hand strength to begin hitting exercises. Three weeks following removal of the splint, the patient was cleared to return to full practice and sport activities. **Uniqueness:** While TFCC and ulnar aspect injuries are relatively common in baseball, trabecular bone injuries to the ulnar styloid are rare. Additionally, the fact that the patient did not make contact with the ball he swung at there was no contact injury that would have increased the force that damaged the bone. **Conclusions:** When treating a patient who has an injury in an area commonly injured in their sport, it is important to make sure that all possible pathologies are ruled out prior to beginning a course of treatment. Evaluation and re-evaluation of treatment and rehabilitation programs is crucial for ensuring optimal patient outcomes. If a patient is not progressing as expected, further evaluation or diagnostic imaging may be indicated.

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Attitudes and Barriers Towards Seeking Behavioral Health Services in Tandem From Collegiate Athletic Trainers and Student-Athletes

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Context: Research indicates college students, including student-athletes, are at an increased risk for experiencing mental health concerns and mental illness. Researchers have analyzed data on collegiate student-athletes' behavioral health services (BHS) utilization and have called for research specific to facilitators and barriers to BHS use from student-athletes in tandem with stakeholders (e.g., athletic trainers [ATs]). The purpose of this study was to examine the attitudes and barriers for BHS for collegiate student-athletes in tandem with ATs with whom they have a previous healthcare relationship. **Methods:** We used a cross-sectional, web-based survey delivered to credentialed NATA ATs with snowball sampling to the student-athletes at their institution. The ATs (n=188; age=36±11y; female=119, 63.3%, male=68, 36.2%, non-binary=1, 0.5%) were mostly White (n=162, 86.2%) and worked at NCAA Division I institutions (n=77, 41.0%). The student-athletes (n=25; age=19±1y; female=19, 76.0%, male=6, 24.0%) were mostly White (n=18, 72.0%) and played at NCAA Division III institutions (n=17, 68.0%). We asked respondents to complete 2 valid and reliable instruments. First, we examined attitudes using the Attitudes Toward Seeking Professional Psychological Help–Short Form (ATSPPH-SF), a 10-item, 4-point Likert scale tool (0=Disagree, 3=Agree) examining comfort seeking professional mental health help. Next, respondents completed the Barriers to Help Seeking Checklist and identified 17 statements as a barrier/non-barrier to seeking help. Student-athletes completed tools in their original form, but we adapted the tools for ATs to focus on their perceptions of student-athletes' attitudes and barriers. We analyzed data using descriptive statistics. **Results:** Only 12.8% (n=24) of ATs reported BHS were available in their ATF. On the ATSPPH-SF, we identified perceived differences in seeking help in multiple areas (Table). Interestingly, 72% of athletes and 55% of ATs reported seeking professional attention would not be their first thought when having a mental breakdown. ATs perceived student-athletes believed their personal and emotional troubles tend to work themselves out (n=149, 79.7%); however, only 32% (n=8) of student-athletes felt similarly. Both groups were split on the value added for the time and expense of psychotherapy (disagree: AT=89, 47.6%, student-athlete=13, 52.0%). From the list of barriers, ATs cited fear of stigma for using BHS (n=162, 86.2%) and fear of being viewed as weak (n=161, 85.6%) as the most common reasons to not seek help. However, student-athletes cited lack of time to seek services (n=19, 76.0%) and services unavailable during their free time (n=15, 56.0%) as barriers. Only 32% (n=8/25) of student-athletes cited stigma as a concern. **Conclusions:** Data suggest attitudes and barriers, when studied in tandem, do not align. Providers indicated they thought patients would be stigmatized, but student-athletes described accessibility as their concern. The implicit bias of providers and accessibility of sport-specific resources must be evaluated to ensure time for obtaining services aligns with the demands of being a student-athlete.

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Table - Attitudes Toward Seeking Professional Psychological Help–Short Form (ATSPPH-SF)

Items	Student-Athlete (n, %) (n=25)		Athletic Trainer (n, %) (n=187)	
	Disagree	Agree	Disagree	Agree
If my student-athletes believed they were having a mental breakdown, their first inclination would be to get professional attention.	18, 72.0%	7, 28.0%	102, 54.5%	85, 45.5%
The idea of talking about problems with a psychologist strikes my student-athletes as a poor way to get rid of emotional conflicts.	19, 76.0%	6, 24.0%	106, 56.7%	81, 43.3%
If my student-athletes were experiencing a serious emotional crisis at this point in their life, they would be confident that they could find relief in psychotherapy.	9, 36.0%	16, 64.0%	92, 49,2%	95, 50.8%
The student-athletes think there is something admirable in the attitude of a person who is willing to cope with his or her conflicts and fears without resorting to professional help.	12, 48.0%	13, 52.0%	57, 30.5%	130, 69.5%
The student-athletes would want to get psychological help if they were worried or upset for a long period of time.	5, 20.0%	20, 80.0%	69, 36.9%	118, 63.1%
The student-athletes might want to have psychological counseling in the future.	5, 20.0%	20, 80.0%	16, 8.6%	171, 91.4%
A student-athlete with an emotional problem is not likely to solve it alone; he or she is likely to solve it with professional help.	9, 36.0%	16, 64.0%	55, 29.4%	132, 70.6%
Considering the time and expense involved in psychotherapy, the student-athletes think it would have doubtful value for people like them.	13, 52.0%	12, 48.0%	89 47.6%	98, 52.4%
The student-athletes think a person should work out his or her own problems; getting psychological counseling would be a last resort.	16, 64.0%	9, 36.0%	72, 38.5%	115, 61.5%
The student-athletes think that personal and emotional troubles, like many things, tend to work out by themselves	17, 68.0%	8, 32.0%	38 20.3%	149, 79.7%

Do Self-Efficacy and Resilience Differ Between Injury Status and Class in Division I Student-Athletes?

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Context: Psychosocial health is a major contributor to injury recovery and sport performance. However, little is known whether specific psychosocial factors of self-efficacy (an athlete's confidence in their abilities) and resilience (an athlete's ability to bounce back) differ in Division I student-athletes. Understanding these differences can provide clinicians insight into when and with whom psychological treatment modalities to build self-efficacy and resilience should be used. This study aimed to compare self-efficacy and resilience between Division I student-athletes 1) with and without a current injury, 2) with and without an injury the previous season, and 3) based on class (freshman, sophomore, junior, senior). We hypothesized that student-athletes who are seniors, do not currently have an injury, and have previously had an injury will have higher self-efficacy and resilience compared to student-athletes who are younger, currently have an injury, and have not previously had an injury. **Methods:** A total of 45 Division I collegiate athletes (17 gymnasts/28 rowers, 45F) completed four self-efficacy questions and the Brief Resilience Scale (BRS) electronically the first week of pre-season. The self-efficacy questions asked student-athletes to rate their confidence in their ability to Q1) perform their sport during competition, Q2) perform their sport during practice, Q3) contribute to the success of their team, and Q4) mentally focus on their sport given their current life circumstances. Class, current injury (not currently participating in practice due to injury) and previous injury (did not participate in at least one competition last season due to injury) were recorded. Following a Shapiro-Wilk Test for normality, Mann-Whitney U Tests were used to compare self-efficacy and BRS scores between injured/uninjured groups and sport, and a Kruskal-Wallis Test was used to compare self-efficacy and BRS scores between classes. If significant, post-hoc tests were used to analyze main effects. **Results:** Mean self-efficacy scores were Q1:73.0±21.6, Q2:72.5±21.0, Q3:70.2±27.9, and Q4:67.6±24.6 on a scale from 0 (not confident) to 100 (most confident). The mean BRS score was 3.2±0.57 on a scale from 1 (lowest resilience) to 5 (highest resilience). None of the self-efficacy or resilience score differed between sports or injury groups ($P \geq 0.10$). None of the self-efficacy scores differed between classes ($P \geq 0.31$), though resilience did ($P = 0.04$) with freshman having lower resilience than seniors (freshman: 3.4±0.50; seniors: 3.9± 011), and sophomores having lower resilience than freshman and seniors (sophomores: 2.9±0.54; freshman: 3.4±0.50; seniors: 3.9±0.11). **Conclusions:** Pre-season self-efficacy and resilience scores demonstrate room for improvement in Division I collegiate gymnasts and rowers. However, they did not differ between sport or injury groups. Resilience, but not self-efficacy, differed between classes with seniors demonstrating the highest resilience. Athletic trainers can use this information to guide interventions, such as SMART goal-setting, to improve self-efficacy and resilience in Division I student-athletes, especially freshman and sophomores.

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Experiences of Current Collegiate Student-Athletes With Mental Health and Mental Health Resources

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Context: There is a stigma surrounding mental health in US culture, but specifically in collegiate athletics. Student-athletes (SAs) are conditioned to be mentally tough and the ability or inability to excel under harsh conditions is often praised or dismissed by coaches and teammates when faced with challenges such as injury or illness. Collegiate SAs experience physical and psychological stressors due to rigid schedules, academic responsibilities, injury, and team conflict. The prospect of failure in balancing demands and athletic performance can cause mental instability that impairs one's self-identity and self-worth. These internal and external factors result in symptoms of mental health conditions, sleep impairment, decreased daily functioning, and suicidality. The mental health of collegiate SAs is a major concern and there are few studies that examine their perceptions of mental health resources. Therefore, the purpose of this study was to explore collegiate SAs lived experiences with mental health, access to and experience with mental health resources available at their college/university. **Methods:** We used a phenomenological approach to explore the lived experiences of 23 NCAA Division 1 SAs (18 females, 5 males; mean age=20+2 years). The participants described their race/ethnicity as White, (n=19, 83%) African American (n=3, 13%), and biracial (n=1,4%). Exclusion criteria were high school students and collegiate SAs who have graduated. Current collegiate SAs were recruited via social media until data saturation was achieved. The participants completed a semi-structured interview following a protocol that included demographic questions as well as those that focused on their experiences with mental health and mental health resources. The interviews were audio-recorded and transcribed verbatim via Zoom (San Jose, CA) web-conferencing platform. Data analysis included a 3-person coding team that reviewed the data using consensual qualitative research tradition to develop domains and core ideas. Credibility and trustworthiness were established via member checking, triangulation, and peer discussion among researchers. **Results:** Two domains: 1) increased expectations and 2) resources and management associated with four core ideas each emerged from the experiences of current collegiate SAs (Figure 1). For increased expectations, the participants shared the core ideas of balancing sport and life as a college student, academic stressors, performance expectations, and an outdated, sport-first, athletics mindset they perceived coaches and support staff embodied and embraced. Additionally, the participants discussed how they used resources and management strategies. This domain encompassed the collegiate SAs' experience with their internal support network that included coaches, the athletic department, and sport psychology. In addition, they remarked on their external support network, which included their family, friends, and personal psychology services. The resources available at their institutions and the accessibility of those resources was perceived as both positive and negative. Collegiate SAs described the resources to be very helpful, whereas other participants described a lack of timeliness for appointments, lack of advertisement, incomprehension of counselors to athlete demands, and no sport specific counseling as barriers. Collegiate SAs who disclosed that they had a mental health condition described management using self-regulation strategies and stated that their stressors were magnified as a SA. For most, self-regulation strategies were very helpful, whereas, for other SAs with mental health conditions, they desired additional coping strategies. **Conclusions:** Collegiate SAs expressed concern with their mental health due to the stress and demands associated with academic and sport participation. Collegiate SAs indicated that self-regulated coping strategies and having a support network continue to be powerful and helpful resources to one's mental health with or without a diagnosed condition. However, some SAs who have used mental health resources at their institutions thought it was not sport specific or accessible. Institutions need to focus on creating athlete-centered mental health resources with appropriate advertisement to increase utilization.

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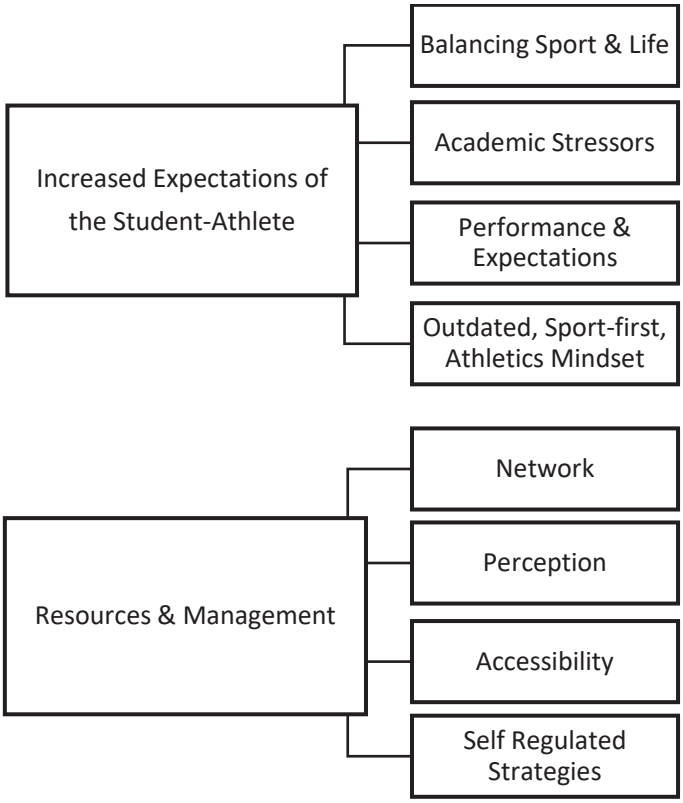

Figure 1. Domains and core ideas

Fear Avoidance Model Elements in Collegiate Young Adults With and Without Musculoskeletal Injury

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Context: The Fear Avoidance Model (FAM) explains why some patients fail to recover from musculoskeletal (MSK) injuries. Fear-avoidance has been reported in both acute and chronic MSK conditions, but it is unknown how injury history influences fear-avoidance beliefs. Many different patient-reported outcomes are available to assess elements of the FAM, but there is also limited evidence how these scales explain variance within the model. Therefore, our objective was to examine elements of the FAM in collegiate young adults with a history of injury, currently injured, and without a history of injury. Our secondary objective was to assess how common scale explain variance within the FAM. We hypothesize those with a current injury will score higher on FAM construct scales and all scales will account for a variability in the FAM. **Methods:** A convenience sample of college students (n=253; gender: 67 males, 186 females; 20.91 ±2.51 years) participated in a cross-sectional online survey. Participants completed a demographics, injury history survey, Pain Anxiety Sensitivity Scale-20 (PASS-20), Fear of Pain Questionnaire-Short Form (FPQ-SF), Pain Catastrophizing Scale (PCS), Anxiety Sensitivity Index (ASI), Tampa Scale of Kinesiophobia-11 (TSK-11), and Fear Avoidance Belief Questionnaire Physical Activity (FABQ-PA) and Sport (FABQ-S). An ANOVA was employed to assess the significance between participants without a history of MSK injury, previous history of injury, and current injury with significance set at $p<.05$. Pearson correlation coefficients were used to compare relationships between scales, and a stepwise linear regression was run to assess variance between FABQ subscales and other scales. **Results:** Participants with a current injury scored higher than healthy controls on the FABQ-PA, FABQ-S, and TSK-11 (mean difference=5.8, $p < .001$; 7.8, $p < .001$; 3.9, $p < .001$). Participants with a history of injury scored higher than controls on the FABQ-PA (mean difference=3.7, $p < .001$) and FABQ-S (mean difference=5.0, $p=.006$). Those with a current injury scored higher than those with a previous history on the FABQ-PA, TSK-11, and PCS (mean difference=22.2, $p=.022$; 4.1, $p < .001$; 5.4, $p=.004$). All scales correlated significantly with the FABQ-PA and FABQ-S at the $p < .01$ level except for the ASI and FPQ-SF. The TSK-11 accounted for a significant amount of variance in both the FABQ-PA ($r2 = .213$, $p < .001$) and FABQ-S ($r2 = .143$, $p < .001$). **Conclusions:** Collegiate-aged adults with a history of MSK injury have higher fear avoidance beliefs than those without a history. Currently injured individuals have higher fear avoidance beliefs and fear of movement compared to the uninjured, regardless of injury history. There was no significant difference in pain-related anxiety, anxiety sensitivity, or fear of pain between groups. Further investigation is needed to explain this disconnect and if group differences also exist in other populations.

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Perceptions of Behavioral Health Specialists at NCAA Power 5 Universities on Athletic Trainers' Roles in Managing Behavioral Health Conditions

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Context: Athletes' psychological responses to injury can unveil or incite mental health issues. Student-athletes are less likely to seek help for mental health than non-athlete counterparts. Developing effective interprofessional teams is vital to achieving quality care for those dealing with behavioral health concerns. Athletic trainers (ATs) are often the first healthcare provider to interact with student-athletes participating in intercollegiate athletics. ATs play a vital role in the healthcare of student-athletes, but research regarding how behavioral health specialists view the role of ATs on interprofessional behavioral health teams is limited. Therefore, the purpose of this study was to explore the views of behavioral health specialist regarding the role, if any, ATs should have in monitoring the treatment, compliance, and progress of behavioral health conditions in NCAA student-athletes. **Methods:** This study utilized a grounded theory approach to explore the lived experiences of behavioral health specialists working with ATs in the college and university setting. We recruited credentialed behavioral health specialists at NCAA Power 5 universities via their publicly available information on institutional websites. Recruitment and data collection continued until data saturation was achieved through repetition of responses. Nine participants (female=6, male=3; age range=30-59 years, years in clinical practice=6-25 years) were interviewed. The participants were from four of the Power 5 Conferences (ACC, SEC, Pac-12, and Big 10). The interview protocol consisted of semi-structured, open-ended questions regarding participants' daily interactions with ATs in order to determine the most effective methods of collaborative care. Interviews were transcribed verbatim, sent to participants for verification, and then coded. Data analysis included a 3-person coding team that reviewed the data using an inductive coding approach for domains and core ideas. Credibility and trustworthiness were established via member checking, triangulation, peer discussion among researchers, and auditing. **Results:** Three domains emerged from the interviews: 1) provider experience, 2) athletic trainer's role in behavioral health, and 3) collaboration. Provider experience included both formal education and interactions with ATs. Sub-themes from the behavioral health specialist's viewpoint on the ATs role in behavioral health included care coordination, information gathering, and positive proximity. Evidence of collaboration included structural collaboration (e.g. office space, shared schedules), cultural collaboration (e.g. staff meetings, shared team presentations), collaboration concerns (e.g. confidentiality, medical independence, role confusion), and suggestions for ideal collaboration. Behavioral health specialists viewed ATs as the first point of contact, noting that how an AT speaks about mental health can dictate what decisions student-athletes make toward their mental health. An AT's positive proximity was described as active and empathic listening, compassion, and utilizing the influence of built relationships. Care teams with strong structural integration experienced more effective cultural collaboration. Physical proximity of behavioral health and athletic training facilities appeared to be highly beneficial. Greater structural and cultural integration of these two healthcare providers led to decreased stigma around behavioral health and was linked with increased care-seeking actions as well as resource utilization by student-athletes. Some concerns of behavioral health specialists in collaborating with ATs were confidentiality, pressure from coaches, ATs already being over-extended, and the sharing on non-medically relevant information. Some suggestions for ideal collaboration included joint trainings, having a decision tree or command structure in place for behavioral health concerns, ATs assisting student-athletes in practicing self-care techniques given to them by the behavioral health specialist, and each provider trusting the other's specialization and training. **Conclusions:** Collaborative models of care can enhance the ability of providers and maximize support of student athlete wellness; this study demonstrates what an effective collaborative care model can look like. Future research should explore how to better equip providers to build a collaborative structure.

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The Association of Negative Life Event Stress or Perceived Stress With Injury: A Critically Appraised Topic

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Context: The stress-injury model theorizes that psychological risk factors, such as negative life event (NLE) stress and personality, increase the likelihood of injury. In athletes, is NLE stress or perceived stress associated with injury? **Methods:** The PubMed database was searched in July 2021 using two Boolean phrases: "psychosocial factors" AND sports injury [MeSH], and "perceived stress" AND sports injury [MeSH]. The article titles, abstracts, and bodies were screened, and relevant articles were chosen based on their ability to answer the clinical question. Articles written in English and comprised of athletes as the subjects were included. Articles were excluded if they were not published within the last five years. The outcome measures gathered related to the probability of NLE stress' association with injury and stress susceptibility and symptoms as they relate to injury. Validated techniques were used to measure NLE and stress. Where pertinent, 95% Confidence Intervals (CI) were calculated. The STROBE checklist for cohort studies determined the validity of each study. **Results:** Forty-eight articles were originally searched, and 3 fit all inclusion and exclusion criteria. In one study, 351 athletes completed NLE surveys throughout the 2-years, and 117 experienced at least one injury. Using a Bayesian model, the study discovered NLE stress +1 standard deviation (SD) from the population mean was correlated to the highest chance of injury. In the second study, 61 athletes completed a stress questionnaire and were divided into three groups: never injured players (NIP), rarely injured players (RIP), and frequently injured players (FIP). Results showed a mean stress susceptibility score of 48.3+8.2 (95% CI [44.95, 51.65]) for NIP, an RIP score of 45.8+5.1 (95% CI [43.30, 48.30]), and an FIP score of 51.7+8.5 (95% CI [48.15, 55.25]). Scores indicated a trend towards FIP having higher stress susceptibility scores than RIP ($p=0.07$). In the third study, 121 athletes completed a stress survey and a 3-month competitive season. There were 0.21+0.52 injuries/person. Using a Bayesian model, the study found athletes who reported more stress symptoms were more susceptible to being injured (ß=0.20, [0.04, 0.38]). The STROBE scores were 21/22, 20/22, and 21/22. **Conclusions:** The evidence demonstrates NLE stress and perceived stress are important variables associated with injury in athletes. A lack of consistency in the types of injuries studied likely weakens the overall significance and the strength of the findings. Future research should explore all injury types and larger sample sizes of athletes representing more sports to determine if conclusions apply to all athletes. The studies provide strong reasoning for athletic trainers to identify and monitor athletes with NLE stress or perceived stress to help decrease their chance of injury. Athletic trainers should use an interprofessional approach to link those in need of care with qualified providers. SORT Grade: B

None of the authors have any financial disclosures.

The Dermatological Presentation of Psychological Distress in a Post-Operative Collegiate Beach Volleyball Player: A Level 4 Clinical CASE Study

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Background: The patient described in this case is a 19-year-old international collegiate beach volleyball player in her first year of college. She has a history of depression, sexual abuse, self harm, as well as suicidal ideation and attempts at suicide. The patient received triangular fibrocartilage complex repair surgery during her first fall semester and then hip labral surgery during her first spring season, prohibiting her from participating and competing for the majority of her first year as a student-athlete. The patient met intermittently with the athletic department's mental health care coordinator but was dissatisfied with the encounters and showed reluctance to continue meeting during her recovery. Approximately 3 weeks following hip surgery, the patient experienced a trigger on social media that led her to partake in self-harming behaviors. The following week, the patient presented to the athletic training facility with full body hives and angioedema of the hands and lips. **Differential Diagnosis:** Differential diagnoses included anaphylaxis, food/medication allergy, systemic infection, hypothyroidism, lymphoma, cholinergic urticaria, and urticarial vasculitis. Given that the chief complaint regarded a dermatological condition, few objective measures could be utilized to come to a diagnosis, leading observation to be the primary evaluative tool. Following the resolution of her symptoms, the patient was referred by the athletic training staff for an allergy test. The physician decided that an allergen test was not necessary. **Intervention & Treatment:** Upon initial evaluation, the patient was treated with Benadryl and Hydrocortisone cream. For the following week, the patient experienced no relief in symptoms while receiving care from numerous different providers including the athletic trainer, a physician at University Health Services, emergency room physicians, and sports medicine fellows. Treatments provided included a Benadryl/Claritin combination, methylprednisolone injection, EpiPen, Prednisone, Famotidine, followed by ceasing the use of all medications except for Benadryl/Claritin and fluoxetine as she tapered off prednisone. After these extensive attempts at treatment with no success, the patient was referred to a psychologist, and shortly after, her symptoms dissipated. Two weeks after the initial complaint, her symptoms fully resolved. In the end, it was determined that the reaction was stress-induced due to the lack of successful treatment following the typical approach for urticaria and angioedema. **Uniqueness:** This case initially presented itself as common urticaria and angioedema. The case became unique when the typical treatment protocol failed to provide relief. At this point in time, the athletic training staff had to re-assess the approach by collaborating with other health care professionals and seeking additional treatment options. In the end, the patient's ailment was not orthopedic or general medical in nature, and thus required a broader consideration of the entire disablement model and health as a multifaceted concept. **Conclusions:** In the clinical setting, it is extremely common to realize that conditions and injuries do not present themselves exactly as learned in a textbook. In instances such as these, one must take a step back and look further into the patient history and the other domains of health to find the answers. In this case, the patient presented with typical allergic urticaria and angioedema until provided with the standard treatment for this condition. At that point, the athletic training staff and collaborating physicians had to take a more comprehensive examination and consider what other aspects of the athlete's life could be contributing to this reaction. Through that, it was found that the environmental and personal factors of the International Classification of Functioning Disablement Model led to the discovery of the underlying causes of the patient's condition. If the Disablement Model and collaborative healthcare team had not been utilized, the patient likely would have been left without a definitive diagnosis and treatment plan.

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Use of the Risky, Impulsive, and Self-Destructive Behavior Questionnaire to Compare Harmful Behaviors Among Dancers According to Sexual Orientation and Gender Identity

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Context: Athletic trainers are opportunely situated to identify dancers at risk of engaging in harmful behaviors. There is a dearth of information about whether lesbian, gay, bisexual, transgender, queer/questioning (LGBTQ+) dancers, who often experience increased psychosocial risk factors, are at increased risk of engaging in harmful behaviors compared to their heterosexual cisgender counterparts. This study describes which harmful behaviors dancers participate in as described by the Risky, Impulsive, and Self-Destructive Behavior Questionnaire (RISQ) and according to self-reported sexual orientation and gender identity (SOGI). This study was partially funded by the National Athletic Trainers' Association Research & Education Foundation. **Methods:** 66 dancers from 2 dance universities and 5 professional dance companies were recruited for this study. All participants completed an on-line survey including basic demographic information along with the RISQ. In order to determine if there was statistical association between RISQ and SOGI in dancers amongst 4 subgroups (cisgender heterosexual female (CHF), cisgender heterosexual male (CHM), LGBTQ+ female (LGBTQ+F), LGBTQ+ male (LGBTQ+M)), chi-squared, independent t-test and ANOVA tests were used. RR [95% CI] was reported. P-value of <0.05 was considered significant. **Results:** SOGI groups differed statistically in total RISQ score for behaviors: difficulty stopping eating (p=0.50); gambling illegally (p=0.036); betting on sports, horses or other animals (p=0.036); buying expensive items that cannot be afforded at the spur of the moment (p=0.019); and drinking 5 or more alcoholic drinks in 3 hours or less (p=0.013). Between-group frequency comparison revealed: the LGBTQ+M group were 92% more likely to have unprotected sex with someone they just met or did not know well ($p < 0.001$) and 83% more likely to use hallucinogens, LSD, or mushrooms (p=0.018) than the other three groups combined; the LGBTQ+F and LGBTQ+M groups were 4.4 times more likely to buy drugs (p=0.01) and 4.88 times more likely to think about killing themselves (p=0.023) than the other two groups; and the CHM and LGBTQ+M groups were 12.8 times more likely to steal money (p=0.006) than the other two groups. **Conclusions:** Harmful behaviors associated with sexual orientation and gender identity should be taken into consideration as part of a biopsychosocial model of health when dancers are treated in order to improve outcomes and quality of life. Athletic trainers would benefit from knowing when to screen dancers for drug use, self-harm, risky sexual behavior, impulsive financial practices and impulsive eating in order to prevent, educate, and improve outcomes as well as quality of life for dancer patients. Athletic trainers should build a healthcare network consisting of, among other providers, clinical psychologists, psychiatrists, social workers, addiction specialists, financial advisors and nutritionists in order to better serve the holistic needs of dancers.

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Perception of Lateral Ankle Sprains in Middle School Student Athletes

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Context: Ankle sprains are the second most common injury in youth athletes, of which, 85% are lateral ankle sprains. An athlete's perception of an injury may play an important role in the overall outcome of recovery, future care, and attitudes toward the injury. Assessing an athlete's perceptions may reveal current patterns and discrepancies in care that are available for lateral ankle sprains. The purpose of this study was to evaluate the perceptions of lateral ankle sprains in middle school student athletes using an online survey. **Methods:** A cross-sectional study was performed to investigate perceptions of ankle sprain in middle school student athletes through an online survey using Qualtrics. A total of 418 students were recruited through convenience sampling from middle schools located in central Texas. Parental consent and minor assent were documented. Participants completed a 27-question survey recording demographics, ankle sprain history, perceptions of ankle sprains, and knowledge of ankle sprains. Age, sex, ethnicity, grade, and sport participation were included for demographics. History of ankle sprain and number of previous sprains were collected. Perception questions pertained to perceived significance of ankle sprain injury, pressure to return to activity, psychosocial aspects of recovery, and feelings of support. Knowledge questions assessed the participants' understanding of ligamentous tears for an ankle sprain and if history of ankle sprain predisposed them to future ankle sprains. This survey was modified from a previous study on ankle sprain perceptions in collegiate athletes. Descriptive statistics (frequency, mean, standard deviation) were calculated for all questions and chi-square analyses were used to assess associations between categorical variables for demographics, ankle sprain history, ankle sprain perception and ankle sprain knowledge questions using Qualtrics stats-IQ. **Results:** Of the students recruited, 309 (198 Female, 11 Male) received parental consent, provided assent to participate, and completed the survey. The majority (49.2%) identified as Hispanic or Latinx origin, followed by multi-ethnic (22.9%), and other (11.7%). Most participants (54%) had not had an ankle sprain. Of the individuals that had sprained their ankle, 34% thought ankle sprains were a serious injury and of those who had not sprained an ankle, 46% thought ankle sprains were a serious injury ($p= 0.0226$). Most participants (92%) reported that they would notify a coach, parent, school nurse, or athletic trainer about their ankle injury. Similarly, 67% of the participants reported that they believed ankle sprains would lead to long-term consequences. **Conclusions:** This study provides a preliminary understanding of perceptions and attitudes of ankle sprains in middle school student athletes. Most athletes reported ankle sprains were not a serious injury but would report the injury to a healthcare provider. Future research should aim to obtain a deeper understanding of perception in these young athletes by administering the questionnaire in various middle school populations.

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Perceptions of Lateral Ankle Sprain in Middle School Athlete's Parents and Guardians

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Context: Parents and guardians play an imperative role in determining the medical services for their children. Perceptions of injury may be an essential factor for reporting an injury and receiving appropriate treatment. The second most common musculoskeletal injury in the youth population are ankle sprains. The purpose of this study was to understand the perceptions of ankle sprains in parents/guardians of middle-school aged athletes. **Methods:** A cross-sectional study was performed to investigate perceptions of ankle sprains in parents/guardians of middle school athletes using an online survey. Parents/guardians received an email with a link to a Qualtrics survey. The survey was modified from a previous study on perception of ankle sprains in college athletes. The survey consisted of 27 questions regarding demographics (age, sex, ethnicity, education level, insurance status, annual household income), child's history of ankle sprains, perceptions of ankle sprains (significance of injury, costliness, if activity should be discontinued, if injury should be reported, if care should be sought), and knowledge of ankle sprains (understanding of ligamentous tears, if history of ankle sprain predisposed child to subsequent ankle sprains or further serious injury). Descriptive statistics (frequency, mean, standard deviation) were calculated using Qualtrics stats-IQ. **Results:** A total of 107 parents/guardians received the email, 93 provided consent to participate, and 88 respondents completed the survey in its entirety. Of the respondents, 88.2% received a high school degree or higher, 68.0% reported annual household income >$50,000, 93.6% reported having health insurance, and 47.3% reported their child had a history of ankle sprain. Parents/guardians felt that ankle sprains were a serious injury (65.9%), that their child should tell them if they sprained their ankle (98.9%), and that their child should not play or practice if they had ankle pain (97.7%). Most parents/guardians (70.5%) reported that having an ankle sprain could increase the chances of suffering another ankle sprain and that damage to the ligaments following an ankle sprain might cause long-term problems. Less than half of parents/guardians (46.6%) reported that an ankle sprain would lead to more serious injuries. In addition, 64.8% of parents responded that if their child sprained their ankle, they should seek care from a health care provider. Lastly, 21.6% of respondents believed ankle sprains are a costly injury. **Conclusions:** The majority of parents and guardians reported that ankle sprains were a serious injury and they would remove their child from activity if they have pain. They also understood that ankle sprains could increase the chances of subsequent injury, however, less than half thought it would lead to a more serious injury. Surprisingly, many parents did not think that ankle sprains are a costly injury which may be related to their income and access to healthcare.

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Recall of Concussion Symptoms Within a Nationwide Survey of United States Parents of Middle School Children

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Context: Concussion knowledge assessments usually involve scale measures that assess the ability to identify specific symptoms. Such measures may overestimate/artificially inflate knowledge for two reasons: 1) providing symptom options not previously considered, and 2) offering limited response options that may lead to correct responses by random means. The inability to accurately appraise parental knowledge of concussions may result in inaccurate conclusions regarding their concussion-related knowledge and care-seeking behaviors for their children. This cross-sectional study assessed concussion symptom knowledge of parents of middle school (MS) children (aged 10-15 years) through a free-response item that solicited concussion symptoms and compared findings to a pre-validated scale-based measure. **Methods:** During September-October 2018, a self-administered online questionnaire was sent to a panel of randomly selected United States residents who were recruited by a third-party company, aged ≥18 years, and identified as parents of MS children. Of the 1,362 parents agreeing to participate; 80.0% (n=1062) met eligibility criteria and provided complete study data. Most were female (65.7%), aged 30-49 years (71.8%), White/non-Hispanic (58.9%), and had MS children participating in organized sports within the past year (74.2%). The questionnaire was modified from a previously validated instrument, with pretesting performed with a sample of MS parents to ensure face validity. Via a free-response item, parents listed what they believed were concussion symptoms. Multiple sections later, parents identified potential concussion symptoms via a scale measure, which featured 25 items (22 actual symptoms, three distractor symptoms) with three response options: yes, no, maybe. The free-response items responses were coded into specific symptoms, with high agreement found among coders in 100 randomly selected cases (K=0.90). The proportions of symptoms reported via the free-response item, and "yes" responses for the 22 real symptoms on the scale-based measure were calculated. McNemar odds ratios (OR) compared the identification of symptoms recalled between measures. ORs with 95% confidence intervals (CI) excluding 1.00 were statistically significant. **Results:** On the scale-based measure, commonly identified symptoms were dizziness (90.2%), blurred vision (87.2%), and balance problems (86.4%). Across the sample, the free-response item yielded 70 unique symptoms (mean±SD=3±2); common identified symptoms between the scale-based measure and identified via the free-response item included headache (49.5%), dizziness (44.4%), and nausea/vomiting (28.0%; Table). The proportion of participants reporting each symptom was smaller via the free-response item versus the scale-based measure [e.g., dizziness via scale-based measure (90.2%) versus free-response item (44.4%); McNemar OR=0.04; 95%CI:0.03-0.07]. **Conclusions:** Concussion symptoms commonly reported via the scale-based measure were reported less frequently within the free-response item. Suggestive aids (such as pre-existing list of symptoms included in scale-based measures) may overestimate/artificially inflate knowledge. However, future research must explore strategies to help clinicians working with parents and their young children to best measure and assess concussion symptom reporting and knowledge.

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Table. Comparison of concussion symptoms recalled via scale measure and free-response

Symptoms	Yes" on scale measure, n (%)	Free-response item, n (%)	McNemar odds ratio (95%CI)
Headache	877 (82.6)	526 (49.5)	0.11 (0.08, 0.15)*
Dizziness	958 (90.2)	472 (44.4)	0.04 (0.03, 0.07)*
Nausea/vomiting	833 (78.4)	297 (28.0)	0.03 (0.02, 0.05)*
Confusion	905 (85.2)	229 (21.6)	0.02 (0.01, 0.04)*
Blurred vision	928 (87.4)	175 (16.5)	0.009 (0.004, 0.02)*
Fatigue or low energy	655 (61.7)	151 (14.2)	0.04 (0.02, 0.06)*
Difficulty remembering	861 (81.1)	149 (14.0)	0.02 (0.01, 0.03)*
Balance problems	917 (86.4)	37 (3.5)	0.003 (0.001, 0.01)*
Sensitivity to light	698 (65.7)	34 (3.2)	0.003 (0.001, 0.01)*
Drowsiness	803 (75.6)	31 (2.9)	0.006 (0.003, 0.02)*
Feeling like "in a fog"	811 (76.4)	12 (1.1)	0.003 (0.001, 0.01)*
Feeling slowed down	675 (63.6)	12 (1.1)	0.005 (0.001, 0.01)*
Difficulty concentrating	845 (79.6)	11 (1.0)	0.004 (0.01, 0.01)*

* Denotes statistical significance (i.e., 95%CI excluded 1.00); Symptoms with n<10 in free-response item are excluded from table: Don't feel right (n=7), Irritability (n=7), Neck pain (n=7), Nervous/anxious (n=5), Sadness (n=5), Sensitivity to noise (n=4), "Pressure in the head" (n=4), Trouble falling asleep (n=0), More emotional (n=0).

Testicular Pain in a Middle School Athlete

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Background: The athlete is an 12 year old male football athlete. He is 67" (1.7m) tall, weighing 154lbs (70kg). During a practice drill he was hit in the groin by another player's knee as he attempted to make a tackle. He stated that he had pain in his testicle but was able to return to practice. Later that evening the athlete reported the pain in his testicle rapidly progressed in severity. He was taken to an ED for evaluation and treatment. **Differential Diagnosis:** testicular contusion, testicular torsion, testicular infarction **Intervention & Treatment:** Upon arrival to the local ED, the patient was given morphine and Zofran. The medication did not produce the desired effect. The patient was transferred to another ED for further evaluation. He presented with scrotal swelling and vomiting. Patient underwent an ultrasound evaluation. Ultrasound noted a decreased vascularization of the right testicle. Upon inspection, the testicle was enlarged, firm, TTP with a horizontal lie. There was concern for a ruptured testicle. The patient was taken to the OR for an emergency scrotal exploration. During surgery it was noted the spermatic cord was twisted 180 degrees. The cord was then detorsed. The testicle appeared to have an infarction. It was dissected and found to have no active blood flow. At that time the decision was made to remove the testicle to prevent an infection. The patient was released the next day with instructions for pain control, told to avoid activities for 2-3wks, use scrotal support x2 weeks. He will be seen for follow up in 3 months. He was instructed to wear a cup when playing all contact sports. **Uniqueness:** The mobility of the scrotum and testicles allow for the avoidance of blunt trauma in most instances. Traumatic testicular torsion is rare with a reported incidence of about 4%–8% of all testicular torsion; Ann et al (2021) **Conclusions:** Any time an athlete suffers trauma to the testicles, torsion and the following infarction must be considered. The possibility and symptoms should discussed with the patient. To make an accurate diagnosis doppler ultrasound evaluation must be completed along with a detailed medical history. Sayjo et al (2021)

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The Epidemiology of Injuries in Middle School Girls Basketball Between the 2015/16 and 2019/20 School Year

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Context: Participation in girls' basketball has increased nationwide. Studies have reported the incidence of injury among collegiate and high school women's basketball players; however, limited research describes injuries among players at the earliest levels of organized basketball. The purpose of this study is to describe the epidemiology of injuries in middle school girls' basketball. **Methods:** Our retrospective descriptive epidemiology study reviewed injury data for 16 middle schools as part of the Advancing Healthcare Initiatives for Underserved Students (ACHIEVES) project located in Virginia between the 2015/16 and 2020/21 school years. Certified athletic trainers collected injury and athlete exposure (AE) data for all games and practices for the school-sponsored girls' basketball teams. Injuries were classified as non-time loss (NTL; <24 hours participation restriction) and time loss (TL; ≥24 hours participation restriction). Time loss was further categorized: mild (1-6 days), moderate (7-21 days), and severe (>21 days) restriction of activity. An AE was defined as one athlete participating in game or practice. Injury frequencies and rates (IRs) were calculated. Injury rate ratios (IRR) with 95% confidence intervals (CIs) compared IRs between games and practices. IRRs with 95% CIs excluding 1.0 were considered statistically significant. **Results:** Overall, 1,033 injuries were observed (IR=27.84/1000AE; 95% CI: 26.14-29.54) during 37,107 AEs: (games=11,071 AEs; practices=26,036 AEs). Girls were more likely to sustain an injury during basketball games (n=406; IR=36.67; 95% CI:33.11-40.24) than practices (n=627; IR=24.08; 95% CI:22.20-25.97; IRR=3.6, 95% CI:2.45-4.71). There was a greater proportion of NTL injuries (n=770, 74.5%; IR=0.75; 95% CI:19.29-22.22) than TL injuries (n=260, 25.2%; IR=7.86; 95% CI:6.16-7.86). The IR for TL injuries was greater during games than practices (10.57 versus 5.49/1000AEs; IRR=1.93; 95% CI:1.12-11.51). The most common TL injuries were strains (n=97, 37.3%), followed by contusions (n=61, 23.5%), and concussions (n=21, 8.1%; IR=0.57/1000AE). Most frequently TL injuries were caused by non-contact (n=68, 26.2%; IR=1.83/1000AE), ball contact (n=40, 15.4%; IR=1.08/1000AE) or player contact (n=35, 13.5%; IR=0.94/1000AE) mechanisms. Among TL injuries, the majority were categorized as mild (n=207, 79.6%) followed by moderate (n=34, 13/1%) and severe (n=19, 7.3%).**Conclusions:** Middle school girls' basketball players experienced higher injury rates than that of their high school and collegiate counterparts. girls were 3.6 times more likely to sustain an injury during a game than a practice. Although, most injuries resulted in NTL, we also observed the rate of TL injuries to also be higher than previously reported. Collectively, these findings reinforce the importance of onsite athletic training services within middle school sport settings. Further research is needed to better understand injury patterns and inform developmentally appropriate and sport-specific strategies to reduce injury within middle school girls' basketball.

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The Epidemiology of Injuries in Middle School Softball

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Context: Softball is a popular team sport in the United States with more than 2 million females participating between 12-18 years of age. Research examining high school, and collegiate softball demonstrate higher injury rates in competition than practice with most injuries caused by non-contact or overuse mechanisms. However, research examining injury among the younger and less experienced softball athletes is lacking. Therefore, the purpose of this study was to describe the epidemiology of injuries in middle school softball. **Methods:** Data originated from nine public middle schools in northern Virginia between the 2015/2016 and 2018/2019 academic years. Certified athletic trainers documented injury and athlete exposure (AE) data during all practices and competitions for school-sponsored softball teams. An AE was defined as one athlete participating in one school sponsored competition or practice. Injury frequencies and rates (IRs) per 1000 AEs were calculated by competition and practice, body part, mechanism of injury (MOI), diagnosis, and injury severity. Injury rate ratios (IRR) with 95% confidence intervals (CI) were calculated to compare IRs between competition and practice. IRRs with 95% CIs excluding 1.0 were considered statistically significant. Injuries were classified as non-time loss (NTL; <24 hours participation restriction) or time loss (TL; ≥24 hours participation restriction). Within TL, injury severity was categorized as mild (1-6 days), moderate (7-21 days), and severe (>21 days) of participation restriction. **Results:** Overall, 153 injuries were reported across 12,845 AE (IR=11.91, 95% CI=10.02-13.80). Injury rates were similar (IRR=1.15; 95% CI=0.00-3.04) between competition (n=48, IR=13.10) and practice (n=105, IR=11.44). Most injuries (95.4%) were minor resulting in NTL (n= 95 [62.1%], IR=7.40, 95% CI=5.91-8.89) or mild TL (n= 51 [33.3%], IR=3.97, 95% CI=2.88-5.06). The most frequent NTL body parts injured were hand/wrist (n=26 [27.4%]), head/face (n=16 [16.8%]), and lower leg (n=13 [13.7%]). Frequent diagnosed NTL injuries were contusions (n=36 [37.9%]), strains (n=16 [16.8%]) and abrasions (n=15 [15.8%]. The most frequent MOI for NTL injuries were ball contact (n=42 [44.2%]), non-contact (n=11 [11.6%]), and surface contact (n=11 [11.6%]). The most frequent TL body parts injured were head/face (n=13 [22.4%]), hand/wrist (n=10 [17.2%]), and ankle (n=9 [15.5%]). Frequent diagnosed TL injuries were contusions (n=21 [36.2%]), strains (n=10 [17.2%]) fractures (n=3 [5.2%]). The most frequent MOI for TL injuries were ball contact (n=26 [44.8%], non-contact (n=10 [17.2%]), and overuse (n=5 [8.6%]) **Conclusions:** Our study suggests the rate of injury to be similar between competition and practice in middle school softball and does not align with previous research involving higher levels of softball. Middle school softball athletes sustained a variety of injuries which were most frequently attributed to ball contact. Our findings warrant further investigation to identify possible coaching and player skill acquisition strategies to reduce ball contact related TL injuries in middle school softball.

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Table. Injury Mechanism by Event Type

	Competition				Practice			
Injury Mechanism	Injury, n	IR (95% CI)[a]	NTL, %[b]	TL, %[c]	Injury, n	IR (95% CI)[a]	NTL, %[b]	TL, %[c]
Contact	-	-	-	-	-	-	-	-
Ball	22	6.00 (3.50-8.51)	82.0	18.0	46	5.01 (3.56-6.46)	52.2	47.8
Equipment	-	-	-	-	1	0.11 (0.00-0.32)	100	-
Non-Specific	3	0.82 (0.00-1.75)	66.7	33.3	2	0.22 (0.00-0.52)	100	-
Player	1	0.27 (0.00-0.80)	-	100.0	3	0.33 (0.00-0.70)	100	-
Surface	7	1.91 (0.49-3.33)	71.4	28.6	8	0.87 (0.27-1.47)	75.0	25.0
Non-contact	6	1.64 (0.33-2.95)	50.0	50.0	14	1.52 (0.72-2.32)	57.1	42.9
Illness/Infection	2	0.55 (0.00-1.31)	50.0	50.0	2	0.22 (0.00-0.52)	50.0	50.0
Overuse	3	0.82 (0.00-1.75)	66.7	33.3	12	1.31 (0.57-2.05)	66.7	33.3
Unknown	3	0.82 (0.00-1.75)	33.3	66.7	8	0.87 (0.27-1.47)	62.5	37.5
Total	48	13.10 (9.40-16.81)	66.7	33.3	105	11.44 (9.25-13.63)	60.0	40.0

[a]Includes injury rates per 1000 athlete exposures

[b]Includes injuries that resulted in participation restriction <24 hours.

[c]Includes injuries that resulted in participation restriction >21 days for the mechanism.

An Examination of the Relationship Between Anterior Talofibular Ligament Thickness and Time-to-Stability

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Context: Ligaments contribute as the static component to the stability of a joint. During a lateral ankle sprain, the anterior talofibular ligament (ATFL) is the most commonly injured ligament. After ankle sprains, morphological changes can occur, presenting as a thicker ligament. Further, those suffering from recurrent ankle sprains often have residual symptoms of impaired balance and stability. Therefore, the purpose of this study was to examine the relationship of ATFL thickness to time-to-stability (TTS) measures. **Methods:** Using a cross-sectional study design, 141 college-aged participants were recruited for this study (74 males, 67 females, mass = 78.9 ± 19.8 kg, height = 178.2 ± 11.8 cm, age = 18.5 ± 0.79 years). Participants were excluded if they had a previous lower extremity fracture, an existing neurological condition, or an ankle sprain within 6 months of data collection. In a laboratory setting, images of the ATFL were captured using a musculoskeletal ultrasound. Using the ultrasound machine, thickness of the ATFL was measured at the midpoint of the ligament. The Multi-Directional Dynamic Stability Protocol was used to measure TTS, jumping over a hurdle and landing single-legged onto a force platform from four different directions. TTS was quantified as the time it took the vertical force component of the ground reaction force to reach and stay within ± 5% of the participant's body weight after landing. Ligament width was normalized with the thickness of the ligament to the participant's body mass. A Pearson correlation coefficient was used to analyze the relationship between normalized ligament width and TTS in the four jump-landing directions. Statistical significance was set at $P < 0.05$. **Results:** Thickness of the left ATFL was 2.02 ± 0.39 mm. TTS (in sec) for the left leg in the forward, backward, medial, lateral jump-landing directions were 1.06 ± 0.54, 1.03 ± 0.49, 1.04 ± 0.46, 1.08 ± 0.55, respectively. Thickness of the right ATFL was 2.16 ± 1.48 mm. TTS (in sec) for the right leg in the forward, backward, medial, lateral jump-landing directions were 1.08 ± 0.49, 1.00 ± 0.53, 1.02 ± 0.52, 1.06 ± 0.59, respectively. When examining the correlation between ATFL thickness and TTS, there were no statistically significant relationships between normalized ligament width of the ATFL and TTS in all four jump landing directions (see table for P and r values). **Conclusions:** While this current study did not find a relationship between ATFL thickness and TTS, this study created a foundation for understanding the contributing factors to balance and stability. When examining contributions to stabilization, the static and dynamic components of the stabilizers of a joint cannot be simply separated without the recognition of the combination of each of the contributions.

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Table. Correlation between Ligament Thickness and Time-to-Stability

	Left Leg		Right Leg	
Jump-Landing Direction	P-value	Pearson's r	P-value	Pearson's r
Forward	0.786	-0.023	0.508	0.056
Backward	0.133	0.127	0.944	-0.006
Medial	0.777	-0.024	0.99	0.001
Lateral	0.122	0.131	0.636	0.04

Computerized Cognitive Function Does Not Correlate With Choice-Reaction Time During a Hopping Task

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Context: Cognitive performance has been shown to be associated with musculoskeletal injury risk. Assessments evaluating cognitive performance are often administered in a controlled environment with minimal disruption. However, sport settings typically challenge cognition in uncontrolled, less predictable environments while performing motor activities, potentially reducing the external validity of cognition-only measures. Cognitive assessments should be representative of sport demands, thus integrating both motor and cognitive assessments may be more representative and clinically relevant. Accordingly, the purpose of this research was to investigate the relationship between performances on tablet-based cognitive tests and choice-reaction time during a hop-to-stabilization task in healthy participants. **Methods:** Twenty-two healthy participants (10 male, 12 females; age: 22.41±3.081y; height: 172.14±9.34cm; mass: 72.20±12.27kg) volunteered to participate. Participants completed three tablet-based cognitive assessments including the Flanker Inhibitory Control and Attention Test, Dimensional Change Card Sort Test, and Pattern Comparison Processing Speed Test, examining inhibitory control and attention, cognitive flexibility, and processing speed, respectively. A composite score was calculated from the fully-corrected scores of the tests. Additionally, participants completed a choice-reaction hop-to-stabilization task to capture motor-cognitive reaction time. Beginning in a double-limb stance, participants completed a forward hop over a 30.5cm hurdle, landed on a single limb in the target area (a distance of 40% of participants' height). Two light sensors were utilized for the choice-reaction component of this assessment. One light sensor was attached to a pole 360cm in front of the participant at eye level to cue them when to hop and which limb to land on (red indicating the right limb, green indicating the left limb). A second light sensor that was in sync with the first was attached to the hurdle to capture reaction time. The light sensor was deactivated when the participant jumped and was within 40cm. To begin the task, participants attention was focused on the first sensor in front of them. Participants were instructed to hop immediately once illuminated. Reaction time was measured as the time (seconds) from activation to deactivation. The relationship between the tablet-based cognitive assessments and the hop-to-stabilization reaction time were examined with Pearson's correlations (alpha=0.05). **Results:** The hop-to-stabilization reaction time (1.26±0.18 s) had a weak correlation to the Flanker Inhibitory Control and Attention Test (49.73±13.10, r=-0.14, p=0.54), Dimensional Change Card Sort Test (61.18±7.37, r=-0.24, p=0.28) and Pattern Comparison Processing Speed Test (57.95±17.98, r=-0.03, p=0.90). **Conclusions:** This study determined that tablet-based cognitive assessments had weak relationships to choice-reaction time on the hop-to-stabilization task. Although reaction time was a critical component of all the assessments in this study, they may be challenging different aspects of cognition and to varying degrees. The extent to which tablet-based and functional cognitive assessments complement each other in identifying musculoskeletal injury risk requires further investigation.

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Perceptual-Motor Accuracy, and Not Remote Concussion History, Is Indicative of Frontal Plane Single-Leg Squatting Mechanics

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Context: Recent research indicates that individuals who sustain a concussion are at increased risk of subsequent lower extremity musculoskeletal injury. Deficits in dynamic neuromuscular control and resultant reductions in quality of lower extremity biomechanics may arise following concussive injury. The purpose of this study was to determine whether perceptual-motor function measured via a smartphone-based flanker task and history of concussion demonstrated isolated or combined influences on single-leg squatting biomechanics. **Methods:** A cross-sectional study was conducted in a convenience sample of 58 females (22.2 ± 3.5 yrs, 1.6 ± .07 m, 64.1 ± 13.0 kg, 14 with prior concussion) and 35 males (23.5 ± 5.0 yrs, 1.8 ± .06 m, 84.7 ± 15.3 kg, 9 with prior concussion) free of musculoskeletal injury, vertigo, and vestibular conditions for 6 months prior. A smartphone-based flanker test presented twenty randomized flanker sets (e.g., <<<<< or <<><<), and participants were instructed to rapidly tilt the phone in the direction of the center arrow. Reaction time (RT), efficiency index (EI; reaction time penalized by incorrect response percentage), and conflict effect (CE; time cost of responding accurately to incongruent trial v. congruent trial) were calculated. Squat testing consisted of three single-leg squats on each limb while a single camcorder filmed from a frontal plane view. Retroreflective markers adhered to seven landmarks were used for extraction of the frontal plane angles of peak trunk lean, peak contralateral pelvic drop, and medial knee projection angle from the point of maximum knee flexion. Backward stepwise regressions were conducted for each kinematic variable and all analyses were stratified by sex. Interactions between concussion history and each flanker variable were assessed. R2 values of 0.10 or greater were considered meaningful. **Results:** In females, greater contralateral pelvic drop during right leg squatting ($R2 = .31$, $p < .001$) associated with the combination of lower RT ($\beta = -0.03$), higher EI ($\beta = 0.017$), and lower CE ($\beta = -0.006$). Greater contralateral pelvic drop during left leg squatting ($R2 = .10$, $p = .06$) associated with the combination of lower RT ($\beta = -0.014$) and lower CE ($\beta = -0.002$). In males, greater contralateral pelvic drop during right leg squatting ($R2 = .11$, $p = .05$) associated with lower EI ($\beta = -0.027$). Concussion history amplified the relationship between lower RT ($\beta = -0.152$) and lower CE ($\beta = -0.017$) to result in greater medial knee projection angle during left leg squatting ($R2 = .20$, $p = .08$). **Conclusions:** Remote concussion history was not associated with two-dimensional frontal plane kinematics, though lower reaction time and worse accuracy were predictive of contralateral pelvic drop in males and females. Future work should determine the point at which perceptual-motor function resolves following concussion.

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Activation of the Posterior Shoulder Muscles on a Pool-Based Surfboard

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Context: Paddling on a surfboard may be beneficial for overhead athletes due to the activation the posterior shoulder musculature, however, surfboards are expensive and available to a limited population. A smaller alternative designed for an indoor pool may increase accessibility, but it must be determined if this board creates similar posterior shoulder activation. Therefore, the purpose of this study is to measure posterior shoulder muscle activation during different phases of the surf stroke (propulsion vs recovery) on a small, pool-based surfboard. **Methods:** Twenty recreationally active participants were recruited to participate in a cross-sectional study (sex: 10M, 10F, age: 20.9 ± 2.2 years, height: 168.6 ± 9.7 cm, mass: 69.6 kg ± 11.5kg). All participants completed a familiarization session with the pool-based surfboard. During the testing session, electromyography (EMG) sensors were placed on six posterior shoulder muscles: latissimus dorsi, infraspinatus, posterior deltoid, upper trapezius, middle trapezius, and lower trapezius. Another sensor was placed on the participants' right hand to determine when the hand was in the water (propulsion phase) versus out of the water (recovery phase). After waterproofing the EMG sensors, the participants completed four 25-meter laps in a pool at 3 separate resistances (low, moderate, and heavy) in a randomized order. EMG signal was rectified, smoothed, and reduced into one final EMG wave for each muscle at each resistance level. The peak EMG signal during each phase was taken from this waveform and used for data analysis. A two-way within subject ANOVA (resistance-by-phase) with post-hoc Bonferroni corrections were used to identify any differences in posterior shoulder EMG activation. **Results:** There was a significant main effect of phase for the latissimus dorsi ($F=91.3$, $p<0.001$), upper trapezius (36.5, $p<0.001$), middle trapezius ($F=33.8$, $p<0.001$), and lower trapezius ($F=21.6$, $p<0.001$). Post hoc testing revealed higher activation in the latissimus dorsi during the propulsion phase (difference=35.8%, $p<0.001$), and all trapezius muscles demonstrated higher activation during the recovery phase (Upper Trapezius mean difference=16.3%, Middle Trapezius mean difference=15.2%, Lower Trapezius mean difference=18%, $p<0.001$). There was a significant main effect of resistance for the posterior deltoid ($F=3.4$, $p=0.043$), with post-hoc testing revealing higher muscle activation in the low resistance trials compared to the heavy resistance trials (difference=4.5%, $p=0.036$). There were no significant differences in activation of the infraspinatus. The waveforms are presented in Figure 1. **Conclusions:** The results indicate activation of the posterior shoulder musculature during the surf stroke in recreationally active individuals. This pool-based surfboard may be beneficial to activate the posterior musculature and may be more accessible than standard surfing. Future research should identify long-term changes that result from surf training, especially in overhead athletes, as it may increase shoulder musculature endurance, posture, or scapular kinematics.

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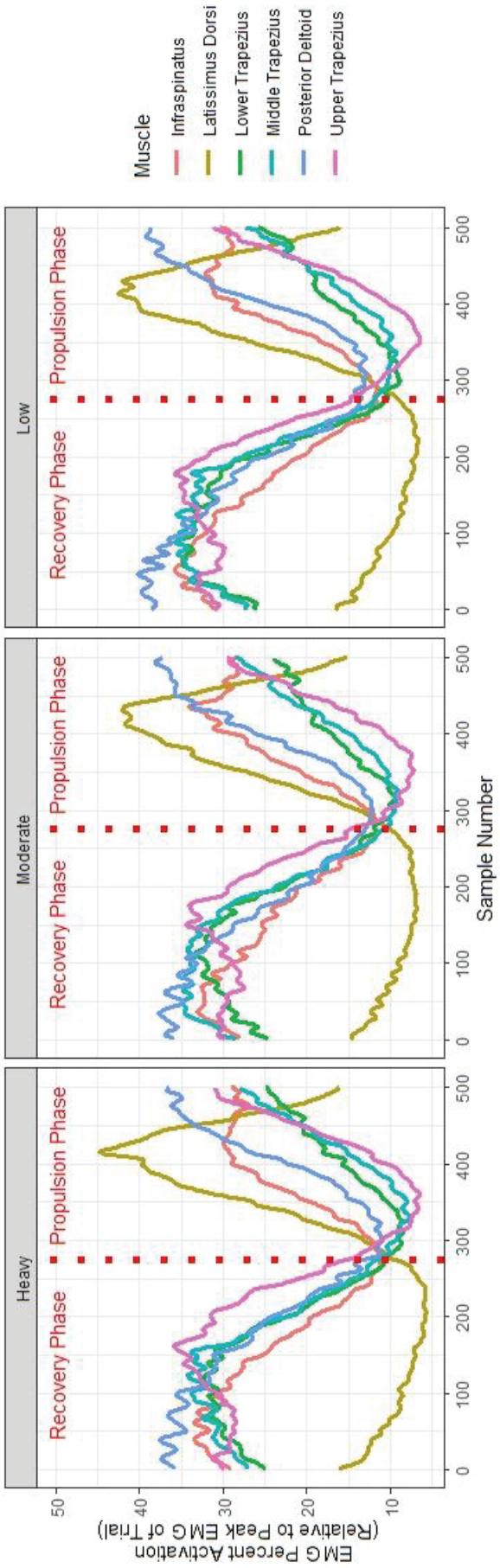

Figure 1. EMG waveforms between recovery and propulsion phases across different resistance intensities.

Relationship Between Neuromuscular Factors and Virtual Reality Agility Performance Screenings

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Context: With advancements in technology, virtual reality motion analysis systems are more readily available for clinicians to assess athlete performance to identify those at increased risk of injury. However, there is limited evidence that identify the neuromuscular factors that relate to agility deficits using these motion analysis systems. Understanding these relationships are a necessary step toward developing appropriate and effective intervention programs in response to agility screening outcomes. Therefore, the purpose of this study was to examine the relationship between neuromuscular factors and measures of agility performance using a virtual reality motion analysis system. **Methods:** Twenty healthy individuals (10M, 10F: 23.3±1.9yrs, 83.6±23.3kg, 173.9±11.2cm) participated as part of this cross-sectional, field-based study. Neuromuscular factors of strength, power, and endurance of the core and lower extremity were assessed using common clinical methods. Peak isometric hip abduction and extension strength (kg) were assessed with a hand-held dynamometer. Single-leg forward hop (SH) and lateral triple hop (LH) for distance were recorded to the nearest cm. Core muscle endurance was assessed using the valid and reliable sport-specific plank test and recorded as the time (s) to failure. Agility performance was assessed using a virtual reality motion analysis system (TRAZER,TRAQ Global, LTD, Westlake, Ohio) during lateral (LAS) and diagonal (DAS) reaction performance screening tests. Performance outcomes included speed (m/s), acceleration (ACC, m/s2), and deceleration (DEC, m/s2) during each performance test. All measures were taken on both the dominant (DOM) and nondominant (ND) limb. The average of 3 trials for each neuromuscular factor and the maximum of each of the agility performance outcomes across 2 trials were used for analyses. Pearson Product-Moment correlations were used to examine the relationship between neuromuscular factors and agility performance. Significance was set at $P < 0.05$. **Results:** Core endurance (96.0±44.6 s), DOM SH (163.0±33.5 cm), DOM LH (346.4±86.0 cm), ND SH (159.4±32.0 cm), ND LH (343.1±79.6 cm) and DOM hip extension strength (59.6±22.9 kg) ND hip extension strength (56.2±19.5 kg) were positively correlated ($P < 0.05$) with agility performance during the LAS and DAS and are summarized in Table 1. No other neuromuscular factors were correlated with agility performance (all $P > 0.05$). **Conclusions:** Neuromuscular factors of hip extension strength, hop distance, and core endurance were related to speed, acceleration, and deceleration during agility testing using a virtual reality motion analysis system. These findings suggest that intervention programs should include strategies to improve these neuromuscular factors in athletes with agility performance deficits. Future research should examine to what extent agility performance deficits contribute to injury and evaluate the effectiveness of intervention programs on agility performance.

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Table 1. Significant Correlations Between Agility Performance and Neuromuscular Factors

Agility Test Measure	Neuromuscular Factor	Pearson *r*	*P* Value
LAS			
DOM speed (0.94±0.12 m/s)	DOM SH	.524	.018
DOM deceleration (2.77±0.49 m/s^2)	DOM SH	.446	.049
ND speed (0.91±0.12 m/s)	ND SH	.471	.036
DAS			
DOM speed forward (1.00±0.15 m/s)	Core endurance	.491	.028
	DOM hip EXT	.478	.033
	DOM SH	.638	.002
	DOM LH	.662	.001
DOM acceleration back (3.02±0.79 m/s^2)	Core endurance	.479	.032
DOM acceleration forward (2.99±0.79 m/s^2)	Core endurance	.479	.033
	DOM SH	.496	.026
	DOM LH	.513	.021
DOM deceleration back (1.98±0.36 m/s^2)	Core endurance	.474	.035
DOM deceleration forward (2.74±0.85 m/s^2)	Core endurance	.450	.046
	DOM LH	.524	.018
ND speed forward (0.98±0.15 m/s)	ND SH	.558	.010
	ND LH	.487	.029
ND acceleration forward (2.93±0.76 m/s^2)	ND SH	.602	.005
ND acceleration back (3.05±1.60 m/s^2)	ND SH	.646	.002
ND deceleration forward (2.59±0.58 m/s^2)	ND SH	.501	.024
ND deceleration back (1.98±0.52 m/s^2)	ND SH	.507	.023
	ND hip EXT	.488	.029

Abbreviations: LAS, lateral agility screening; DAS, diagonal agility screening; DOM, dominant limb; ND, non-dominant limb; SH, single leg hop; LH, lateral hop; EXT, extension strength.

Outcomes Assessed by Athletic Trainers to Determine Return-to-Activity Following an Ankle Sprain

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Context: Athletic trainers (ATs) often oversee patients' return-to-activity clearance after an ankle sprain. While correction of impairments and limitations prior to return-to-activity is important for avoidance of long-term consequences of ankle sprains, patients are often cleared for unrestricted activity with residual deficits. To facilitate thorough evaluation and restoration of relevant outcomes, the International Ankle Consortium published an expert consensus of recommended Rehabilitation Oriented Assessments (ROASTs) for clinicians treating patients with ankle sprains. However, preliminary data suggest the outcomes ATs evaluate at return-to-activity often deviate from recommended guidelines. The purpose of this study was to broadly examine methods used by ATs to determine patients' return-to-activity readiness following an ankle sprain. We also aimed to identify demographic determinants of ATs' selected outcomes. **Methods:** We invited 10,000 ATs to participate in an online survey. Participants were required to have treated and returned to activity at least one patient with an acute ankle sprain within the previous year. A total of 602 ATs accessed the survey and 574 completed it (95.3% completion rate). The survey asked about assessment of pain, swelling, range of motion, arthrokinematics, strength, balance, gait, functional capacity, physical activity level, and patient-reported outcomes (PROs) in determining return-to-activity readiness. We collected demographics related to gender, age, degree(s) earned, education program(s) completed, years of clinical practice, and current practice setting. Descriptive data were analyzed with frequencies and percentages. Chi-square analyses determined influences of demographic data on selection of each outcome. **Results:** Rates of outcomes assessed by ATs are reported in Table 1. Chi-square analyses indicate that ATs employed in non-traditional settings used PROs more (41.2%) than those employed in K-12 athletics (17.5%;$\chi 2$=61.73,P=0.02). For highest degree attained, ATs with a doctoral degree reported greater PROs use (57.1%) compared to those with a masters (25.6%) or bachelor's degree (14.6%;$\chi 2$=37.69,P=0.01). Relative to program(s) attended, ATs who completed a DAT program used PROs more (71.4%) than those who completed professional undergraduate programs (25.3%), professional masters programs (25.8%), post-professional masters programs (31.0%), or an internship route to BOC certification (19.0%;$\chi 2$=92.26,P=0.04). ATs with at least 30 years of clinical practice assessed arthrokinematics more (62.5%) than individuals with less than 5 (30.0%) or less than 10 years (30.4%) of experience ($\chi 2$=82.42,P<0.01). **Conclusions:** Outcomes recommended for evaluation are often not assessed by ATs before clearing patients with ankle sprains for return-to-activity. Arthrokinematics, physical activity level, and PROs appear to be the outcomes most neglected by ATs. ATs who practice in non-traditional settings, completed more advanced education, and possess more clinical experience are more likely to evaluate recommended outcomes for return-to-activity following an ankle sprain. Continued research must determine the effects of varying assessment methods on long-term outcomes of patients with ankle sprains.

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Personalized Volumetric Assessment of Lower Body Muscles in Patients With Knee Injuries: A Case Series

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Context: Patients with knee joint pathology present with variable muscular responses across the muscles of the lower limb and pelvis. Conventional approaches to characterizing muscle function are limited to gross strength assessments that may overlook subtle changes both in the thigh, hip and shank musculature. Muscle volumetric assessments using magnetic resonance imaging (MRI) is a method that enables a personalized approach to evaluating muscle function for each lower extremity muscle. This will further enable refined rehabilitation prescription based on precisely calculated muscle impairments. Therefore, our purpose was to characterize individualized patterns of lower extremity muscle volumes in patients with knee pathologies. **Methods:** In this case series, we calculated lower extremity muscle volumes in a convenience sample of nine patients with knee pathologies seeking care (2F/7M, age: 45.6 ± 8.5 years, height: 181.8 ± 7.3 cm, mass: 98.7 ± 17.3 kg, BMI: 29.9 ± 5.2 kg/m2, time from injury: 5.4 ± 5.5 months, time from surgery [n=6]: 0.6 ± 0.3 months) for a diagnosed meniscus tear. All patients underwent a 3.0 Tesla MRI of their lower extremities in a university medical research center during a single visit. Thirty-five MRI-derived muscle volumes were normalized to patients' mass and height. Z scores were calculated using previously published healthy normative data. Scores were calculated for each muscle and considered "normal" if values were between -1 and 1 (i.e., ± 1 standard deviation from the normative data). Raw muscle volumes were compared between limbs and expressed as percentage asymmetry (%). The data are presented as individual cases. **Results:** All patients were prescribed arthroscopic partial meniscectomy following the diagnosis of a medial meniscal tear. Six patients were also diagnosed with mild-to-moderate degenerative joint disease. Lesser muscle volumes of the injured limb were observed for each muscle (Figure 1). However, the ankle musculature (dorsiflexors, plantar flexors, and invertors) was the only group to be consistently smaller than normal for all patients (Z range: -1.2 to -5.3), with the psoas major (Z range: -1.8 to -3.2) and flexor hallucis (Z range: -1.3 to -3.8) longus being the only individual muscles. There were no consistent patterns observed when considering limb asymmetries among all patients (range: -36.8% to 35.7%). The severity or chronicity of injury and presence of surgical intervention did not appear to have a clear effect on muscle volumes. **Conclusions:** Patients with a history of meniscal pathology demonstrate inconsistent patterns of lower extremity muscle volumes about the hip, knee, and ankle in comparison to uninjured individuals and between limbs. These data support the need for individualized assessment and intervention among individuals with knee pathologies.

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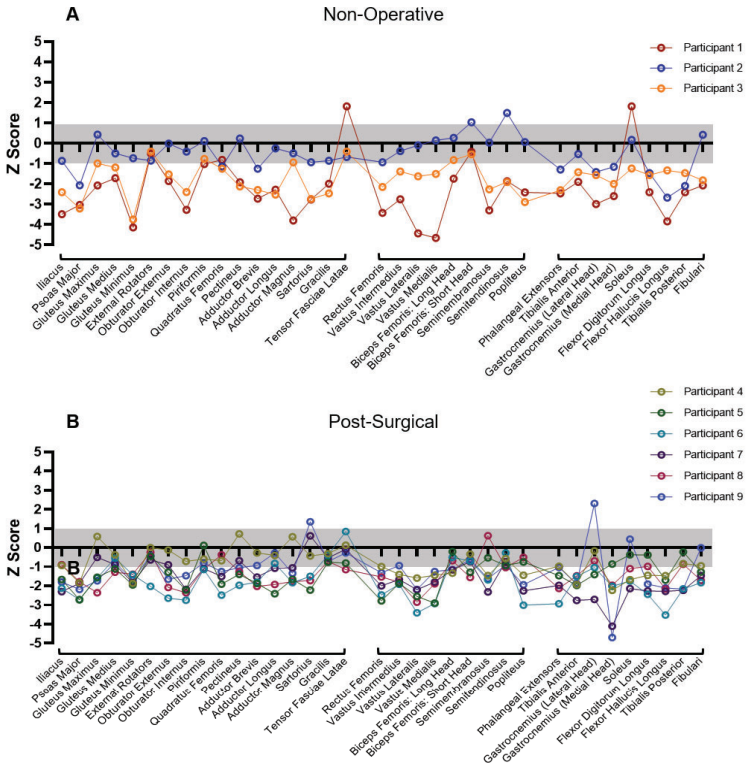

Figure 1. Z scores for individual muscles of the index limb in (A) non-operative and (B) post-surgical patients. Gray shaded regions indicate z scores within a normal range.

Preliminary Validation of a Novel Patient-Reported Outcome Measure to Assess Golf-Specific Low Back Pain

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Context: Low back pain (LBP) is common among competitive and recreational golfers. There is a need for patient-reported outcome measures to better assess and manage the unique impairments and limitations specific to golfers with LBP. The purpose of this study was to assess the construct validity of a novel golf-specific LBP (Golf-LBP) scale. We examined whether golfers with LBP demonstrated poorer Golf-LBP scores than golfers without LBP and whether Golf-LBP scores were correlated with Oswestry Disability Index (ODI) scores, a commonly used LBP-specific patient-reported outcome measure. **Methods:** We used a cross-sectional design in a laboratory setting. Participants included a convenience sample of young-adult, varsity college golfers from two mid-west NCAA division III and NAIA institutions (n=32, 17 female, 19.6±1.3 years). We stratified participants into LBP (n=16, 9 female, 19.7±1.3 years, 4.6±4.5 LBP episodes) and non-LBP groups (n=16, 8 female, 19.6±1.3 years, 0.1±0.3 LBP episodes) based on whether they reported 2+ episodes of LBP in the previous 6-months. Golf-LBP and ODI questionnaires were administered using paper/pen. The Golf-LBP included 22-questions organized into three subscales: Severity, Frequency, and Limitations (Table 1). Responses for each question were scored on a 0-4 point scale. We calculated scores for each subscale and a total score on a normalized 0-100% scale by summing the points for each question, dividing by the total possible points, and multiplying by 100 (Table 1), with a score of 100% suggesting no impairments/limitations. The ODI contains 10-questions and was also scored on a 0-100% scale; however, a 0% suggests no impairments/limitations for the ODI. We used Mann-Whitney tests and Cohen's d effects sizes (>0.80=large) with 95% confidence intervals to assess group comparisons. We used Spearman's Rho (ρ) correlation coefficients to assess correlations between the Golf-LBP and ODI scores (0.0-0.4=weak, 0.4-0.7=moderate, 0.7-1.0=strong). **Results:** We observed that the LBP group reported significantly poorer scores than the non-LBP group on the Golf-LBP Severity subscale (LBP=80.7± 11.3%, non-LBP=93.0±8.0%, P=.001, d=1.3 (0.5-2.0)), Frequency subscale (LBP=73.4±14.2%, non-LBP=86.3±16.5%, P=.02, d=0.8(0.1-1.6)), Limitations subscale (LBP=78.7±18.2%, non-LBP=94.3±6.9%, P<.001, d=0.8 (0.1-1.6)), and Total score (LBP=77.5±12.4%, non-LBP=90.9±10.2%, P=.001, d=1.2(0.4-1.9)). We observed significant, moderate, inverse correlations between the ODI score and each Golf-LBP subscale and total score (Severity: ρ=-0.45, P=.01, Frequency: ρ=-0.59, P<.001. Limitations: ρ=-0.56, P=.001, Total: ρ=-0.59, P<0.001). **Conclusions:** We observed that the novel Golf-LBP scale detected large magnitude (effects sizes all >0.8) impairments/limitations in a small sample of young-adult, college golfers with a recent history of LBP compared to those without LBP. We also observed that all Golf-LBP subscales and total scores were moderately correlated with ODI scores, suggesting that the scales are assessing similar constructs. Collectively, these findings suggest the Golf-LBP demonstrated acceptable construct validity for assessing LBP impairments/limitations in college golfers. These findings support further examination of the Golf-LBP scale in larger and more diverse golfer populations.

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Table 1: Golf-specific Low Back Pain (Golf-LBP) Scale

Questions	Responses & Scores				
Severity: *What amount of low-back pain you have experienced in the past 4-weeks during the following golf activities?*	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
Playing 9-holes of golf	④	③	②	①	⓪
Playing 18-holes of golf	④	③	②	①	⓪
Swinging you driver or woods	④	③	②	①	⓪
Swinging your irons	④	③	②	①	⓪
Chipping	④	③	②	①	⓪
Putting	④	③	②	①	⓪
Bending over to pick up your ball or place your tee	④	③	②	①	⓪
Lifting and carrying your clubs	④	③	②	①	⓪
Frequency: *How often have you experienced low-back pain in the past 4-weeks during the following golf activities?*	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Playing 9-holes of golf	④	③	②	①	⓪
Playing 18-holes of golf	④	③	②	①	⓪
Swinging you driver or woods	④	③	②	①	⓪
Swinging your irons	④	③	②	①	⓪
Chipping	④	③	②	①	⓪
Putting	④	③	②	①	⓪
Bending over to pick up your ball or place your tee	④	③	②	①	⓪
Lifting and carrying your clubs	④	③	②	①	⓪
Limitations: *How often does your low-back pain limited your ability to:*	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Play golf at your normal performance level?	④	③	②	①	⓪
Finish an 18-hole round of golf?	④	③	②	①	⓪
Play golf as often as you would like?	④	③	②	①	⓪
Enjoy playing golf?	④	③	②	①	⓪
Walk/carry your golf clubs when playing golf	④	③	②	①	⓪
Participate in non-golf physical activities (ie. Exercise, recreational activities, housework)?	④	③	②	①	⓪

Severity (%) =(points/32)x100, *Frequency* (%) =(points/32)x100, *Limitations* (%) =(points/24)x100, *Total* (%) =(points/88)x100

Senaptec Sensory Station: The Clinical Utility of Percentile Scores

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Context: The Senaptec Sensory Station Full Test is a novel tablet-based assessment containing 10 subtests evaluating cognition, coordination, reaction time, and vision.1 This device provides clinicians with raw scores and percentiles. Raw data are transformed into percentiles by comparing the subject's scores to the most recent 500 scores in their testing category (based on sport, level, sex). As additional data are collected in the same category, the percentiles fluctuate. For example, if an athlete's raw score is 241 with a 9th percentile ranking in their category, this may indicate a retest. Five days later, that same raw score is ranked in the 52nd percentile due to new, worse scores or calculation error, which would be deemed acceptable.2 This is particularly important when determining the need for retesting due to low scores. The objective of this study is to investigate percentile change scores for a single testing session overtime. **Methods:** Forty-six active, healthy adults (24.50 ± 10.11 years; female = 30) were administered the Senaptec Sensory Station Full Test once in spring 2020. Percentiles were recorded for all 10 subtests after data collection was completed (April 2020). Percentiles for the same assessments were rerecorded 17 months later (October 2021). T-tests were conducted to compare the original and rerecorded percentile scores using SAS 9.4 (Cary, NC) with a p-value of 0.005. **Results:** Table 1 displays the means and standard deviations for the 10 subtests at Timepoint 1 (April 2020) and Timepoint 2 (October 2021). There were no significant differences in percentile scores between the 2 entry Timepoints ($p > 0.06$) for this single session. However, the percentile change scores from Timepoint 1 and Timepoint 2 differed from 0-76% across the 10 subtests (Table 1). **Conclusions:** Although significant differences in percentiles overtime were not observed, the large change score differences are clinically important. Percentiles are easily accessible to clinicians, thus making them more likely to be used for clinical decisions than raw data.2 However, these results indicate that percentiles may not be the best option for determining test validity. This is particularly true when a testing category has low numbers because each additional completed test will have more weight than categories with larger numbers, resulting in greater percentile changes overtime. As a result, clinicians should use caution when using percentiles related to new technology when attempting to determine the need for retest. Importantly, these issues are not reflected in the raw scores; however, to our knowledge normative values have yet to be determined for each of the Senaptec subtests. This clinical hurdle can be partially overcome with time and experience, but best practice indicates the need for normative values to be established to optimize clinical use.

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Table 1. Senaptec Subtest Change Score Distribution, and Means and Standard Deviations by Timepoint

Change in score	Score	VC	CS	DP	NFQ	PS	MOT	RnT	TC	EHC	GNG	Total
Increase	15-59		2	13	3	1		14		2	8	44
	10-14	4	4	1	1	2		3	2	3	2	22
	5-9		3	6	5	6	4	3	4	2	2	35
	1-4	1	4	4	5	9	7	4	8	2	4	48
No change	0	38	14	15	17	16	17	12	18	15	12	174
Decrease	1-4		5	3	10	6	6	8	9	9	1	57
	5-9		1	1	3	4	8		2	4	3	26
	10-14		6			1	3		2	5	1	18
	15-79	3	7	3	2		1	2	1	4	13	36
Scores mean ± sd by timepoint	1	57.43 ± 22.63	44.59 ± 35.01	40.72 ± 25.06	53.83 ± 29.54	57.85 ± 27.16	39.59 ± 27.43	71.11 ± 27.01	55.20 ± 33.27	64.6 ± 30.10	31.26 ± 23.63	
	2	58.04 ± 22.68	48.76 ± 31.95	31.35 ± 30.42	52.76 ± 29.91	55.41 ± 27.01	42.13 ± 27.42	63.74 ± 25.35	54.76± 31.40	66.61 ± 28.99	34.74 ± 17.34	

VC = Visual Clarity, CS = Contrast Sensitivity, DP = Depth Perception, NFQ = Near Far Quickness, PS = Perception Span, MOT = Multiple Object Tracking, RnT = Reaction Time, TC = Target Capture, EHC = Eye Hand Coordination, GNG = Go/No-Go

The Effect of Sport Type on Reaction Time During Complex Visual-Motor Tasks in Collegiate Athletes

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Context: Longer sports experience has been shown to improve complex visual-motor task performance following concussion; however the relevant improvements may actually exist based on sport type. Thus, quantifying the effect of sport type on reaction time (RT) in cognitive-motor integration (CMI) tasks is essential for clinicians to identify associated factors to visual-motor task performance. **Methods:** This project was part of a prospective study conducted among collegiate athletes. A convenience sample of freshman collegiate athletes (59 males [51.3%], 56 females [48.7%]) were recruited during their pre-participation physical examination. All assessments were conducted in a quiet, climate-control laboratory environment. Participants completed an online survey to report their demographic information (age, sex), sports participation (sport type, years of involvement), and medical history (concussion, attention deficit hyperactivity disorder [ADHD]). RT was collected from two different visuomotor tasks (standard, CMI) that required participants to slide their dominant index finger on a tablet computer. We categorized participants into contact, limited contact, and noncontact sport groups. A 2 (conditions) X 3 (groups) mixed model analysis of covariance (ANCOVA) was performed to identify the differences in RT performance during visual-motor tasks among three groups while controlling for sex (male/female), ADHD (yes/no), and previous concussion (yes/no). **Results:** A total of 115 participants (contact = 49, limited contact = 35, noncontact = 31) were included in this study. The overall RT were 216.8 ± 68.1 and 238.5 ± 166.8 milliseconds during standard and CMI conditions, respectively. The results of mixed model ANCOVA suggested that there was no significant main effect of conditions ($F_{(1,109)} = 1.23$, $P = 0.27$) on RT nor interaction between conditions and the covariates ($P > 0.05$). Similarly, no significant main effect of sport type on RT was determined ($F_{(1,109)} = 1.40$, $P = 0.25$) and the interaction between sport type and the covariates was not significant ($P > 0.05$). **Conclusions:** Sport type does not affect RT performance on complex visual-motor tasks in the present study. Although not statistically significant, slower RT was observed during CMI conditions, and the limited contact sport group had faster RT than the other two groups. When examining visual-motor tasks, the nature of the sport may not influence the initial response planning. Future work should consider the effect of sport type on motor execution during visual-motor tasks.

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Utility of the Biering-Sørensen Test to Assess Functional Impairments in College Golfers With and Without Low Back Pain

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Context: Low back pain (LBP) is a leading cause of injury in golfers. The Biering-Sørensen test is a common clinical measure used to assess functional impairments in core stability and endurance in LBP populations. The purposes of our study were to compare Biering-Sørensen test time between college golfers with and without LBP and to examine the relationship between Biering-Sørensen performance and golfer's Oswestry Disability Index (ODI) score and episodes of LBP. **Methods:** We used a cross-sectional design in a laboratory setting. Our sample included thirty-two college golfers at the NCAA Division III or NAIA level stratified into an LBP group (n=16, 9 female/7 male, age=19.7±1.3 years) and non-LBP group (n=16, 8 female/8 male, age=19.6±1.3 years) based on whether they had 2+ episodes of LBP in the previous 6-months. Our primary outcomes included Biering-Sørensen time, ODI score, and episodes of LBP in the previous 6-months. For the Biering-Sørensen test, participants were positioned prone on a treatment table with their anterior superior iliac spines aligned with the edge of the table, their upper body off the table, and lower extremities secured to the table by straps at the proximal thighs and mid-calves. During testing, participants were instructed to maintain a horizontal torso position with the arms crossed across their chest for as long as possible. Time to failure (defined as inability to maintain a horizontal trunk position or uncrossing arms from the chest) was recorded for each trial. Two trials were performed (separated by 90-seconds of rest) and the best (longest) time was used for analyses. Group comparisons were performed using independent t-test and Mann-Whitney tests and correlations were performed using Spearman Rho tests. **Results:** LBP group reported significantly greater ODI scores (P=0.001, LBP=7.9±5.5%, non-LBP=2.5±3.6%) and significantly greater episodes of low back pain (P<0.001, LBP=4.6±4.5, non-LBP=0.1±0.3); however, we observed no difference in Biering-Sørensen time between the two groups (P=0.28, LBP=60.9±28.3, non-LBP=71.8±27.5 seconds). We observed no significant correlations between participants' Biering-Sørensen time and their ODI scores (Rho=-0.22, P=0.24) or episodes of LBP in the previous 6-months (Rho=-0.12, P=0.53). **Conclusions:** Biering-Sørensen time did not differ between college golfers with and without LBP, and there was no correlation between Biering-Sørensen time and ODI scores or episodes of LBP. Our findings suggest that the Biering-Sørensen test may have limited clinical utility as a tool for assessing clinically relevant impairments in core stability and endurance in college golfers with LBP. There is a need for a more effective assessment tool to better identify and treat clinically relevant impairments in golfers with LBP.

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Validity of Different Cameras and Software for the Assessment of Kinematics With 2-Dimensional Joint Analysis

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Context: Altered lower extremity joint motion has been reported in individuals with lower extremity injury. Lower extremity movement patterns have been studied using two-dimensional (2D) motion analysis during dynamic tasks. However, the literature inconsistently describes the camera properties (e.g., resolution, sampling rate, distortion) and software used for 2D motion analysis. Clinicians may utilize different cameras and software as well, so it is important to know if results are consistent among different tools. The purpose of our study was to determine the concurrent validity of 2D sagittal and frontal plane joint angles when captured and processed by different cameras and software. We hypothesized that there would be strong correlations between 2D joint angles among the different types of cameras and software. **Methods:** Our cross-sectional study included healthy adult females (n=30, age=21.6±2.7 years). Markers were placed on participant's upper and lower extremities to identify anatomical landmarks. Participants completed a single set of seven single leg squats to their self-selected maximal squat depth. Squats were simultaneously recorded by four different types of cameras based on their level of radial distortion (iPod Touch, Yi 4k Action, Sony Full HD High Def, Logitech C922x Pro Stream Webcam). Custom rigs were used to secure all four cameras to the same tripod and the tripods were placed 2 m anterior and 2 m lateral to participants to record frontal and sagittal plane motion, respectively. Videos were uploaded to Kinovea where frontal and sagittal plane videos were time synchronized and screen shots were extracted at the frame of peak knee flexion. The screenshots were then processed for each of the four cameras using Kinovea, ImageJ, and a custom MATLAB script to extract sagittal (trunk flexion, hip flexion, knee flexion, ankle dorsiflexion) and frontal plane (lateral trunk lean, pelvic drop, hip adduction, knee abduction) joint angles. Pearson correlations compared the relationships among camera types and software and were categorized as poor (< 0.50), moderate (0.50-0.74), good (0.75-0.89), and excellent (≥ 0.90). **Results:** We observed good-to-excellent relationships among camera types (r=0.89-1.00) and moderate-to-excellent relationships among software programs (r=0.63-1.00) for joint angles in the sagittal and frontal plane (Table 1). **Conclusions:** Different types of cameras and motion analysis software may be used for 2D motion analysis in the frontal and sagittal plane. While camera properties including resolution, sampling rate, and distortion varied among the different types of cameras, good-to-excellent relationships were found among all camera types. Similarly, good-to-excellent relationships were found among software programs, except for hip adduction which had moderate relationships between Kinovea and other software. With consistent camera setup on a tripod, clinicians may use their preferred camera and software for 2D motion analysis of sagittal and frontal plane joint angles.

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Table 1. Pearson correlations among camera types and software programs.

Comparison	LTF	PD	HADD	KABD	TF	HF	KF	ADF
Yi vs Sony	0.91	0.89	0.97	0.89	1.00	1.00	1.00	1.00
Yi vs iPod	0.92	0.90	0.95	0.98	1.00	1.00	1.00	0.98
Yi vs Logitech	0.91	0.88	0.95	0.95	1.00	1.00	1.00	0.99
Sony vs iPod	0.96	0.98	0.99	0.88	1.00	1.00	0.99	0.97
Sony vs Logitech	0.99	0.98	0.98	0.98	1.00	1.00	1.00	0.99
iPod vs Logitech	0.96	0.97	0.98	0.95	1.00	1.00	1.00	0.98
Kinovea vs ImageJ	0.99	0.95	0.67	0.89	1.00	0.97	0.96	0.94
Kinovea vs MATLAB	0.97	0.93	0.63	0.99	1.00	0.97	0.96	0.93
ImageJ vs MATLAB	0.98	0.96	0.99	0.92	1.00	1.00	1.00	0.99

Abbreviations: LTF = Lateral Trunk Flexion, PD = Pelvic Drop, HADD = Hip Adduction, KABD = Knee Abduction, TF = Trunk Flexion, HF = Hip Flexion, ADF= Ankle Dorsiflexion

Does Eccentric Exercise Improve Knee Pain & Function in Athletes With Patellar Tendinopathy: A Critically Appraised Topic

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Context: Patellar tendinopathy, also known as 'jumper's knee', gives rise to considerable functional deficit and disability in recreational and professional athletes. While progress has been made in recognition and diagnosis, treatment protocols have not been definitive. Therefore, this study looks to answer, in subjects with patellar tendinopathy, does eccentric training improve knee pain and function when compared with other forms of non-operative treatments? **Methods:** Studies were obtained through the PubMed database using the keywords: patellar tendinopathy, eccentric training, non-surgical interventions, passive treatment options, and knee pain & function. Studies were included if the athletes were clinically diagnosed with patellar tendinopathy, eccentric exercise was a form of treatment for patellar tendinopathy, the Victoria Institute of Sports Assessment-patella (VISA-P) functional score was used as an outcome measure, the study was in English, and if it was published in the last 5 years (except for one study, 7 years). Studies were excluded that included patients with other knee pathologies, previous knee surgeries, previous patellar tendon injections, and intervention durations that lasted less than 10 weeks. The Physiotherapy Evidence Database (PEDro) scale was used to appraise the quality of evidence gathered using a minimum score of 5/10. VISA-p results were used to compare groups among studies. Statistics in the studies consisted of independent t-tests with 95% confidence intervals. That data was used to compare pre- and post-treatment to find the % improvement for each treatment. **Results:** Out of 54 identified studies, 4 met the inclusion criteria. These studies presented with an average PEDro score of 7.5. The mean of the results of the studies based on treatment type demonstrated the following clinical improvement: placebo: 6.25%, Eccentric Exercise (Ex): 34.21%, Topical glyceryl trinitrate (GTN) + Ex: 15.87%, Extracorporeal Shockwave Therapy (ESWT): 12.46% ESWT + Ex: 29.56%, Low-Level Laser Therapy (LLLT): 39.59% and LLLT + Ex: 64.07%. Here, eccentric exercise and LLLT have the greatest clinical improvement among the treatments presented in the studies. **Conclusions:** Overall, the current research shows that eccentric training is an effective intervention in improving self-reported pain and function in subjects with patellar tendinopathy. LLLT was also shown to be an effective treatment, particularly when combined with eccentric exercise. However, the addition of ESWT or GTN did not significantly improve clinical outcomes greater than the eccentric training alone. Recommended treatment protocols for patellar tendinopathy should include eccentric exercises. LLLT can be combined with eccentric exercise for further increases in clinical outcomes. The recommended duration of treatment is 12 weeks and allows for subjects to continue participation in activity.

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Gluteus Maximus Activation Can Discriminate Between Females With and Without Patellofemoral Pain: A Pilot Study

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Context: Patellofemoral pain (PFP) is a prevalent knee pathology, resulting in poor long-term function and pain. Strength-based rehabilitation for the hip musculature is standard, yet does not appear to transfer to improved movement profiles. Gluteal activation failure has been described in females with PFP, suggesting that pain-related muscle inhibition may underlie muscular impairments. However, the ideal threshold of appropriate gluteal activation is unknown. Our purpose was to investigate the ability of gluteal activation to discriminate between individuals with and without PFP to establish a clinical threshold. **Methods:** We cross-sectionally assessed gluteal activation, patient-reported function, and single leg squat (SLS) biomechanics among individuals with PFP (n=7, age: 22.3±3.6 years, mass: 70.1±17.0 kg, height: 1.7±0.04 m, duration of symptoms: 36.1±32.2 months) and controls (n=12, age: 22.8±1.3 years, mass: 73.1±13.7 kg, height 1.7±0.1 m) during a single laboratory session. Hip extension and abduction maximal voluntary isometric contraction torque (Nm/kg) were quantified for the involved, or matched involved, limb and used to derive the gluteus maximus (GMax) and gluteus medius (GMed) central activation ratio (CAR, %) via burst superimposition. Peak hip and knee joint angles and moments were calculated from a SLS performed on a force plate. Patient-reported outcomes were assessed using a visual analog scale for worst pain and anterior knee pain scale. Independent t-tests were used to compare all outcomes between groups. Receiver-operator-characteristic curves were used to determine if gluteal CAR could discriminate between individuals with PFP and controls, and to establish a clinical threshold of gluteal activation. Outcomes were descriptively compared between those with PFP who met or failed to meet the established thresholds using mean differences and effect sizes with 95% confidence intervals. **Results:** Individuals with PFP reported higher pain, lower knee function, and greater hip abduction torque than controls (Table 1). GMax CAR was the only acceptable discriminate of group status (area under the curve=0.732, P=.099), where a threshold of 88.5% maximized the sensitivity (0.86) and specificity (0.67) of discrimination. On average, individuals with PFP and low GMax CAR (n=3) demonstrated less hip flexion (-13.9°, d=-0.68 [-2.22, 0.86]), hip extension moment (-0.07 Nm/kg*m, d=-1.26 [-2.89, 0.38]), hip adduction (-7.1°, d=-0.60 [-2.13, 0.93]), hip abduction moment (-0.08 Nm/kg*m, d=-1.07 [-2.66, 0.53]), and knee flexion (-6.3°, d=-0.55 [-1.07, 0.98]) than those with high GMax CAR (n=4). **Conclusions:** A GMax CAR threshold of 88.5% was able to acceptably discriminate between females with and without PFP. However, more than half of the sample (n=4, 57.1%) met this threshold, suggesting GMax activation failure, or inhibition, may only be present in a subset of individuals with PFP. Our data provide preliminary evidence that some individuals with low GMax CAR may adopt a stiffened SLS pattern, possibly as an attempt to unload the hip and knee.

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Table 1. Participant demographics and outcomes data

	PFP (n=7)	Control (n=12)	*P* value
VAS (cm)	5.1 ± 1.8	0.4 ± 0.8	**<.001**
AKPS (0-100)	72.3 ± 7.1	99.8 ± 0.6	**<.001**
Hip abduction torque (Nm/kg)	1.60 ± 0.43	1.26 ± 0.26	**.049**
Hip extension torque (Nm/kg)	2.20 ± 0.59	2.05 ± 0.40	.524
GMax CAR (%)	84.0 ± 6.3	88.2 ± 6.8	.206
GMed CAR (%)	91.1 ± 6.8	88.3 ± 8.4	.464
Hip flexion angle (°)	39.2 ± 19.9	27.8 ± 22.2	.282
Hip adduction angle (°)	12.6 ± 11.5	5.3 ± 12.2	.215
Hip extension moment (Nm/kg*m)	0.08 ± 0.06	0.08 ± 0.06	.857
Hip abduction moment (Nm/kg*m)	0.04 ± 0.08	0.001 ± 0.06	.242
Knee flexion angle (°)	71.2 ± 11.1	68.1 ± 12.7	.606
Knee abduction angle (°)	7.1 ± 5.2	3.3 ± 6.7	.209
Knee extension moment (Nm/kg*m)	0.08 ± 0.03	0.08 ± 0.03	.937
Knee adduction moment (Nm/kg*m)	0.02 ± 0.02	0.003 ± 0.03	.234

Abbreviations: VAS, visual analog scale; AKPS, anterior knee pain scale

Influence of Unilateral or Bilateral Patellofemoral Pain on Self-Reported Function, Pain, and Physical Activity

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Context: PFP is a chronic condition that results in long-term disability and functional limitations. Physical activity level is impaired in those with PFP, with fewer steps per day and less time in mild and vigorous physical activity compared to healthy controls. The comparison between unilateral and bilateral PFP influences sport participation, however, the extent on physical activity is unknown. Therefore, the purpose of this study was to compare self-reported function, pain, and physical activity between individuals with unilateral and bilateral PFP. We hypothesized that individuals with bilateral PFP would have worse self-reported function, greater pain, and engage in less physical activity than those with unilateral PFP. **Methods:** Thirty-eight individuals (30 females) with PFP participated in this observational study. Self-reported function was assessed on the initial day of data collection by the anterior knee pain scale (AKPS) and worst knee pain in the previous week with the visual analog scale (VAS). Those with bilateral pain reported their most painful limb. Participants then wore an Actigraph wGT3X-BT monitor on their non-dominant wrist for seven days. Data were collected at 30Hz and processed with 60-second epochs. Data were valid if monitor wear time was greater than eight hours a day for a minimum of four days. Average daily step count and time (minutes) spent in moderate-to-vigorous physical activity (MVPA) were calculated. Participants with PFP were dichotomized into unilateral (n=17) and bilateral PFP (n=21). We used independent t-tests to determine differences in patient demographics, self-reported function, pain, and physical activity across groups, significance set a priori at $p < 0.05$. Cohen's d effect sizes with 95% confidence intervals were calculated for magnitude difference between groups for all variables. **Results:** There were no difference in patient demographics between unilateral PFP (23.4±4.3 years, 72.9±14.2kg, and 1.6±.1m) and bilateral PFP (22.3±3.1 years, 69.5±13.4kg, and 1.6±.06m), $p > .05$. There were no between group differences in AKPS (unilateral: 78.9±8.4, bilateral: 79.9±7.7, p=.70), VAS (unilateral: 5.3±1.6, bilateral: 4.8±1.4, p=.33), time spent in MVPA (unilateral: 73.1±33.8, bilateral: 57.7±25.6, p=.11) and steps per day (unilateral: 7,559.0 ± 2,203.1, bilateral: 6,103.5 ± 2,028.0, p=.13). While not statistically significant, there was a moderate effect size that did not cross zero in steps per day, with those experiencing unilateral PFP engaging in almost 1,500 more steps per day compared to the bilateral group. **Conclusions:** Our data suggests that unilateral or bilateral PFP does not result in a statistical difference in self-reported function, pain, or physical activity, however a large magnitude effect size exists in steps per day. Clinicians should be aware that bilateral PFP may have a larger negative impact in physical activity, but additional research is warranted. Deficits in function, pain, and activity level should continue to be monitored by clinicians and addressed with rehabilitation.

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Injury Characteristics & Socio-demographic Factors Associated With Perceptions of Pain and Function in Individuals With Patellofemoral Pain

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Context: Patellofemoral pain (PFP) is widely studied using a pathomechanical model of biomechanical and muscular factors that increase patellofemoral joint loading. However, PFP may be better understood using the biopsychosocial model of injury rehabilitation to explore how injury characteristics and sociodemographic factors may impact a patient's perception of pain and function, which could influence treatment. The purpose of this study was to identify if injury characteristics (symptom duration, painful locations) and sociodemographic factors (age, gender) are related to psychological factors (perceptions of pain and function) in individuals with PFP. **Methods:** Cross-sectional, U.S. population-based online survey shared via social media, email, and word of mouth to individuals (18-45 years) with knee pain. The survey included: 1) Survey instrument for Natural history, Aetiology and Prevalence of Patellofemoral pain Studies (SNAPPS), discriminates PFP from other knee pain (sensitivity and specificity > 90%), 2) Multidimensional Sex/Gender Measure (MSGM) to self-identify gender, 3) Numerical Pain Rating Scale (NPRS) to self-report pain (excellent test-retest reliability; online use validated for chronic pain), 4) Anterior Knee Pain Scale (AKPS) to self-report functional ability (reliable, valid, and responsive in individuals with PFP). 243 / 400 participants completed the survey (61% completion rate). Of those 137 (105 females, 32 males, 30.80+8.68 years) had PFP. The dependent variables were NPRS and AKPS, and independent variables were symptom duration, painful locations, age, and gender. AKPS, NRPS, symptom duration, and painful locations violated the assumptions of normality. AKPS data were transformed, and NPRS score, symptom duration, and painful locations were categorized. A multinomial logistic regression was utilized to create a model of the relationship between the independent variables and NPRS. A multiple linear regression was used to create a model for the relationship of the independent variables and AKPS. **Results:** AKPS significantly predicted NPRS, -2 Log Likelihood=334.338, $\chi 2(3\ N=134)=36.917$, $p < .001$ (Table 1). The Nagelkerke psuedo R2 indicated that the model accounted for approximately 25.7% of the total variance. The prediction model for AKPS that included NPRS, symptom duration, and painful location was significant, $F(3,134)=20.533$, $p=.014$, accounting for approximately 32% of the variance in AKPS (R2=.322, Adjusted R2=.306). Participants who had PFP for a longer period of time, experienced widespread pain, and reported higher levels of pain also perceived their function to be lower. Age and gender did not impact perceptions of pain or function in our sample. **Conclusions:** Our results support that injury characteristics such as symptom duration and painful locations are related to how individuals with PFP perceive their function, which could impact treatment outcomes. It emphasizes the need for early identification and treatment of PFP to minimize pain and preserve function. Further research should explore other biopsychosocial factors that may influence pain and function and improve outcomes in PFP patients.

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Sagittal and Frontal Plane Trunk Kinematics Influence Knee Biomechanics in Females With Patellofemoral Pain

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Context: Patellofemoral pain (PFP) accounts for 25% of all knee-related pathologies, with females being twice as likely to experience PFP compared with males. Altered movement strategies of the trunk and lower extremity have been identified in the PFP literature; however, the association between proximal and local biomechanical factors is still poorly understood. If any relationships exist between these factors, proximally targeted interventions would be necessary to reestablish functional movement patterns in females with PFP. Therefore, the aim of this study was to evaluate whether sagittal and frontal plane trunk kinematics are associated with hip and knee kinematics and kinetics during a drop vertical jump (DVJ) in females with PFP. We hypothesized that trunk flexion in both the sagittal and frontal plane would be related to hip and knee kinematics and kinetics in this PFP population. **Methods:** Twenty females with PFP (age: 22.7 ± 3.2 years; height: 167.7 ± 9.6 cm; mass: 67.8 ± 10.1 kg; symptom duration: 36.6 ± 39.1 months; pain severity during the DVJ: 2.2 ± 1.6 cm in Visual Analog Scale; self-reported function: 84.1 ± 6.7 points in Anterior Knee Pain Scale) completed this cross-sectional laboratory study. A 3-dimensional motion capture system with a force plate was utilized to assess trunk, hip, and knee angles and moments during peak knee flexion on the first landing of the DVJ. Pearson r correlation coefficients were calculated among trunk flexion, lateral trunk flexion, knee flexion, knee abduction, hip flexion, hip adduction, knee extension moment, knee abduction moment, and hip adduction moment. Variables significantly correlated with either trunk flexion or lateral trunk flexion were included in a stepwise multiple regression. All statistical analyses were performed using SPSS (version 28.0; IBM Corp., Armonk, NY) with an alpha level set a priori at $P < .05$. **Results:** During the DVJ, trunk flexion was positively correlated with knee extension moment ($r = 0.684$, $P = .001$). A negative correlation between lateral trunk flexion and knee flexion ($r = -0.452$ $P = .046$) was identified. Stepwise multiple regression revealed that trunk flexion accounted for 46.8% of the variance in knee extension moment ($R = 0.684$, $R2 = 0.468$) and lateral trunk flexion accounted for 20.4% of the variance in knee flexion ($R = 0.452$, $R2 = 0.204$). No other variables were significantly associated with any trunk motions ($P > .05$). **Conclusions:** Sagittal and frontal plane trunk kinematics may influence knee biomechanics during the DVJ in females with PFP. Increased knee extension moment and decreased knee flexion due to greater anterior and ipsilateral trunk lean could induce increased knee joint loading. Clinicians should evaluate proximal compensatory movement strategies during functional tasks and incorporate effective interventions to improve trunk stability when treating females with PFP.

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Athletic Trainers' Perceived Barriers Towards Developing and Maintaining an Area of Contemporary Expertise

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Context: In compliance with accreditation standards, all educators and preceptors affiliated with CAATE-accredited professional ATPs must identify an area of contemporary expertise. However, as a relatively new concept, little is known about areas of contemporary expertise ATs are most likely to identify with, or barriers they may face when trying to develop and maintain an area of contemporary expertise. This study explored areas of contemporary expertise selected by ATs and perceived barriers to develop and maintain contemporary expertise. **Methods:** Our cross-sectional online survey, consisting of demographic and open-ended response items, was distributed to educators and preceptors affiliated with CAATE-accredited ATPs in February 2021. Of the 534 ATs that accessed the survey, 372 fully completed it (70% completion rate; 113 educators, 259 preceptors). Within the survey, participants were asked to identify if they had a defined area of contemporary expertise. If yes, they were asked to describe their area of contemporary expertise. All participants were also asked to describe perceived barriers with the development and/or maintenance of contemporary expertise. We analyzed the open-ended responses using a consensual qualitative research approach. The first 40 responses were reviewed by three researchers to develop a consensus codebook which was then confirmed through the analysis of the subsequent 40 responses. Following the coding of the remaining responses, all analysis procedures were confirmed by an auditor, which provided trustworthiness. **Results:** 84% of preceptors and 78% of educators who identified they had an area of contemporary expertise described their area was within the eight areas of athletic training practice identified by the CAATE (Figure). Other common areas of contemporary expertise amongst respondents were organization and administration and leadership. Relative to barriers in developing or maintaining contemporary expertise, educators discussed lack of opportunity to clinically practice and identified time management with other faculty responsibilities as a barrier. Educators also identified the need to use continuing education to promote contemporary expertise for the CAATE while also needing continuing education to demonstrate minimal competence for the BOC as a barrier. Barriers for preceptors also addressed time management, money to access professional development in selected areas, and lack of professional resources to support the development of contemporary expertise. Participants in both groups indicated that the COVID-19 pandemic had become a barrier to accessing resources for the development and maintenance of contemporary expertise. **Conclusions:** Some preceptors and educators have not yet identified an area of contemporary expertise to fulfill the CAATE requirement. Targeted professional development to aid in the acquisition and maintenance of contemporary expertise is a needed resource for both preceptors and educators. The development of asynchronous materials that are widely accessible and low in cost could also assist in overcoming the identified barriers of time, cost, and the COVID-19 pandemic.

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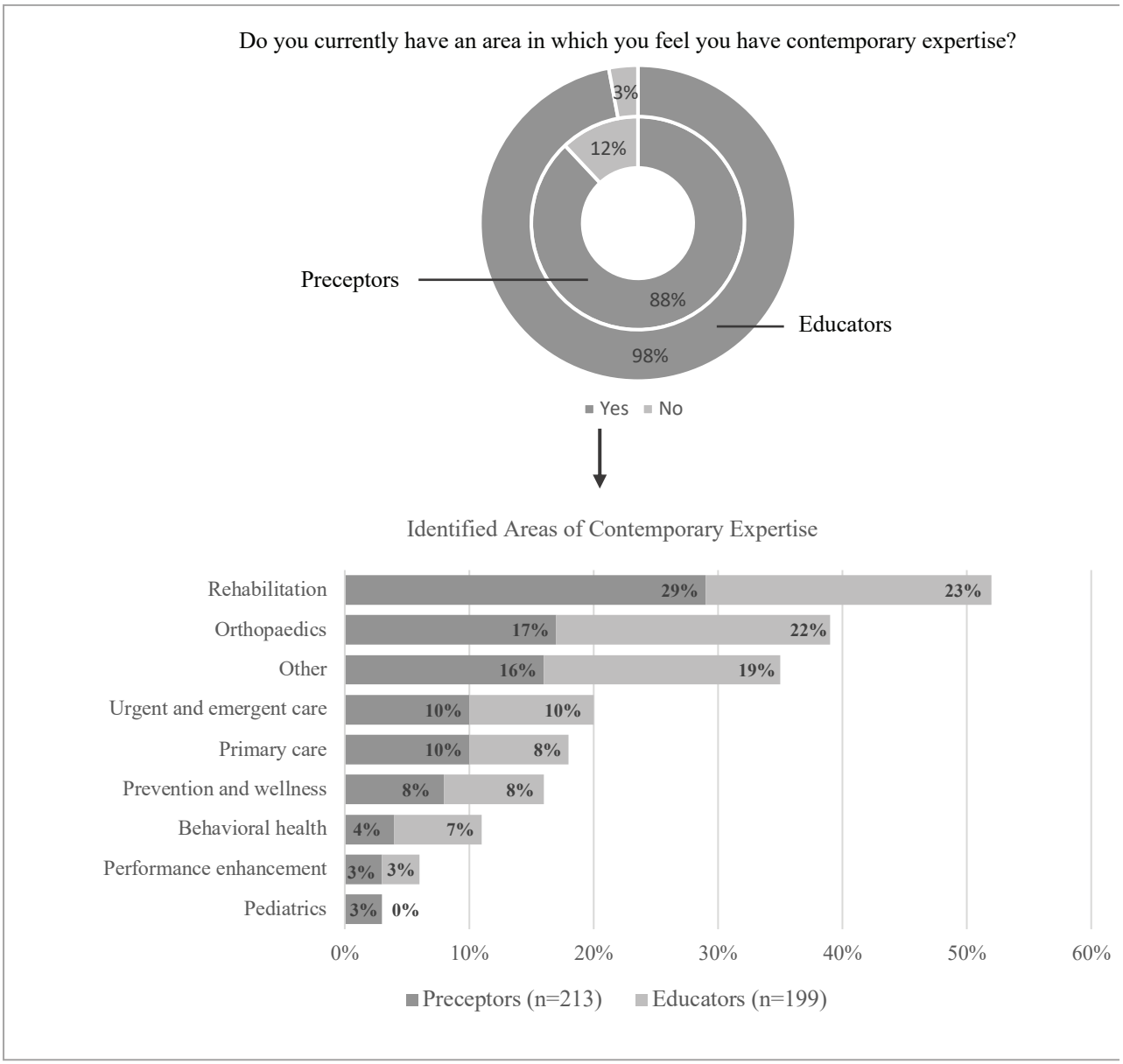
Figure. Athletic Training Educators' and Preceptors' Identified Areas of Contemporary Expertise



Clinical Leadership in Athletic Training

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Context: Literature on clinical leadership in other health professions exists, however, in athletic training clinical leadership has not been broadly investigated. Past leadership literature in athletic training focused primarily on those in positions of formal leadership authority, such as head athletic trainers or athletic training education program directors. The purpose of this study is to investigate clinical leadership in athletic trainers to determine which athletic trainers are more likely to demonstrate clinical leadership behaviors. **Methods:** We used a cross-sectional, quantitative online survey design to complete this study. The survey was distributed via email to a randomly selected population of athletic trainers who are members of the NATA. The survey included 7 demographic questions, the Clinical Leadership Survey (CLS) and a Global Rating of Clinical Leadership Scale (GRCLS). The CLS is a reliable (alpha = 0.86) validated survey with 15 Likert scale questions relating to leadership behaviors in clinical practice. The GRCLS is a reliable (alpha = 0.78) and valid survey with 2 Likert scale items where participants rate their overall perceived level of clinical leadership. **Results:** Emails with the survey link were sent to 6,999 potential participants. A total of 344 participants began the survey (access rate = 4.9%), of which 80 were ineligible (23.2%). Of those who were eligible, 214 completed the survey in its entirety (completion rate = 81.1%) (age = 37.8±12.1 years, years of experience = 14.6±11.9 years). The majority of participants did not hold a supervisory role (n = 147/214, 68.7%). There was a statistically significant difference between the CLS score of those in a supervisory role (mean = 65.3±5.4) and those who are not (mean = 63.5±5.5, mean difference = 1.8±0.8, t (212) = 2.27, p = 0.02). A moderate positive correlation ($r = 0.51$, $p<0.001$) exists between an individual's CLS score and perceiving themselves as a clinical leader. A moderate positive correlation ($r = 0.59$, $p<0.001$) exists between an individual's CLS score and believing they demonstrate leadership behaviors in clinical practice. **Conclusions:** Athletic trainers in supervisory roles report demonstrating clinical leadership behaviors more often than athletic trainers who are not in these roles. A discrepancy exists between athletic trainers' self-reported frequency of demonstrating individual clinical leadership behaviors and how frequently they see themselves and express themselves as clinical leaders in practice. The data suggest athletic trainers who are not in supervisory roles may believe, because they hold no positional authority, they are not clinical leaders. Future research should explore concepts of "leading from the middle," the role of influence up, down, and across an organization, and the psychological ownership of those not in positional authority in an effort to develop future leaders in the profession.

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Impact of Health and Safety Meetings on State Level Policy Adoption for Secondary School Athletics

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Context: Local Adoption of health and safety policies on the management and care of catastrophic sport-related injuries improves when state-level mandates are in place. However, implementation of state-level mandates for such policies varies (range, 30.80 – 85.00%) between states. The Team Up for Sports Safety (TUFSS) initiative was created in 2017 to assist states and associated policy decision makers propel policy adoption forward. The impact of these state meetings has yet to be examined. The purpose of this analysis was to evaluate adoption of state-level health and safety policies between 2017-2020 for states that had and those that did not have a TUFSS meeting. **Methods:** A 100-point rubric, developed in 2017, comprised of 5 equally weighted sections for sudden cardiac arrest, traumatic head injuries, exertional heat stroke, appropriate medical coverage, and emergency preparedness. This rubric was used to assess the presence of mandated policies (via state association policy, legislation, or other mandate) in all 50 states and the District of Columbia biannually. Absolute and relative (%Δ) changes in health and safety policy adoption among states that had TUFFS meetings compared to states that did not have TUFSS meetings (CON) between the 2016/2017 and 2020/2021 academic years (AY) were compared using Mann-Whitney U tests. **Results:** There were no significant differences in the absolute scores of TUFSS states and CON states between the 2016-2017 (p=0.506) and 2020-2021 (p=0.056) AY rubric reviews. The % Δ for TUFSS states (n=14) was significantly higher (p=0.045) compared to % Δ for CON states (n=37). See table. **Conclusions:** The relative improvement of state-level health and safety policies was significantly greater in states that held TUFSS meetings between 2017 – 2020. While many states have continued to improve health and safety policy adoption since the 2016-2017 AY, TUFSS meetings may have served as an added catalyst to promote greater policy improvements. While the socioecological approach to the structure of the TUFSS meetings may serve as a model to propel evidence-based best practice policy adoption, further exploration is needed to elucidate the factors most responsible for change.

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Impact of TUFSS Meetings on Safety Policies Based on Average Scores and Percent Change

	2016 – 2017 AY Score	2020 – 2021 AY Score	%Δ in Score
TUFSS Meetings	49.37±10.28	62.24±15.78	26.52±11.16*
CON	47.03±11.64	52.45±11.02	13.65±5.74
Combined Mean	47.67±11.23	55.14±13.10	17.18±8.21

* = $p<0.05$. CON = States that did not have a TUFSS meeting between 2017 – 2020. AY = Academic Year

Leadership Development in Athletic Training: A Qualitative Study

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Context: Effective leadership is important in healthcare, especially for the continued growth and promotion of the athletic training profession. National Athletic Trainers' Association (NATA) Hall of Fame (HoF) members represent a group of athletic trainers who have engaged in leadership activity and contributed to the growth and promotion of the profession; learning from their experiences can inform future leadership development initiatives in the discipline. The purpose of this project was to explore how athletic trainers such as HOF members describe their leadership and obtain their advice as to how the profession can assist in developing future leaders. **Methods:** Prior to data collection, a research team developed a structured interview protocol that was validated for content (researcher triangulation). The interview protocol reflected the aims of the study, the literature on leadership, and the research team's knowledge of the topic. The participants were recruited using a criterion sampling procedure: 1) induction into the HoF, 2) demonstration of leadership within the profession (i.e., service roles). Inclusion of both male and female leaders was made a priority. Upon recruitment of individuals meeting our criteria, and using professional networking, one-on-one interviews were completed with eight athletic trainers (males = 4, females = 4, average age = 71.6 years, average years in the profession = 44.8). Data saturation guided the total number of participants. Interviews were transcribed verbatim and shared with each participant for confirmation on content. Participants were asked to comment on the content of their transcript to ensure that their thoughts and responses were captured accurately (i.e., member checks). Coding followed a general inductive approach and was done by two researchers independently (i.e., multiple analyst triangulation). Data immersion was a key aspect of coding, which was then funneled by specific coding of the key concepts. Prior to the coding process, the two authors discussed the process and agreed. To establish trustworthiness, researcher triangulation, multiple analyst triangulation, and member checks were completed. Consensus was reached between the authors upon completion of the analyses and data saturation was determined to be achieved as the findings between interviews were consistent (i.e., constant comparison). **Results:** Two higher-order themes emerged from the data analysis: 1) Characteristics of Leaders, and 2) Development of Leaders. The Characteristics of Leaders theme was operationalized as those traits and qualities held by individuals who position themselves to lead others. Subthemes of Characteristics of Leaders were: Interpersonal Skills--defined as those skills needed to interact with others, including effective communication, Vision--defined as adopting a goal that can help advance the profession, Pride in Others' Success--defined as gratification in accomplishments of subordinates, Being Ethical and Moral--defined as decision making that is honest and honorable, and Self-Reflective--defined as the ability to recognize limitations. The theme of Development of Leaders was operationalized as development that occurs through formal and informal personal interactions. Subthemes of Development of Leaders were: Role Models both Personal and Professional--defined as following the behavior of mentors, Involvement and Networking--defined as development through service to the profession, and Workshops--defined as development through formal leadership courses and activities. **Conclusions:** HoF members report that they communicate well, adopt goals, take pride in the success of others, demonstrate sound decision-making, and recognize their limitations. Future leaders should emulate these attributes as they mature in the profession. Engaging with role models, volunteering in service to the profession, and participating in leadership activities helps leaders develop their skills. Future leadership initiatives should focus on developing various interpersonal skills (e.g., communication, goal setting, ethics) and provide opportunities for networking and identification of mentor relationships.

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The Meaning and Importance of Contemporary Expertise in Athletic Training

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Context: To align with current accreditation standards, all preceptors and educators affiliated with CAATE-accredited professional ATPs are required to report an area of contemporary expertise. The CAATE defines contemporary expertise as knowledge and training of current concepts and best practices in routine areas of athletic training practice. However, limited guidance is provided on acceptable contemporary expertise areas, leaving most educators and preceptors to navigate this concept themselves. The purpose of this study was to explore athletic training educators' and preceptors' perceptions of the meaning and importance of contemporary expertise. **Methods:** A 15-item cross-sectional online survey, which included 10 demographic items and 5 open-ended response questions, was distributed to athletic training educators and preceptors affiliated with professional ATPs in February 2021. 372 of the 534 ATs that accessed the survey completed it in its entirety (70% completion rate; 113 educators, 259 preceptors). As part of the survey, respondents were asked to rate their familiarity with contemporary expertise. Those who reported they were at least minimally familiar were then asked to describe what contemporary expertise meant to them and how contemporary expertise would improve their practice. Descriptive statistics were used to calculate familiarity percentages and the open-ended data were coded following the 4-phase consensual qualitative research approach. Strategies for trustworthiness included multi-analyst triangulation and an external auditor. **Results:** 75% of preceptors reported they were not at all or minimally familiar with contemporary expertise whereas more than 75% of educators reported they were moderately or extremely familiar. Only 9% of preceptors indicated that they were extremely familiar with the concept of contemporary expertise. Alternatively, only 7.5% of educators noted that they were not familiar at all with contemporary expertise. Although there were commonalities between preceptor and educators when asked to describe contemporary expertise (Figure), preceptor responses centered around defining characteristics and parameters of contemporary expertise while educator responses focused on the meaning and mechanisms for developing contemporary expertise. Preceptors also highlighted improvements or no improvements contemporary expertise could have on their practice while educators instead discussed the beneficiaries of their contemporary expertise. Some of the preceptors who indicated that contemporary expertise provided no improvement to their practice explained that being a generalist was important to their role as a clinician. **Conclusions:** The educators in our sample were more familiar with contemporary expertise than the preceptors, which points to the need for increased resources targeted towards the development or maintenance of contemporary expertise along preceptors. ATP administrators could likely assist in the delivery of such targeted resources during the program-required preceptor development. Future research should aim to address how contemporary expertise might benefit the patients or students of the educator or preceptor as this would support the need for contemporary expertise.

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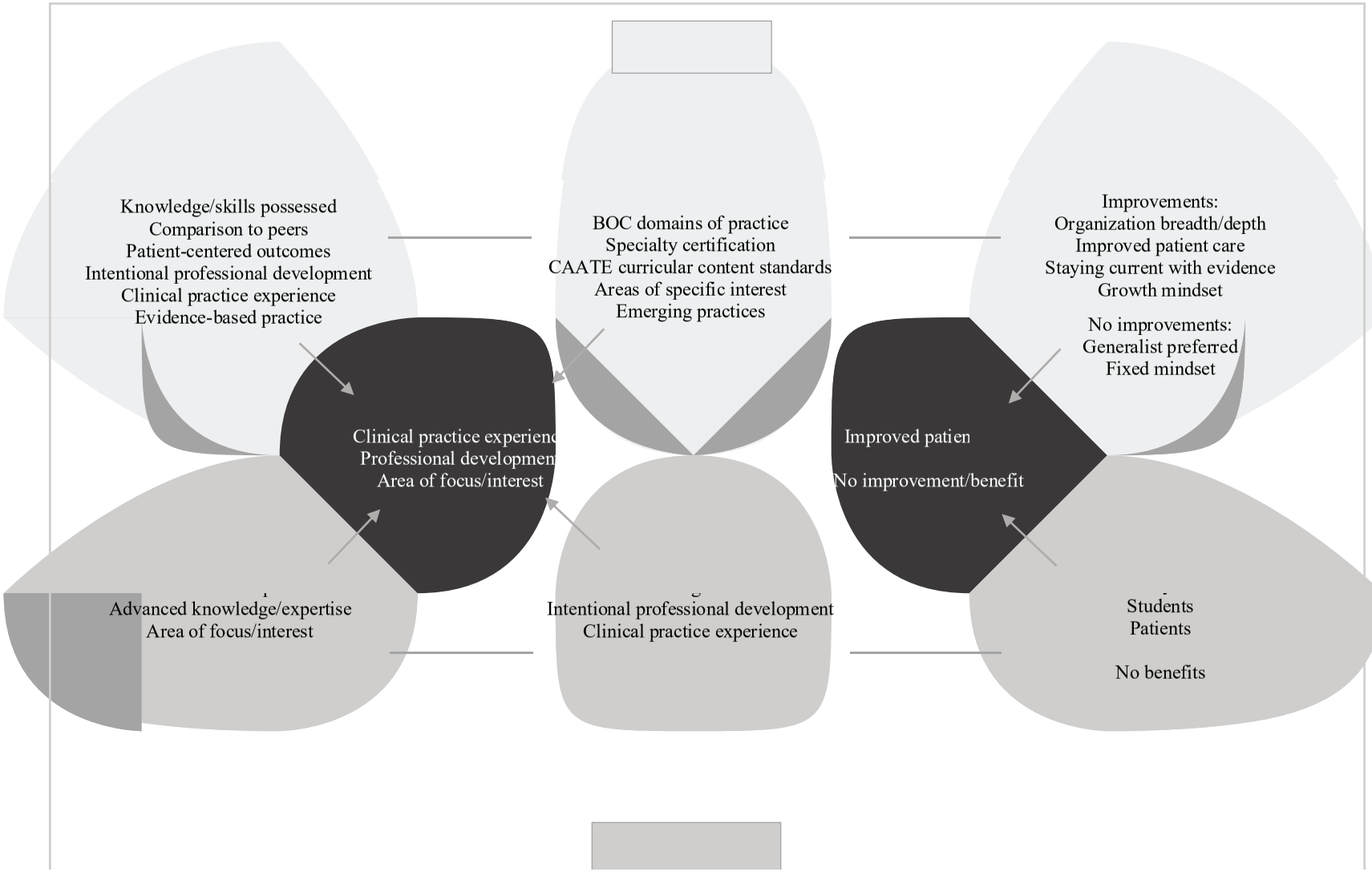
Figure. Preceptors' and Educators' Perceptions of Contemporary Expertise



Lower Extremity Strength Differences Among Sexes and Maturation in Adolescent Long-Distance Runners

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Context: Up to 68% of adolescent long-distance runners report a previous RRI. Altered hip and knee muscle function has been proposed to contribute to lower extremity injury in adolescent long-distance runners. A prior study in adolescent athletes from a variety of sports reported hip and knee strength measures differed between sexes and maturation levels. However, it is unknown if there are sex or maturational differences in hip and knee muscle strength in adolescent long-distance runners, specifically. The purpose of our study was to compare isometric hip and knee strength among male and female adolescent long-distance runners of different stages of physical maturation. We hypothesized 1) males would be stronger than females, 2) in males, post-pubertal strength would be greatest, and 3) in females, mid- and post-pubertal strength would be greatest. **Methods:** This cross-sectional study included 113 healthy adolescent long-distance runners (F=58, M=55, age=13.5±2.8y). Bilateral hip and knee strength were assessed via maximum voluntary isometric contractions measured by a dynamometer platform system (ForceFrame, VALD Performance). Hip strength assessments included adduction, abduction, flexion, extension, internal rotation, and external rotation. Knee strength assessments included flexion and extension. The order of muscle group testing was counterbalanced. Each assessment consisted of thee, 5-second MVICs where the participant pushed against the dynamometer with maximal effort followed by a 15-second rest period between contractions. Peak force was extracted for each muscle group for the right leg and normalized to body weight. Participants were stratified by sex (female, male) and stage of physical maturation (pre-, mid-, post-pubertal) according to the Pubertal Maturation Observational Scale.4 Two-way ANOVA (sex-maturation) compared group differences and pairwise comparisons with Bonferroni correction were used when significant interaction or main effects were found ($p \leq .05$). **Results:** We observed a significant sex-maturation interaction for hip abduction strength (p=.03, Table 1), but there were no significant pairwise differences (p=.07-1.00, d=0.11-0.80). We observed a significant maturation main effect for knee extension strength (p=.03, Table 1), but there were no significant pairwise differences (p=.14-1.00, d=0.03-0.95). No other significant interactions or main effects were observed (p=.16-.94, Table 1). **Conclusions:** While we did not observe statistically significant differences in lower extremity strength, we observed moderate-to-large effect sizes (d=0.35-0.95) for pairwise comparisons of hip abduction and knee extension strength. With a larger sample size, we would expect pre-pubertal females to have greater hip abduction and knee extension strength than mid- and post-pubertal females, but pre-pubertal males to have lower hip abduction strength than post-pubertal males. Our results indicate hip and knee strength may be influenced by sex and maturation for adolescent long-distance runners. Lower extremity strength should be assessed on an individualistic basis, with consideration for sex and maturation.

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Table 1. Body weight-normalized lower extremity strength comparisons among sex and maturation.

Muscle Group [N/kg]	Female Pre [n=12]	Female Mid [n=18]	Female Post [n=25]	Male Pre [n=20]	Male Mid [n=19]	Male Post [n=19]	Sex-Mat *p*	Sex *p*	Mat *p*
Hip Flex	3.4±0.6	3.5±0.9	3.3±0.9	3.2±1.3	3.6±1.3	3.7±1.4	.45	.62	.79
Hip Ext	2.6±1.3	2.9±0.8	2.8±1.1	2.8±1.2	3.1±1.3	4.5±1.7	.67	.61	.79
Hip Add	2.4±0.4	2.6±0.5	2.3±0.5	2.2±0.4	2.3±0.7	2.3±0.7	.42	.35	.26
Hip Abd	2.5±0.6	2.3±0.6	2.1±0.5	2.2±0.4	2.6±0.8	2.6±0.6	.03*	---	---
Hip IR	1.4±0.3	1.5±0.4	1.4±0.4	1.5±0.4	1.5±0.4	1.7±0.5	.55	.67	.94
Hip ER	1.2±0.3	1.2±0.3	1.2±0.3	1.3±0.4	1.4±0.4	1.5±0.4	.86	.76	.17
Knee Flex	2.4±0.6	2.5±0.9	2.5±0.6	2.5±0.8	3.1±0.9	3.1±1.1	.47	.62	.88
Knee Ext	5.3±1.2	4.1±1.5	4.1±1.3	4.6±1.4	4.5±1.5	4.1±1.3	.17	.16	.03*

Abbreviations: Flex=flexion, Ext=extension, Add=adduction, Abd=abduction, IR=internal rotation, ER=external rotation, *significant difference ($p \leq .05$)

Relationship Between Eccentric Hip Strength and Dynamic Balance in Runners With and Without a History of a Running-Related Injury

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Context: Running requires repetitive dynamic balance and cyclic concentric to eccentric muscle activity to maintain stability and appropriate kinematics during each gait cycle. Decreased eccentric hip abduction strength is associated with an increased risk of developing a running-related injury, specifically patellofemoral pain in novice runners. The Star Excursion Balance Test (SEBT) is a screening tool used to assess dynamic balance and SEBT scores are positively correlated with isometric hip strength. However, hip musculature activates concentric and eccentrically to control the hip and pelvis during the SEBT and weight-bearing activities such as running. Therefore, the objective of this study was to examine the relationship of eccentric hip strength and SEBT performance in healthy recreational runners with and without a previous running-related injury (RRI). **Methods:** Fifty-two healthy recreational runners with (n=34; 36.5±8.98yrs; 170.7±10.02cm; 68.42±9.98kg) and without a history of RRI (n=18; 36.05±9.42yrs; 171.74±9.29cm; 71.57±10.32kg) volunteered for this cross-sectional study. A RRI was defined as any injury related to running that altered or halted training within the past year. A handheld dynamometer was used to test eccentric strength of the hip abductors (HABD), adductors (HADD), and internal (HIR) and external rotators (HER). Three 5-second trials were performed for each test with 1-minute rest between trials, and 3-minutes rest between muscle groups. Torque values were calculated [Strength (Newtons)*Moment arm 'limb length'(meters)] and normalized by body mass and height (Nm/kg*m). All participants performed the anterior (ANT), posteromedial (PM), and posterolateral (PL) directions of the SEBT on their dominate limb. The average of three trials were recorded in centimeters and expressed as a percentage of the stance limb length. Additionally, the three reach direction values were averaged to create a composite (COMP) reach score. Pearson correlations were performed separately for runners with and without a history of RRI. Significance was set at $p<0.05$. **Results:** In runners with a history of RRI, there were significant, moderate, and positive correlations between HIR and the SEBT-PM (r=0.505, p=0.002), SEBT-PL (r=0.552, p=0.001) and SEBT-COMP (r=0.524, p=0.001). Additional minor but significant relationships were found within the RRI group for SEBT-PM, PL, and COMP, but none between any of the strength variables and the SEBT-ANT. No relationships were found between any of the strength and SEBT variables within the runners who had no history of RRI. (Table 1) **Conclusions:** The results indicate that various eccentric hip strengths are positively correlated with the PM, PL, and COMP SEBT, when assessing healthy runners with a history of RRI. Runners with a history of RRI may be relying more on eccentric strength for dynamic balance, whereas healthy runners with no history of RRI are utilizing other channels such as neuromuscular control. Future research should examine additional factors beyond eccentric hip strength that could correlate with SEBT performance.

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Table 1. Pearson Correlations for dominant eccentric hip strength and the directions and composite score of the SEBT.

		SEBT-ANT	SEBT-PM	SEBT-PL	SEBT-COMP
Previous History RRI (n=34)	**HER**	r=0.117 p=0.510	r=0.392* p=0.022	r=0.487* p=0.003	r=0.403* p=0.018
	HIR	r=0.301 p=0.084	r=0.505* p=0.002	r=0.552* p=0.001	r=0.524* p=0.001
	HABD	r=0.178 p=0.314	r=0.273 p=0.118	r=0.404* p=0.018	r=0.333 p=0.054
	HADD	r=0.179 p=0.312	r=0.251 p=0.152	r=0.351* p=0.042	r=0.301 p=0.083
No History RRI (n=18)	**HER**	r=-0.228 p=0.364	r=0.086 p=0.733	r-0.023 p=0.927	r=-0.019 p=0.941
	HIR	r=0.165 p=0.512	r=0.406 p=0.094	r=0.296 p=0.233	r=0.320 p=0.195
	HABD	r=-0.53 p=0.834	r=0.140 p=0.579	r=0.03 p=0.885	r=0.052 p=0.838
	HADD	r=0.063 p=0.802	r=0.308 p=0.214	r=0.232 p=0.355	r=0.230 p=0.359

*Statistically significant correlation ($p<0.05$). Abbreviations: HER, hip external rotation; HIR, hip internal rotation; HABD, hip abduction; HADD, hip adduction; SEBT, star excursion balance test; SEBT-ANT, anterior reach on the SEBT; SEBT-PM, posteromedial direction on the SEBT; SEBT-PL, posterolateral direction on the SEBT; SEBT-COMP, Composite score of all three directions on the SEBT; RRI, running-related injury.

Running Speed and Cadence at the Beginning, Middle, and End of Running Sessions in High School Cross-Country Runners

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Context: High school cross-country runners with a low cadence are at greater risk of sustaining a shin injury compared to runners with a higher cadence. During competition, triathletes demonstrated a reduction in cadence at the end of their run. Fatigue and cadence may interact to influence injury but it is unknown if running speed and/or cadence changes for adolescent runners during training sessions. This study investigated changes in running speed and cadence during typical training runs in cross-country runners. It was hypothesized runners would demonstrate slower running speeds and lower cadence at the end of the running session. **Methods:** High school cross-country runners (F=12, M=9, age=15.9±1.2y, BMI=19.7±2.2kg·m-2) participated in this study during the fall 2020 cross-country season. Participants were issued a GPS watch (Garmin Forerunner45s) during the season and instructed to record all training runs with the watch. After each running session, participants were instructed to self-report the type of running session using an electronic journal (Qualtrics). At the conclusion of the season, recorded running session files were retrieved from the watch and tcx files were run through a custom MATLAB script. Set distance or time running sessions were included in the analysis. Each running session was split into three portions: 1) beginning (0-20%), middle (40-60%), and end (80-100%) and the average running speed and cadence was calculated during each portion. For each participant, running speed and cadence was averaged together for all eligible runs for each portion of the run, respectively. Repeated measures ANOVA compared average running speed and cadence at the beginning, middle, and end of the running session. Sidak pairwise comparisons with conducted if a significant main effect was found ($p \leq .05$). **Results:** We observed no significant difference in running speed during the beginning, middle, or end portion of the typical running sessions (p=.41) but observed a significant difference in cadence (p=.02; Table 1). Pairwise comparisons showed cadence was significant higher at the beginning of the run compared to the middle (p=.01) and end (p=.04) of the running session. **Conclusions:** Running cadence was higher at the beginning of running sessions compared to the middle and end of run sessions but speed was not different among statistically different portions of running sessions. Running speed dropped from 11.84 km/h at the start of the running sessions to 11.66 km/h at the middle and end of the running sessions, which may be a performance-related meaningful difference and could have contributed to the decrease in cadence. Our findings suggest adolescent long-distance runners alter their running cadence during typical running sessions. Researchers should consider allowing an adequate warmup or familiarization period prior to collecting running data in adolescent long-distance runners.

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Table 1. Running speed and cadence at the beginning, middle, and end of typical running sessions.

Variable	Beginning	Middle	End	*p*
Running speed [m/s]	3.29±0.31	3.24±0.40	3.24±0.47	.41
Cadence [steps/min]	173±9	171±9	170±8	.02*†

Significant differences ($p \leq .05$): *beginning vs middle, †beginning vs end

Sex and Maturation Differences in Lower Extremity Flexibility Among Adolescent Long-Distance Runners

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Context: Up to 68% of adolescent long-distance runners report a previous RRI. A relationship between running-related injuries and reduced lower extremity flexibility has been reported for adult long-distance runners.2 However, the potential confounding effects of sex and maturation on flexibility3 may limit the generalizability of adult research to adolescents. The purpose of our study was to compare lower extremity flexibility among male and female adolescent long-distance runners of different stages of physical maturation. We hypothesized 1) females would be more flexible than males and 2) pre-pubertal runners would be more flexible than post-pubertal runners. **Methods:** This cross-sectional study included 113 healthy adolescent long-distance runners (F=58, M=55, age=13.5±2.8y). Lower extremity flexibility was assessed by measuring hamstring/low-back from the sit-and-reach test (cm), knee extension from popliteal angle (°), ankle dorsiflexion from the weight-bearing lunge test (cm), and hip rotation range of motion from passive internal and external rotation of the hips (°). Testing order was randomized among participants and data from the right side were included in analysis. Participants were stratified by sex (female, male) and stage of physical maturation (pre-, mid-, post-pubertal) according to the Pubertal Maturation Observational Scale.4 Two-way ANOVA (sex-maturation) compared group differences and pairwise comparisons with Bonferroni correction were used when significant interaction or main effects were found ($p \leq .05$). Effect size was assessed with Cohen's d. **Results:** We observed no significant sex-maturation interactions for any of the lower extremity flexibility assessments (p=.12-.39, Table 1). We observed a significant maturation main effect for the sit-and-reach test ($p < .001$, Table 1). Pairwise comparisons revealed that reach distance was greater for post-pubertal runners compared to pre- ($p < .001$, d=1.37) and mid-pubertal runners (p=.01, d=0.71) and for mid-pubertal runners compared to pre-pubertal runners (p=.02, d=0.66). We observed a significant sex main effect for popliteal angle; females demonstrated smaller popliteal angles than males (p=.03, d=1.20, Table 1). No other sex or maturation main effects were found (p=.07-.84, d=0.04-0.62, Table 1). **Conclusions:** Post-pubertal runners demonstrated farther sit-and-reach distances than mid- and pre-pubertal runners; females demonstrated a smaller popliteal angle than males. The sit-and-reach test combines hamstring and spine flexibility while the popliteal angle is an isolated measure of hamstring flexibility. Male adolescent long-distance runners have less isolated hamstring flexibility than females. Previous research has linked reduced flexibility to increased injury risk, but the relationship between flexibility and injury risk, specific to adolescent long-distance runners, is unknown. We did not observe significant differences for hip rotation but there were medium effect sizes (d=0.49-0.56) between pre- and post-pubertal groups. More research is needed to understand flexibility and running-related injury in adolescent long-distance runners. Clinicians may need to consider sex and maturational differences when assessing hamstring flexibility in adolescent long-distance runners.

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Table 1. Lower extremity flexibility comparisons among sex and maturation.

	Female			Male			Sex-Mat	Sex	Mat
Flexibility Test	Pre [n=12]	Mid [n=18]	Post [n=25]	Pre [n=20]	Mid [n=19]	Post [n=19]	*p*	*p*	*p*
SRT [cm]	28.7±10.8	38.6±9.9	46.3±6.1	26.4±8.6	28.9±7.8	35.0±10.8	.12	.48	<.001*
PA [°]	9.7±10.9	7.9±9.8	9.9±8.9	18.4±12.3	22.9±11.6	24.9±10.6	.39	.03*	.83
WBL [cm]	7.8±3.3	5.5±3.4	6.4±3.4	7.5±3.5	6.0±3.5	8.7±4.0	.27	.84	.22
Hip IR [°]	46.5±6.4	45.3±8.0	45.1±7.9	48.2±7.9	40.1±8.9	40.8±8.5	.17	.56	.88
Hip ER [°]	45.2±6.4	46.9±7.0	41.2±7.7	47.8±9.3	44.8±9.2	44.8±8.1	.26	.38	.07

Abbreviations: SRT=sit-and-reach test, PA=popliteal angle, WBL=weight-bearing lunge, IR=internal rotation, ER=external rotation, *significant difference ($p \leq .05$)

Access to Resources Necessary to Sustain Telehealth Use in Athletic Training Facilities

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Context: The integration of telehealth requires several different kinds of resources, such as physical space, trained providers, technology, and buy-in from stakeholders. The access to these resources may influence implementation and sustained use of the healthcare delivery mechanism for patient care. Therefore, the purpose of this study was to assess the resources available to athletic trainers (ATs) in their ATF and their use of telehealth. **Methods:** This cross-sectional study used an online survey sent to credentialed ATs to explore resources and telehealth use. We recruited ATs that were members of the NATA (n=23452). In total, 1,519 ATs responded to the survey and 817 responses were used for analysis. We explored participant's job setting and telehealth use (yes/no) with follow-up on type of telehealth encounter being synchronous (i.e., live video), asynchronous (i.e., store-and-forward), or indirect (i.e., calls, text). In addition, we asked participants to identify (yes/no) if they had access to resources necessary for telehealth consultations such as a dedicated healthcare facility, private space, internet, computer, and webcam. The participants (age=39±13 year; female=429, 52.5%, male=373, 45.7%, non-binary=1, 0.1%, did not disclose=14, 1.8%) were mid-career ATs (experience=15±12 years) providing AT services to various communities (suburban=361, 44.6%; urban=281, 34.7%, rural=168, 20.7%). Data were analyzed using descriptive analysis with a follow-up 'if case' descriptive analysis for telehealth use (yes/no) and ATF availability (yes/no) in conjunction with one's job setting to explore resource allocation and integration of telehealth services. **Results:** In total, 62.9% of participants (n=514 / 817) had previously used telehealth. Most ATs that were telehealth users reported using indirect (n=413, 50.6%) or synchronous (n=412, 50.4%) encounters. When examining resources, 78.7% of ATs (n=643) reported having a dedicated ATF to provide healthcare services. Of those individuals with access to an ATF, 75.1% have a private office (n=480 / 639). Almost all ATs with access to an ATF had high-speed internet (n=613 / 642, 95.9%), a computer (e.g., desktop, laptop, tablet; n=625 / 642, 97.4%), and a webcam (n=497 / 643, 77.3%). The case analysis identified that 48.7% of ATs in this study had both used telehealth and access to an ATF facility (resourced users=398); however, the majority had either not used telehealth but had access to an ATF (resourced non-user=245, 30.0%), had used telemedicine without an ATF (non-resourced user=116, 14.2%), or had neither used telehealth nor had access to an ATF (non-resourced non-user=58, 7.1%). These resource-use groups are further explored by job setting in Table. **Conclusions:** Only 78.7% of participants had an ATF. While nearly all with an ATF had access to necessary technology resources for telemedicine use, only 62.9% had previously used them. Further research on what barriers prevent athletic trainers with an ATF from implementing telemedicine use into their practice needs to be done.

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Table. Telehealth Use and Facility Access by Job Category (n, %)

Job Setting (n=817)	Resourced User (n=398)	Non-Resourced User (n=116)	Resourced Non-User (n=245)	Non-Resourced Non-User (n=58)
Clinic (n=96)	34, 8.5%	38, 32.8%	11, 4.5%	13, 22.4%
College (n=250)	177, 44.5%	3, 2.6%	68, 27.8%	2, 3.4%
Health Club (n=12)	7, 1.8%	3, 2.6%	1, 0.4%	1, 1.7%
Hospital (n=30)	6, 1.5%	12, 10.3%	7, 2.9%	5, 8.6%
Independent Contractor (n=14)	6, 1.5%	4, 3.4%	0, 0%	4, 6.9%
Industrial (n=37)	11, 2.8%	15, 12.9%	8, 3.3%	3, 5.2%
Other (n=39)	9, 2.3%	17, 14.7%	4, 1.6%	9, 15.5%
Professional Sports (n=28)	13, 3.3%	3, 2.6%	12, 4.9%	0, 0%
Public Safety (n=37)	11, 2.8%	9, 7.8%	8, 3.3%	9, 15.5%
Secondary School (n=262)	119, 29.9%	10, 8.6%	123, 50.2%	10, 17.2%
Youth Sports (n=12)	5, 1.3%	2, 1.7%	3, 1.2%	2, 3.4%

Applying the Transtheoretical Model for Change to the Adoption of Telemedicine by Athletic Trainers

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Context: Healthcare delivery by athletic trainers (ATs) has evolved over the past two years as a result of the COVID-19 pandemic. Previous research has identified an integration of telemedicine as a necessary, urgent replacement for face-to-face patient encounters in athletic training; however, there is a lack of data to support the habitual and intentional change to one's clinical practice that includes telemedicine. Therefore, the purpose of this quantitative study was to identify and analyze ATs respective stages of change related to telemedicine adoption. **Methods:** We used a cross-sectional, web-based survey to explore the adoption of telemedicine by ATs. We recruited 23,542 credentialed ATs across all job settings that were members of the NATA. Of the available respondents, a sample of 883 ATs were used for the analysis. The participants (age=39±13y; females=464, 52.5%, males=403, 45.6%, other=16, 1.8%; years of experience=15±12y) completed a survey asking their highest degree earned followed by a modified transtheoretical model (TTM) stages of change assessment used in previous literature. The reliable assessment asked participants to identify if they had 1) heard, 2) used, 3) considered using, and 4) general thoughts regarding telemedicine in athletic training. The responses postulated a stage of change category (Table 1) for the ATs included 1) unaware, 2) precontemplation, 3) contemplation, 4) preparation, or 5) action, maintenance, and/or termination (AMT). For the ATs who were categorized as stage 5 (AMT), an additional question was presented related to the timeframe for adoption, use, and current status of telemedicine in relation to March 2020 (start of COVID-19 restrictions). Data were analyzed using descriptive categorization into one of the five modified-TTM stages of change. A follow-up logistic regression model was executed to identify if an ATs highest degree earned (bachelor, professional master, post-professional master, doctoral) could predict adoption using the modified-TTM categories. **Results:** Most ATs were categorized in the AMT stage (n=551/882, 62.4%). Other participants were categorized in the stages as unaware (n=8, 0.9%), precontemplation (n=82, 9.3%), contemplation (n=78, 8.8%), and preparation (n=164, 18.6%). For ATs the AMT phase, most had been using telemedicine before March 2020 (n=152, n=27.6%) or started in March 2020 (n=205, 37.2%). However, 30.5% of participants who were once users of telemedicine have stopped use for unidentified reasons. The logistic regression model was statistically significant ($x2(3) = 21.504$, $p<0.001$). The model was highly sensitivity (86.3%; specificity=23.3%) and correctly classified 62.5% of cases **Conclusions:** Our results suggest that most ATs have recently changed their delivery of healthcare in the last 6+ months and intend to continue using telemedicine. Additionally, increasing an ATs highest level of degree earned was associated with an increased likelihood of being in stage five (AMT) on the modified-TTM assessment suggesting focused, professional development could sustain telemedicine use in athletic training.

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Table 1. Modified-Transtheoretical Model Descriptions adapted from Boston University School of Public Health

Stage of Change	Description
Unaware	AT has not heard of telemedicine
Precontemplation	AT does not intend to adopt telemedicine in the next 6 months
Contemplation	AT intends to start using telemedicine within the next 6 months
Preparation	AT is ready to change in the next 30 days
Action, Maintenance, and Termination (AMT)	AT has either recently changed (last 6 months) or for a while sustained (longer than 6 months) telemedicine adoption. In addition, the AT intends to maintain telemedicine use moving forward.

AT=Athletic Trainer

Factors Affecting Adoption of Telemedicine in Athletic Training

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Context: The profession of athletic training has recognized that the integration of technology for job specific tasks has been a long-standing challenge for clinicians. The adoption of technology has been slow for many athletic trainers (ATs) with them often citing software complications as the most common barrier to use. This finding may match potential barriers related to the adoption of telemedicine. To address the integration of telemedicine in athletic training, we must first explore the factors that may be affecting one's ability to use telemedicine for healthcare delivery. Therefore, the purpose of this study was to explore the barriers and motives to use of telemedicine by ATs. **Methods:** We performed a cross-sectional study to explore the factors affecting telemedicine adoption. We recruited credentialed ATs from all job settings that were members of the NATA research database (n=23,452) to participate in the web-based survey. A total of 883 ATs (age=39±13y; females=464, 52.5%, males=403, 45.6%, other=16, 1.8%; years of experience=15±12y) completed the tool in its entirety. The survey consisted of a 51-item telemedicine barriers and motives tool adopted from previous literature and adapted for athletic training. The tool consisted of 37 barriers which were categorized into seven subscales including cultural (i.e., patients, incentives), administration (i.e., physician, leadership), technological (i.e., usability, internet), regulatory (i.e., credentialing, reimbursement), hamper to success (i.e., exposure, understanding), buy-in (i.e., staff, executives), and maintenance (i.e., other providers, managers). In addition, the tool contained 14 items focused on motives, importance, and value of telemedicine implementation. All items were evaluated using a 5-point Likert-scale respective to agreement (1=strongly disagree, 5=strongly agree). Responses were combined as agree/strongly agree or disagree/strongly disagree, with all neutral responses omitted. The total number of agree/strongly agree barriers per category were summed per individual to identify the most common subscales. Data were analyzed using descriptive statistics. **Results:** Throughout the seven barrier subscales, most participants expressed concerns with at least one 'hamper to success' (790 / 883) or technological barrier (711 / 883); however, they did not commonly identify barriers with administration (226 / 883). The most prominent barriers included patient quality of care (583, 77.2%), lack of effective leadership in telemedicine (477, 75.7%), lack of exposure (518, 70.9%), and medico-legal issues (393, 67.2%). ATs strongly disagreed/disagreed that telemedicine was seen as a local threat (637, 93.5%) and that their collaborating physician would not like telemedicine (454, 86.6%). Motivators, importance, and value of telemedicine use are presented in Table 1. **Conclusions:** The ATs in the study identified that telemedicine success was hampered by a lack of exposure but did feel that telemedicine fills gaps in patient care and addresses patient satisfaction. Professional development in the use and benefits of telemedicine by clinicians, leaders, and physicians may bridge the gap between these factors.

Zachary Winkelmann is a consultant with Splynt, LLC. No other authors have any financial disclosures.

Table 1. Motivators, importance, and value of telemedicine.

Item	Disagree/Strongly Disagree	Agree/Strongly Agree
Quality improvement	196, 32.6%	405, 45.9%
Filling gaps in service	73, 9.4%	704, 90.6%
Immediacy of patient access	79, 10.4%	678, 89.6%
Driving institutional growth	180, 33.5%	357, 66.5%
Assisting with staff retention	259, 50.4%	255, 49.6%
Assisting with staff recruitment	273, 55.7%	217, 44.3%
Improving institutional metric	163, 33.7%	320, 66.3%
Satisfying institutional leadership	176, 36.5%	306, 63.5%
Addressing national guidelines	120, 22.9%	403, 77.1%
Addressing patient satisfaction	74, 10.2%	648, 89.8%
Providing clinical support	62, 8.7%	651, 91.3%
Addressing marketing	222, 45.5%	266, 54.5%
Providing quality care	108, 15.1%	609, 84.9%
Reducing costs	126, 20.7%	484, 79.3%

Mobile-Delivered Mindfulness Meditation in Individuals With ACL Reconstruction: A Phase I, Single-Arm Feasibility Study

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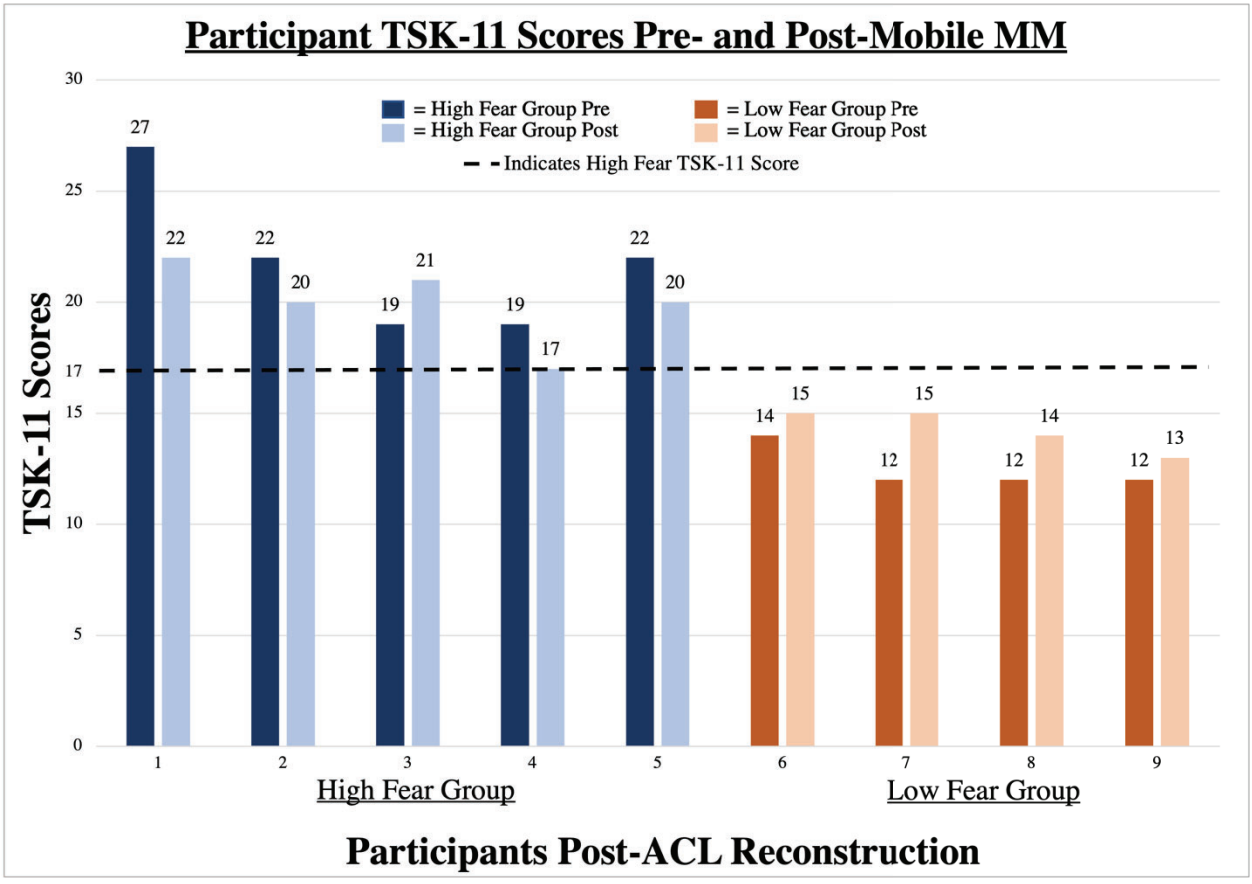
Context: Injury-related fear (IRF) after ACL reconstruction (ACLR) is associated with secondary ACL injury. Failure to address IRF through evidence-based interventions perpetuates the cycle of elevated injury risk and may negatively affect long-term knee joint health. Mindfulness meditation (MM), a mental practice that encourages staying in the present moment, has decreased IRF in patients with knee pathologies and may benefit patients post-ACLR. Therefore, the purpose of this study was to examine the feasibility and preliminary efficacy of a 4-week Mobile-Delivered MM (Mobile MM) intervention in individuals with ACLR. We hypothesized that the intervention would have high retention and high acceptability and would lead to decreased IRF. **Methods:** A phase I, single-arm feasibility study was used to examine the feasibility and preliminary efficacy of Mobile MM. Nine participants with unilateral ACLR (7 females, 2 males; 23.4±5.1 years old; 38.3±13.6 months since ACLR) were recruited using social media. Participants completed the Tampa Scale of Kinesiophobia-11 (TSK-11) to assess IRF pre- and post-intervention. Participants completed 4-weeks of Mobile MM via the HeadspaceTM mobile application, which included three 10-minute guided MM sessions per week (12 total sessions) delivered via video conference with the primary investigator. MM techniques taught during sessions included body scan and focused attention. A 2-item acceptability survey was sent to participants after completing the intervention to evaluate the benefit-to-effort relationship of the Mobile MM and perceived changes in IRF (scored 0 to 10 with 0 indicating low benefit-to-effort/increased IRF and 10 indicating high benefit-to-effort/decreased IRF). Mean scores ≥ 8 were interpreted as highly acceptable and scores between 6 and 8 were interpreted as moderately acceptable. Descriptive statistics (mean±SD) were used to describe participant retention, adherence, and acceptability. Participants with ≥ 17 on the TSK-11 were considered to have elevated IRF and the frequency of decline in IRF between those with high fear and low fear was examined. **Results:** 100% participant retention and 100% intervention adherence were observed during the 4-week study. Seven participants (77.8%) completed the follow-up participant acceptability survey. Participants reported a high benefit-to-effort relationship (8.63±1.93) and moderate changes in IRF were observed (6.00±2.4). Five out of the 9 participants exhibited elevated IRF prior to the intervention. Four out of these 5 participants exhibited decreases in IRF after Mobile MM at the post-test when compared to the pre-test (Figure 1). **Conclusions:** Mobile MM is a feasible intervention for individuals with ACLR because high retention, high adherence, and high benefit-to-effort relationship were observed. Additionally, preliminary efficacy suggests that Mobile MM may be beneficial to decrease IRF for individuals post-ACLR with elevated IRF. Future research should explore the efficacy of Mobile MM using a longer intervention period (e.g., 8-weeks) and in a post-operative ACLR population to enhance potential benefits of the intervention.

None of the authors have any financial disclosures.



Patient Satisfaction and Patient Reported Outcomes Post-Operatively Collected via Telemedicine or In-Office

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Context: The wide-spread use of technology in medicine requires more athletic trainers to interact with telemedicine. Telemedicine has been widely adopted in different domains of healthcare with its ability to improve clinical outcomes, accessibility to healthcare, and patient satisfaction through timely and affordable care. The aim of this investigation was to compare patient reported outcomes and patient satisfaction between telemedicine and in-office visits post-operatively in an orthopedics setting with both athletic trainers and physicians. **Methods:** We conducted a retrospective, cross-sectional analysis at the point of care with the intention of evaluating common clinical practice to improve care delivery. Data were acquired retrospectively from 2 weeks to 12 months post-operative for both telemedicine and in-office patient encounters occurring through a Sports Medicine clinic. Patients were included if they had received a surgical intervention from March 2020-September 2021. Patient satisfaction items, "likelihood to recommend" and "how well staff worked together," from the Press Ganey Patient Experience Survey were collected via the patient's electronic medical record. Demographic data included patient type (new or established), visit type (telemedicine or in-office), and provider (full-time athletic trainer, resident athletic trainer, MD resident/fellow, or float athletic trainer). Descriptive statistics including mean, standard deviation (SD), and frequencies were used to describe the participants. Data were analyzed using the nonparametric Mann-Whitney and Kruskal Wallis testing. **Results:** This study included 255 patients (age=50±17 years) who engaged in a telemedicine (n=80, 31.3%) or an in-office visit (n=175, 68.4%) over the study period. All patients were seen by the attending physician and additional provider, which included full-time athletic trainers (n=134, 52.3%), resident athletic trainers (n=77, 30.1%), physician (MD) residents/fellows (n=38, 14.8%), or float athletic trainers (n=6, 2.3%). Patients were predominantly established (n=195, 76.2%; new=60, 23.4%) with this clinic. No significant difference was found with patient satisfaction between in-office or telemedicine visits ($p>.44$). A significant difference was found with patient satisfaction and new or established patients, where established patients had higher patient satisfaction than new patients ($p<.04$). There was a significant difference with patient satisfaction and provider type ($p<.001$). Further investigation patients were more satisfied with care provided by the full-time athletic trainers compared to MD residents/fellows ($p<.001$), and more satisfied with full-time athletic trainers compared to resident athletic trainers ($p<.01$). No significant difference in patient satisfaction was found between the other identified providers ($p>18$). **Conclusions:** This study demonstrates no significant differences found with patient satisfaction between in-office or telemedicine visit type. To improve access and efficiency without sacrificing quality of care, telemedicine can serve as a viable option for post-surgical follow-up visits for patients across age ranges. Further, patients seeing full-time athletic trainers had the highest patient satisfaction, demonstrating the capability of athletic trainers to effectively use telemedicine.

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Wearable Data Differs Based on Coaches' Intended Workload Categorization

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Context: Sport coaches have a responsibility to modify training regimens to condition and rest their athletes so they can perform at their best. By planning and monitoring workloads, coaches and healthcare staff can make better informed decisions about athlete care and progression. The aim of this study is to determine if athlete measured workload collected via a wearable sensor in collegiate female soccer players aligned with coach intended workload (CIW) for each day of practice. **Methods:** During the 2021 spring soccer season, workload data was recorded with Beyond Pulse (Portland, OR) heart rate monitors in 32 collegiate women's soccer players (age: 19.7 ± 1.4 years, height: 167.3 ± 5.9 cm, mass: 67.2 ± 6.5 kg). The women's soccer season was in the spring due to NCAA COVID-19 rules. At the beginning of the season the coach provided researchers with a category of the workouts with the intended workload for each day of practice. The CIWs were divided into 4 categories: light, medium, heavy, and game day. Data from game days was removed from analysis because coaches did not create workouts to produce intended training loads on those days. During each activity session, the system recorded HR average (HRave), active participation (AP), distance, high-speed duration (HSD), and Banister's Training Impulse (TRIMP) for every athlete. A within-subject ANOVA was used to compare the differences for each wearable dependent variable across the different CIW categories. Post-hoc testing was performed with Bonferroni corrections and Cohen's d effect sizes were calculated. **Results:** The ANOVA revealed significant differences for each wearable variable ($p<0.05$). Post hoc testing showed significant differences between light and medium days in distance ($p<0.01$, $d=1.29$) and TRIMP ($p<0.01$, $d=0.82$). There were significant differences between light and heavy days in AP ($p<0.01$, $d=1.44$), distance ($p<0.01$, $d=3.08$), HSD ($p<0.01$, $d=0.67$), and TRIMP ($p>0.01$, $d=2.1$). There were also significant differences between medium and heavy days in AP ($p<0.01$, $d=1.14$), distance ($p<0.01$, $d=2.33$), and TRIMP ($p<0.01$, $d=1.72$). Table 1 contains all descriptive data. **Conclusions:** CIW was consistent with TRIMP measures for light, medium, and heavy days and each average TRIMP score was significantly different. The measurements for distance and AP were also significantly different between days for each intended workload. The data showed that coaches consistently predicted external workloads in athletes, such as AP and distance. However, data showed that measures of internal workload, such as HRave, were harder for coaches to predict. Athletic Trainers and other healthcare staff should be prepared to recommend longer recovery periods when CIW is high, as high external workload could lead to negative physical changes. Future analysis may reveal a difference in the wearable variables and player position.

None of the authors have any financial disclosures.

	Light			Medium			Heavy		
Distance (m)[1,2,3]	3439.1	±	495.8	4249.8	±	675.3	7090.4	±	1260.4
HSD (m)[2]	19.4	±	5.9	20.8	±	6.3	23.8	±	6.7
TRIMP (AU)[1,2,3]	8.4	±	2.2	10.6	±	2.8	18.2	±	4.4
HRave (bpm)	122.1	±	17.7	126.5	±	16.3	134.9	±	19.5
AP (AU)[2,3]	25.5	±	5.1	27.7	±	6.2	37.2	±	8.5

Table 1. Descriptive data (mean ± standard deviation) of the dependent variables across coach intended workloads (Light, Medium, Heavy) in the current study. HSD = High Speed Distance. TRIMP = Training Impulse. HRave = Average heart rate. AP = Active Participation. [1] indicates significant difference between Light and Medium Days. [2] indicates significant difference between Light and Heavy Days. [3] indicates significant difference between Medium and Heavy Days.

Blood Flow Restriction in Competitive Athletes, Does It Work? A Systematic Review

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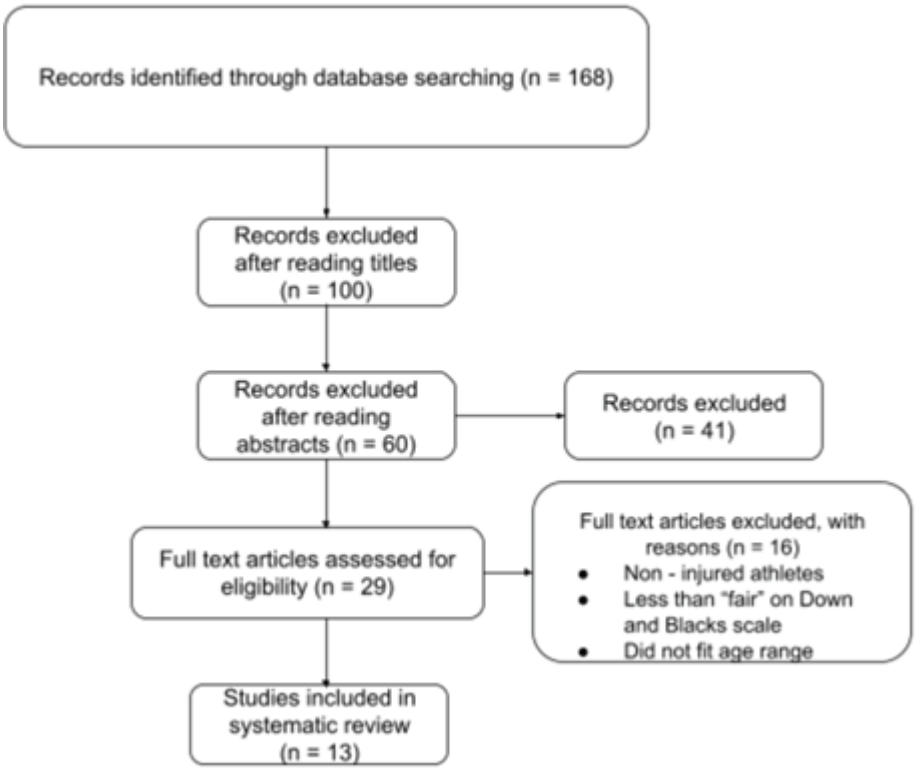
Context: Blood flow restriction training (BFR) is a specific technique that can be used to combine blood flow occlusion with low load resistance exercises to allow athletes to regain musculoskeletal strength and hypertrophy following a sport-related injury. Following an injury, athletes are faced with impairments such as muscular atrophy and weakness. Whether the injury is surgical or non -surgical, physical limitations will require a distinctive therapeutic intervention. Thus, a systematic review examined the benefits of BFR rehabilitation in both male and female athletes who were suffering from surgical and non-surgical injuries. **Methods:** A literature search was conducted investigating the combination of exercise and BFR on muscular hypertrophy, strength, and rehabilitation time. The inclusion criteria consisted of the following: 1. BFR applied as a therapeutic intervention 2. Population fit the description of "athlete" 3. Report of muscular atrophy 4. Study conducted after 2010 5. Article was written in English. An "athlete" was defined as an individual older than 16 who is skilled in an organized competitive sport. The following keywords and phrases were used for the article search: "blood flow restriction training," "occlusion training," "competitive athletes," "blood flow restriction; musculoskeletal injuries," "blood flow restriction; rehabilitation," "blood flow restriction; low load resistance training." The initial articles were eliminated by title, and then by abstract contents. Articles not meeting the inclusion criteria were eliminated. The quality of the articles were assessed using the Downs and Black Checklist with a cutoff of "fair" used to determine inclusion in the systematic review. Therefore, in total, 13 articles were included in the systematic review. A detailed illustration of the search process is provided below. **Results:** A total of 13 studies fit the inclusion criteria and were eligible for further review. Eight studies consisted of participants with surgical injuries (61.5%). The remaining five studies included participants with non-surgical injuries (38.5%). The common application of (1) frequency and (2) intensity showed quality results in each study. Participants utilized BFR training 2 - 4 days per week for 4 - 12 weeks. Participants utilized the 4-set standard of 30/15/15/15 for a total of 75 repetitions and with a 60% - 80% blood flow occlusion for the lower body and 30% for the upper body. Participants had an increase in 1RM values, muscular endurance/strength/hypertrophy, and decreased musculoskeletal rehabilitation time. **Conclusions:** Moderate evidence suggests that athletes who suffered an injury requiring surgical or non-surgical interventions demonstrated improved patient outcomes with low load resistance BFR training. Outcomes included an increase in musculoskeletal function leading to a decrease in physical rehabilitation time. BFR can be an effective tool used in combination with low load resistance training as part of a complementary patient-centered care plan.

None of the authors have any financial disclosures.



Blood Flow Restriction Training Effect on Post-Surgical Knee Arthroscopy: A Critically Appraised Topic

Markie C, Tierney RT, Mansell JL, Russ AC: Temple University, Philadelphia, PA

Context: Skeletal muscle atrophy occurs in the postoperative recovery phase following orthopedic surgery. Blood flow restriction training (BFRT) may provide an alternate mode for strength gains during rehabilitation. In knee arthroscopy patients, how does BFRT compare to conventional therapy in facilitating knee extensor strength during postsurgical rehabilitation? **Methods:** PubMed, Ovid, and EBSCOhost databases were searched in June and July 2021 using the following PICOT strategy: Patient: knee surgical, Intervention: blood flow restriction training AND (therapeutic or treatment), Comparison: traditional/conventional rehabilitation (strengthening OR Resistance), Outcome(s): knee extensor torque OR 1-repetition maximum, Time frame: post-surgical rehabilitation. In addition, these Boolean phrases were used: blood flow restriction AND "ACLR", blood flow restriction AND knee arthroscopy. Titles were reviewed for relevance, then abstract, then full text. Articles were included based on their ability to answer the research question and matching clinical outcome measures. Only studies from the previous 5 years were considered. Articles were excluded if patients had other non-surgical pathologies or other lower extremity injuries. Studies were assessed by the sole author using the Physiotherapy Evidence Database scale to identify trials for internal validity and have sufficient statistical information to guide clinical decision-making. Outcome measures gathered were representative of strength gains or deficit comparisons of Isokinetic Knee Extension Torque @60/sec scores, and 1- or 10-repetition maximal score (1RM/10RM). Medians, interquartile ranges, means, standard deviations, 95% confidence intervals, p-values and effect sizes are reported. Strength deficit scores were calculated by taking the difference between pre and post-test scores. **Results:** Five studies were returned and 3 were selected. In one study, there were decreases over time in isokinetic strength @60°/sec final deficit scores in the low-load BFRT group (LL-BFRT; pre=106.86[29.97-165.82]; post=34.82[-4.56-73.76]; p=0.001) and the conventional therapy group [pre=79.81[39.16-145.27]; post=41.25[-17.93-117.47]; p=0.008), demonstrating improvement in knee extension strength. Although both groups improved significantly, the LL-BFRT exhibited nearly a 2-fold percent increase compared to the conventional therapy. In a study between LL-BFRT (104.00[94.38–113.62]) and high load resistance training (HLRT; 106.00(94.78–117.22) both groups showed similar strength gains in 10RM (p=0.22,d=0.10). The third study comparing high resistance BFRT and conventional training showed no significant differences in isokinetic strength deficits @60°/sec [19.2(2.8–22.00), 34.40(-2.2–32.20); p=0.49,d=0.09] or 1RM strength increase [2.44(1.84–3.05), 2.10(1.63–2.58); p=0.24,d=0.10]. Two randomized control trials had an appraisal score of 7/10, and one randomized control trial scored 8/10. **Conclusions:** During postsurgical rehabilitation BFRT seems equally effective in increasing knee extension strength compared to conventional or HLRT. LL-BFRT could be a low stress alternative for increasing knee extensor strength compared to conventional therapy in early stages of rehabilitation. Limitations when examining these articles include different BFRT amounts, intervention timeframes, and outcome measures across studies. Future studies should examine specific surgical techniques and involve consistent intervention strategies and outcome measures.

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Elastic Therapeutic Tape for Reported Cervical Pain: A Critically Appraised Topic

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Context: Cervical pain is a common complaint among the general population with prevalence ranging between 0.4% and 86.8% (mean 23.1%). In current studies on the use and application of elastic therapeutic tape (ETT), there is disagreement on the efficacy of the tape application as it relates to pain. Limited evidence exists to examine the outcomes of ETT on patients with reported cervical pain. In patients with reported cervical pain, does the use of ETT lead to a reduction in reported pain when compared to no tape? **Methods:** A search of CINAHL and PubMed was conducted in July of 2021 using the following Boolean phrase: elastic therapeutic tap* OR kinesiology tap* OR kinesio tap* OR kinesio-tap* or k tap* or kt tap* or kinesiotape* AND neck OR cervical spine OR cervical AND pain OR pain management OR pain relief OR pain control OR pain reduction. Inclusion requirements were, studies had to compare ETT to a control group with no tape, use outcome measures for patient reported pain, use pre- and posttreatment measures, published within the past 5 years, and written in English. Studies were excluded if there was no comparison of pain between ETT and no tape use or if the application of the tape was not to the cervical region. The PEDro scale was used to assess internal and external validity. All studies used either a VAS scale ranged 0 – 10, or a VAS line range 0mm – 100mm. Means, standard deviations (SD), 95% confidence intervals (CI), and p-values were gathered. **Results:** Of the 37 studies found, 24 were not duplicates. Four studies were included and screened for further analysis. Three of the included studies resulted in no significant differences ($p > .05$) between the taped and no tape groups. One study reported a statistically significant difference ($p = 0.001$) in VAS scores at 3 months post treatment only between the taped group (1.56+.94; 1.17-1.95) compared to the no tape group (2.95+.97; 2.55-3.35). PEDro scores were 10/11, 10/11, 8/11, and 11/11. **Conclusions:** There is conflicting evidence regarding the use of ETT for cervical pain management. While Azatcam et al. reported a change in the participant's VAS pain scores, the other studies did not have similar results. Current research neither fully supports nor refutes the use of ETT for a variety of injuries. While the physiological theory behind the effects of the tape application are not well supported or agreed upon, there have been many reported improvements in patient reported outcomes. Using ETT should be a tool added to the clinician's toolbox to aid in the recovery of conditions, but should not be fully relied upon at this time.

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Greater Force Toward End of Suspension Strap Bridging Exercise Associated With Better Exercise Performance

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Context: Suspension training can target muscle groups throughout the body, specifically the core, which has led to its usage to advance rehabilitation exercises throughout athletic training and sports medicine settings. However, instrumenting the suspension equipment itself is rarely implemented, yet the suspension straps likely contribute more to how the individual completes the exercise than we may currently understand. The purpose of this study was to determine the relationship between force exerted on a suspension strap system during a double leg hip bridge and the hold time of the exercise as a measure of performance. **Methods:** Forty physically active individuals (Age:23.3±4.9years, Height: 170.2±7.9cm, Weight: 69.2±11.2kg, 20 males, 20 females) with no previous history of low back, core, or hip injury participated in this study. Participants completed one double leg hip bridge with their feet placed in a suspension strap system fixed to a closed door, with arms resting on the floor next to their torso. Participants were instructed to raise their hips off the floor, creating 90-degrees of knee flexion and to keep their thighs and torso in a straight line during the bridge. A load cell (ShapeLog®) sensor was attached to the suspension strap holding the participant's right foot and captured force data (lbs) in real-time using an iPad throughout the trial. Exercise time was calculated (s) starting when the participant moved into the appropriate position and concluded when they discontinued on their own or when the investigator determined they were no longer maintaining proper positioning. Force (lbs) data was reduced to 100 points to represent 0-99% as the complete hip bridge, where 0% indicates the participant was in the initial position and 99% was the conclusion of the exercise. Mean and standard deviation were calculated for force and time of exercise. Pearson's r correlation coefficients were calculated between time of exercise and each force percentage point of the bridge. **Results:** The total time of the hip bridge was 47.2±25.2s. There was a moderate significant relationship (r=.331-.478, $p<.05$) between time of hip bridge and force at 12 consecutive percentage points (87%-98%) at the end of the exercise (force 87%=44.0±16.5lbs, force 92%=39.0±18.3lbs, force 98%=18.5±19.0lbs). **Conclusions:** Individuals who were able to hold the double leg hip bridge longer on the suspension strap system (i.e., perform better) exhibited a greater force on the straps as they neared the end of the exercise. Although all participants decreased force gradually, this relationship was only significant as participants were about to discontinue the exercise indicating the importance of focusing on the end stages of suspension training exercises. As suspension strap training is useful for building core strength and stability, understanding how individuals are interacting with the straps throughout an endurance-focused task is beneficial.

None of the authors have any financial disclosures.

Pelvic Floor Therapy in Athletes With Urinary Incontinence: A Critically Appraised Topic

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Context: Exercise and sports put a strain on the pelvic floor muscles, causing many women to experience Urinary Incontinence (UI) or pain during activity. It has been reported that up to 75% of athletes experience urine loss while participating in sport and it is purported that pelvic floor therapy may decrease incidence of UI. In female athletes with UI, does pelvic floor therapy decrease incidence of urinary leakage? **Methods:** Pubmed, Cochrane, and Google Scholar were searched in June of 2021 using the Boolean phrases: Pelvic floor therapy AND athletes, Pelvic Floor OR urinary incontinence AND athletes, stress incontinence AND athletes, Pelvic floor muscle training AND athletes, Pelvic floor AND physically active, Pelvic Floor therapy, Pelvic floor muscle training. Study titles were reviewed for relevance, then abstract, and full text. Articles were included based on their ability to answer the research question and matching clinical outcome measure. Only studies from the past 7 years were considered. Internal and external validity were assessed using the STROBE checklist for cohort studies and the Center for Evidence Based Management (CEBM) critical appraisal of randomized control trials and the CASP for case control studies. **Results:** The search initially resulted in 1,460 articles, all but 15 were excluded based on title and study type. Of the 15 screened, 2 were included for analysis. In both studies, UI was assessed using the Pad test to measure urinary leakage. In one study using the pad test (Ferreira et al), female athletes were randomly assigned to control or experimental (pelvic floor muscle rehabilitation program) group. UI decreased by 45.5% in the experimental group vs 4.9% in the control. In another study using the pad test (Pires et al), athletes were randomly assigned to an at-home pelvic floor muscle training group or control group. There was a significant reduction in the mean leakage for the experimental group between initial (1.83 ± 2.40) and funal phases ($2.00\ 0 \pm 1.67$). The percentage of urine loss decreased in EG to 42.9% ($n = 3$) and increased in CG to 83.3% ($n = 5$). One study scored 9/10 on the CASP and one scored 3/3 on CEBM. **Conclusions:** There is consistent evidence that pelvic floor therapy is beneficial in decreasing urinary incontinence in athletes. This is reliant on the ability to target the correct muscles to build awareness of proper muscle contraction and adherence to the exercise protocol. UI is common in athletes, particularly females participating in high impact sports. Pelvic floor therapy protocols should be developed and available for high impact sport athletes to mitigate the occurrence of urinary incontinence during sport. SORT B.

None of the authors have any financial disclosures.

The Effectiveness of a Posterior Shoulder Stretching Program in Decreasing the Pain Prevalence in Adults Diagnosed With Subacromial Impingement Syndrome: A Critically Appraised Topic

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Context: Subacromial impingement syndrome (SIS) is the leading cause of shoulder pain and dysfunction, representing more than 60% of all shoulder pain cases. Posterior capsule tightness is often associated with scapular dyskinesia and changes in rotator cuff muscles which can lead to SIS. Stretching exercises increase the available space between the shoulder and the humerus, helping to alleviate compression of the rotator cuff, bursae, and biceps tendon. Stretching the structures related to the scapula and posterior shoulder may positively affect clinical symptoms and functional status in patients with SIS. Our objective was to explore if there is evidence to suggest that a posterior shoulder stretching program decreases the pain prevalence in adults diagnosed with SIS. **Methods:** The literature was searched in November of 2020 for studies published within the last 5 years investigating the effects of a posterior shoulder stretching program on pain in adults with SIS. Databases searched included Pubmed, Sciencedirect, Sportdiscus and Medline. Articles were included if they met the following criteria: a) investigated adults with SIS (≥18 y.o.), b) diagnosis for SIS was confirmed by positive findings for 2 of the following special tests: painful arc, Hawkins Kennedy, or Neers, c) intervention consisted of a posterior shoulder stretching program that included the pectoralis minor stretch, crossbody stretch and/or sleeper stretch, d) assessed pain using a standardized patient reported outcome measure. The Physiotherapy Evidence Database (PEDro) scale was used to appraise the included randomized control trials. Cohort studies were assessed using The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) statement. **Results:** The search of literature produced 67 studies. Ten duplicates were removed. After review of title, abstract, and assessment for inclusion criteria, 4 studies were identified for appraisal. The studies utilized various questionnaires to assess pain prevalence including the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, QuickDASH, Visual Analog Scale (VAS), and Shoulder Pain and Disability Index (SPADI). Program durations ranged from 4 weeks to 12 weeks. Three out of the 4 studies identified a reduction in pain scores after participation in a posterior shoulder stretching program as well as an increase in shoulder functionality. All stretches including pectoralis minor stretch, the cross body stretch and the sleeper stretch showed improvements for pain on the DASH and VAS questionnaires. **Conclusions:** There is level B evidence to suggest that a posterior shoulder stretching program is effective in decreasing pain in adults with SIS. Incorporation of posterior stretches in a comprehensive rehabilitation program for individuals with functional SIS should be considered. Stretching programs lasting at least 4 weeks are most beneficial, highlighting the importance of continuity of care and regular maintenance when treating SIS patients.

None of the authors have any financial disclosures.

The Effects of a Percussive Therapy Intervention on Patient-Reported Delayed Onset Muscle Soreness (DOMS): A Critically Appraised Topic

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Context: Patients that perform muscular exercise may develop the muscular fatigue concept known as Delayed Onset Muscle Soreness (DOMS) and a potential decrease in related performance. Evidence indicates that vibration therapy is a relatively new technique used to decrease the effects of DOMS. In physically active individuals, does the use of a percussive therapy device decrease the effects of delayed onset muscle soreness? **Methods:** Google Scholar, PubMed, and Medline databases were searched in October of 2021. The primary search terms used were: (Percussive therapy OR Vibration therapy OR theragun OR massage gun) AND (Delayed onset muscle soreness OR DOMS OR muscle soreness). Studies were included if they were Level 4 evidence or higher, included the use of a percussive or vibration therapy device, included physically active individuals, include DOMS as a measurement tool in patients, and were published in English within the past 10 years. Outcome measures evaluated were patient-reported pain assessed on the Visual Analog Scale (VAS) and Pain Pressure Threshold (PPT) measured in pounds or CC's of force. Pre- and Post-intervention scores were analyzed using VAS and PPT with 95% confidence intervals (CI) and effect sizes (ES). ES were calculated at different recovery times in comparison to the experimental and control groups. **Results:** Titles and abstracts of 40 studies were reviewed and 8 studies were selected for full-text screening. After secondary screening 3 randomized control trials (RCT) were analyzed for this critically appraised topic. CI and ES were calculated where not reported. In the first RCT, authors noted moderate effect sizes for reduction in PPT favoring the percussive therapy (PT) intervention group at 24-hrs (d=0.378) and 48-hrs (d=0.495) post event. At the 72-hrs post-event time period authors noted a moderate effect (d=0.536) that favored the control group. The second RCT evaluated PPT at various locations on the quadricep and calf 24-hours after a fatiguing event. The authors noted large effect sizes ranging from (d=1.18) to (d=2.11) on both right and left legs favoring the percussive therapy intervention group when compared to a control in each location. These authors also noted substantial effects (d=4.99) and (d=4.03) on VAS favoring the PT intervention of the right and left legs respectively. The third RCT demonstrated large to substantial effects sizes of the PT on VAS at 24-hrs (d=1.61), 48-hrs (d=3.97), and 72-hrs (d=2.91) when compared to a control group. PEDro scores were 5 / 10, 6 / 10 and 7 / 10 respectively. **Conclusions:** Moderate SORT B evidence shows percussive therapy decreases the effect of DOMS. Based on the evidence that vibration therapy has some clinical utility for the decrease of effects in DOMS.

None of the authors have any financial disclosures.

The Effects of Blood Flow Restriction in Improving Shoulder Muscular Strength Versus Traditional Exercise Strengthening: A Critically Appraised Topic

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Context: Blood flow restriction (BFR) is an increasing popular method to improve strength in populations that are unable to complete traditional resistance exercises. While there is a wide selection of literature on the application and efficacy of BFR in the lower extremity, research related to the upper extremity remains sparse. Therefore, this paper questions: Is BFR effective in improving strength in shoulder musculature compared to traditional resistance exercises in the healthy population? **Methods:** SportDiscus, PubMed, CINAHL, Medline, and Google Scholar were searched using the terms: "blood flow restriction", "shoulder", and "strengthening". The parameters of the search were publication the past 5 years and English translation. After identifying articles, they were screened for completion of resistance exercises by both the control and experimental groups, along with the use of a safe level of occlusion. Articles were scored using the PEDro scale and needed to be rated at 5 or higher. The outcomes considered included the mean differences and p-values. The initial search returned 6 articles that met the criteria, of those 3 were reviewed. Of those,, 2 rated 9/10 on the PEDro scale and 1 rated 7/10. **Results:** There were significant increases in strength for all groups across all 3 studies. Between group differences were significant for the pectoralis major ($p=0.028$, $d=1.7614$) and lower trapezius ($p=0.046$, $d=0.8929$) muscles, and as a group the shoulder flexors ($p=0.01$, $d=2.556$), muscles that work in scaption ($p=0.05$, $d=3.1$), and abductors ($p=0.02$, $d=3.286$). Also tested,with no significant difference between groups was isokinetic strength for external rotation ($p=0.88$) and the cross sectional area of the supraspinatus tendon ($p=0.610$). There were significant changes in strength of the supraspinatus ($p<0.001$, $d=0.91$) and external rotators ($p<0.001$, $d=0.904$) within the BFR group but no significant difference between the experimental and control groups. **Conclusions:** BFR training does increase strength in shoulder musculature at the same or higher levels compared to traditional resistance training. Among the 3 studies included, there were limitations including allowing patients to complete resistance exercises outside of the study and that the exercises for both groups were completed at the same percentage of single repetition maximum. One study was also limited by only having male participants and a between group difference existing at baseline. BFR is a tool that can be effective and increase patient outcomes in the clinical setting with education of athletic trainers in all settings. Based on the Centre for Evidence-based Medicine there is Grade B evidence BFR increases strength in shoulder musculature.

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The Effects of Minimalist Shoes on Intrinsic Foot Muscle Size and Strength: A Systematic Review

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Context: Minimalist shoes have become increasingly popular over recent years. They are proposed to prevent injury and enhance athletic performance by strengthening the intrinsic foot muscles (IFM), yet there is little consensus on the effectiveness of minimalist shoes in increasing IFM strength or size. Therefore, this systematic review assesses the effects of using minimalist shoes as an intervention on changes in IFM size (MRI or ultrasound for volume or cross-sectional area [CSA], respectively) and strength. **Methods:** PubMed, CINHAL, Web of Science, and SPORT Discus were systematically searched for articles between January 2000 to October 2021. Studies were included if they were prospective randomized controlled trials with an intervention of at least 2 weeks examining the effect of minimalist shoes on IFM strength, volume, or CSA. Two reviewers independently screened all abstracts and articles based on inclusion criteria. After removing the duplicates, full length-articles were appraised based on the PEDro scale. **Results:** We found 805 total titles using the search criteria and after removing duplicates, 453 remained. After screening of the abstracts and full texts according to the above criteria, 446 articles were excluded. Seven studies remained that evaluated the outcomes of minimalist shoe usage on IFM size and strength. Five of the studies were considered good with PEDro scores ranging from 6-8, and 2 studies were considered fair with PEDro scores ranging from 4-6. These were all randomized controlled trials that used traditional running shoes as a control group. The results of changes in muscle strength, IFM volume, and CSA are listed in Table 1. It is important to mention that consistent changes were not found in the same muscles across the included studies. Two of the studies had additional comparisons between minimalist shoes and other interventions, which were a muscle strengthening program and an electrical stimulation protocol. One study also showed that walking in minimalist shoes and performing foot strengthening exercises achieved similar increases in muscle size and strength. **Conclusions:** Findings from this review suggest that the use of minimalist shoes may be an effective way to increase IFM size and strength in healthy individuals. Authors emphasized the importance of gradually transitioning to minimalist shoes safely, such as beginning with walking if the intention is to run eventually. Future research is needed to explore using minimalist shoes as an intervention for symptomatic populations that involve weakened or atrophied IFM, such as plantar fasciitis, chronic ankle instability, or patients with diabetes.

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Table 1. Methods and results of changes in intrinsic foot muscles

Author Year (PEDro)	Sample size	Length, Intervention	Participants	Outcome measures	Results for IFM
Chen 2016 (7)	n=20 n=18 control	6 months, Transition to run	Habitually shod runners (>20 km/wk)	Volume: MRI	P<.01*, ES=.54 7-9% increase
Curtis 2021 (4)	n=22 n=24 control	6 months, Wear 70% of time	Habitually shod runners	Strength: toe dynamometer	P<.001* ES = .84 57.4% increase
Ebrecht 2018 (5)	n=32 run n=15 e-stim n=12 control	8 weeks, Transition to run	Young, healthy people	CSA: US	P=.203, ES=.801 16.3% increase
Goldmann 2013 (6)	n=18 minimal n=18 traditional n=7 control	3 weeks, High intensity athletic training	Female sport students	Strength: toe dynamometer	25º MPJ flexion: P<.001*, ES=.6 9% increase
Johnson 2015 (6)	n=18 n=19 control	10 weeks, Transition to run	Recreational runners (24-48 km/wk)	CSA: US	P<.001* 10.6% increase
Miller 2014 (6)	n=17 n=16 control	12 weeks, Transition to run	Healthy runners (30 miles/wk)	Volume: MRI	P=.007-.03*
Ridge 2015 (7)	n=57	8 weeks, Walking program	Experienced runners (15-30 mi/wk)	Strength: toe dynamometer CSA: US	Increases: 7.05% ± 2.92% size, 41.11% ± 12.55% strength

* denotes significance

The Effects of the Game Ready® vs a Frozen Elastic Bandage on Intramuscular Temperature

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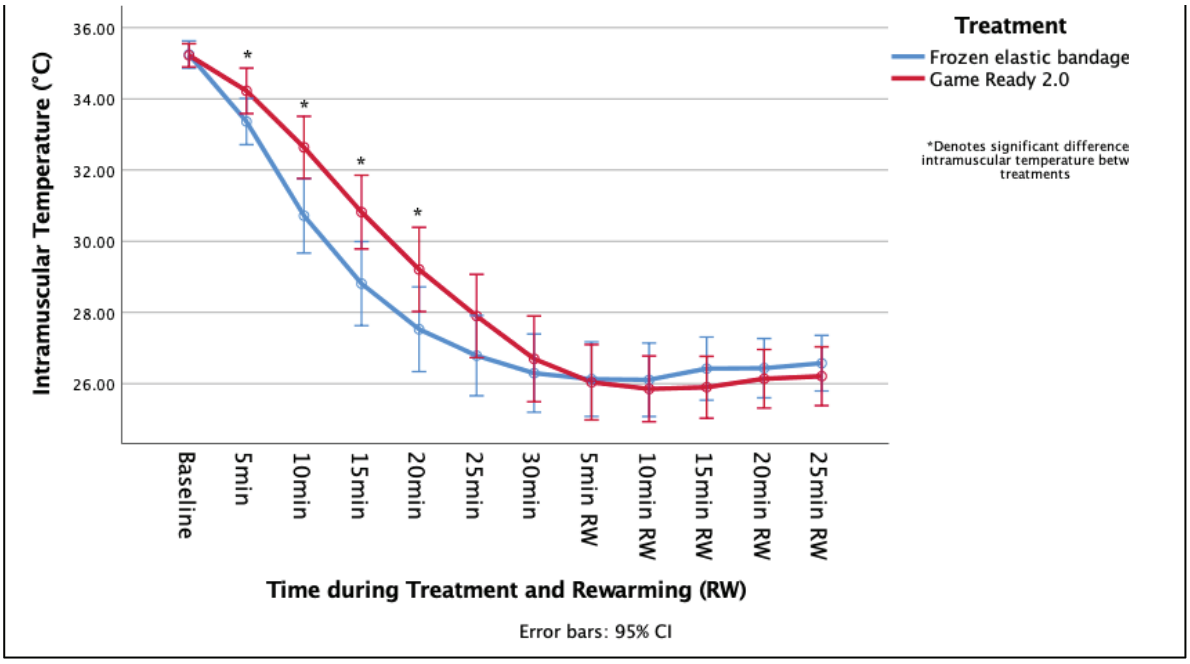
Context: Previous research has shown the effectiveness of various devices in cooling intramuscular tissue. Because of the low cost, a frozen elastic bandage may be a more practical clinical technique than commercially available cold compression units. The objective was to compare the intramuscular temperature changes in the gastrocnemius using a Game Ready® 2.0 (~$2,500) or a frozen elastic bandage (~$10) in healthy, recreationally-active individuals. Our hypothesis was that the frozen elastic bandage would reduce intramuscular temperature more than the Game Ready®. **Methods:** This was a randomized controlled crossover study in a controlled research laboratory. Twenty-four individuals (12 males, 12 females, age =24.5±2.6years, wt=76.0±14.7kg, ht=173.3±.8.5cm) volunteered to participate. Each received both treatments, with at least 7 days between bouts. Participants were randomly assigned to the treatment order, counterbalanced by treatment and sex. The total treatment time was 30 min., followed by 25min. rewarming. 30.5cm of the low leg was cooled and compressed (45-55mmHg – measured with a PicoPress®) with a 9.1m x 10.1cm frozen elastic bandage or the Game Ready® on the high pressure setting (cycled 5-70 mmHg). Data were collected using an Isothermix™ thermocouple to record intramuscular temperature every 30-sec for 60-min. The dependent variable was intramuscular temperature at 1cm (+subcutaneous fat). Data were analyzed using a two-way repeated measures ANOVA, 0.05 alpha level. **Results:** There was no statistical difference in baseline intramuscular temperature (P=.908) between the frozen elastic bandage (35.24±.90°C) and the Game Ready® (35.22±.78°C). A significant time x treatment interaction (F(11,253)=11.38,P<.001,n2=.331,observed power=.998) indicated a difference over time between the two treatments (Figure 1). Post-hoc testing showed lower intramuscular temperature with the frozen elastic vs. the Game Ready® at several timepoints during the treatment, with greatest difference at 15min (P=.002), respectively (28.81±2.79°C vs. 30.82±2.45°C). There was no difference in intramuscular temperature between the two treatments at the end of the 30min treatment (P=.533) or during rewarming at 10min (P=.638) or 25min (P=.484). The coldest intramuscular temperature for the frozen elastic bandage was achieved 10 minutes into rewarming (26.11±2.44°C) and for the Game Ready® at five minutes into rewarming (26.04±2.51°C). **Conclusions:** The frozen elastic bandage reduced intramuscular temperature more quickly than the Game Ready®, but resulted in the same overall cooling by the end of the 30-minute treatment and throughout the 25 minutes of rewarming. Both treatments were effective at decreasing intramuscular temperature, however, the frozen elastic bandage is significantly more affordable. Future research is needed to determine tissue temperature thresholds at a variety of depths and within joint spaces for specific therapeutic effects including preventing edema, reducing pain, and reducing secondary injury.

None of the authors have any financial disclosures.

Figure 1 – Intramuscular Temperature during Cryotherapy Treatments



The Knowledge of Complimentary and Integrative Health Among Athletic Trainers

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Context: Complimentary and integrative health (CIH) interventions are modalities not considered mainstream and are used to complement traditional care. Athletic trainers may use CIH modalities or may have patients with interest and experience with using complementary care. The purpose of this project is to investigate collegiate athletic trainers' usage and attitudes towards CIH interventions. **Methods:** We used a cross-sectional, web-based survey that included questions about demographics, CIH integration, and the Complimentary Health Belief Questionnaire (CHBQ). The CHBQ has been shown to be a valid and reliable measure of individual provider's attitudes and beliefs towards CIH interventions. The CHBQ is a 10-item instrument, with all items scored on a 7-point Likert scale (1= absolutely disagree to 7= absolutely agree; max score=70). Demographics were analyzed using measures of central tendency. An independent t-test was used to determine differences in beliefs and attitudes towards CIH between those that use CIH interventions and those that do not. **Results:** Emails were sent to 6,225 potential participants; 758 participants responded (access rate=12%) and 613 completed the tool in its entirety (completion rate=80.9%) (age=40±12y; years certified=16±11y). A large majority of participants are employed at a Predominately White Institution (n=418/613, 68%), Part B Institution (Historically Black College and University) (n=15/613, 2%) and Hispanic Serving Institutions (n=16/613, 3%). A large number of participants reported that they use CIH within their practice (n=499/613, 81%) and several participants reporting that they have referred patients out to CIH professionals (n=453/613, 74%). The average total score for the Complimentary and Integrative Health Belief Questionnaire (CHBQ) is 43.41±4.26, indicating generally positive beliefs and attitudes towards CIH interventions. There was no difference (p=.06) in CHBQ scores between participants who use CIH (43.60±4.15) and those who do not (42.57±4.66). When asked about confidence in using CIH, 40% (n=241/613) of participants indicated being somewhat confident in using CIH, while 33% (n=205/613) reported being confident. A majority of participants indicated they work with patients who demonstrate interest in using CIH (n=521/613, 85%) and many participants either somewhat agreed or agreed the patients they work with should have the option to use CIH interventions (n=364/613, 59%). A majority (n=363, 59%) indicated having some form of formal training in CIH interventions. The most commonly used CIH interventions were, massage (439/613, 72%), yoga (303/613, 49%), chiropractic care (231/613, 38%), dry needling 213/613, 35%), and meditation (152/613, 25%). **Conclusions:** Many collegiate athletic trainers integrate CIH within their practice and report being somewhat confident using CIH. Collegiate athletic trainers tend to have a more positive attitude towards CIH, regardless of their personal practice integration. Athletic trainers should consider interventions, including complementary and integrative health interventions, resulting in positive patient outcomes. Moreover, future research should evaluate the patient and clinical outcomes related to CIH.

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Acute Alterations in Neuromuscular Function Induced by Aquatic Exercise

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Context: Aquatic exercise has been broadly utilized during rehabilitation and post-training recovery as a primary or adjunctive tool. The unique physical properties of water provide athletic trainers with various training options that may be challenging or even impossible to perform on land. However, research examining the effects of aquatic immersion on neuromuscular function is limited. Thus, the purpose of this study was to investigate, from a crossover experimental design, whether an aquatic environment alters neuromuscular functions, including maximal isometric force production (PF) and rate of force development (RFD) during the isometric midthigh pull test when compared to a land environment. **Methods:** Eleven healthy young adults (age: 26.5 ± 1.1 years) without any ongoing neuromuscular injuries or disease were asked to participate in the study. The midthigh pull test was performed on a custom testing device, that included a waterproof force platform and an adjustable bar. First, participants completed a warmup, consisting of 3 isometric efforts at a perceived intensity of 25%, 50%, and 75% of maximum effort. Following the warmup, participants were asked to pull the bar, which was positioned at the midpoint between the center of the patella and the anterior superior iliac spine, as hard and quickly as possible and maintain the maximal effort for 5 seconds. Participants completed 2 visits to the laboratory, separated by 24 hours, and the orders of the exercise environments (i.e., aquatic and land) were randomized. During the aquatic session, participants were immersed in thermoneutral water (32.5 ± 0.2°) to the xiphoid process. PF and time-specific RFDs, including early phase (RFD100; 0 - 100 ms) and late phase (RFD200; 100 - 200 ms), were computed from ground reaction force data (sampled at 1,000 Hz). Changes between the two environments were assessed via a paired t-test ($\alpha = 0.05$). **Results:** RFD100 was greater during the aquatic sessions when compared to the land sessions (4,108.27 ± 3,282.95 N·s-1 vs. 1,649.13 ± 2,304.64 N·s-1, $p = 0.04$). No significant differences were observed in PF (1,080.87 ± 530.93 N vs. 1,016.34 ± 713.78 N, $p = 0.40$) and RFD200 (2,585.14 ± 2,347.34 N·s-1 vs. 1,832.21 ± 3,133.62 N·s-1, $p = 0.52$) between the environments. **Conclusions:** The results identified that aquatic immersion might induce a greater early rate of RFD. Early RFD plays an important role in various athletic performances, especially those involving movements with a small amplitude over a short period (e.g., countermovement jump). Understanding the neuromuscular responses to aquatic immersion during exercise may offer a foundation for creative applications and help athletic trainers when building a rehabilitation or performance training program for athletes. Further research with a larger sample size is warranted to fully corroborate the suggestion.

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Acute:Chronic Workload Ratios and Positional Differences in Collegiate Men's Lacrosse Players

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Context: Acute:chronic workload ratios (ACWRs) have been used to determine injury risk during sport participation. However, positional differences in ACWRs throughout a season for men's lacrosse players have not been determined. Further, distance traveled and activity intensity have not been compared across positions during an entire collegiate lacrosse season. The purpose of our research was to determine if there were positional differences in ACWRs, distance traveled, and activity intensity in men's NCAA DIII lacrosse players. **Methods:** We recruited 53 participants (age=20.4 years, weight=81.6 kg, height=182.4 cm, Attack=12, O-Mid=14, D-Mid=6, FO=4, Goalie=3, Defense=14) from one NCAA DIII lacrosse team for our cross-sectional study. Sport Performance Tracking (SPT, Melbourne, Australia) GPS units tracked athletes'ACWRs (AU), total distance traveled (m), and intensity (proprietary composite score; AU) for every game and practice of the traditional spring lacrosse season (12 weeks). The units used 10 Hz GPS sampling rates which have been found to be both valid and reliable. We used a 9x6 mixed model ANOVA to determine differences in ACWR (dependent variable) between the 6 positions (between factor) over 9 weeks (within factor) following the first 3 weeks of acclimation time required for calculating ACWRs. We also determined differences in distance traveled (dependent variable) and intensity (dependent variable) across 6 positions (between factor) and 2 session types (game or practice, between factor) using separate 2-way ANOVAs. **Results:** There was no interaction present between weekly ACWRs and positions ($F_{5,18}=.186$, $P= .964$, $\eta p2=.049$), but there was a main effect for time ($F_{3.75,67.57}=10.87$ $P= <.001$ $\eta p2=.376$). There was significant interactions between session type and positions for total distance traveled ($F_{5,2406}=8.092$ $P= <.001$ $\eta p2=.017$) and between session type and positions for intensity ($F_{5,2406}=12.132$ $P= <.001$ $\eta p2=.025$). Means and standard deviations for total distance and intensity across positions and session type can be found in the Table. **Conclusions:** Although ACWRs were similar across positions, they varied across the 9 weeks of the traditional season suggesting varying levels of injury risk. Several positions had significant differences between games for intensity, distance traveled, or both. In all situations, players had higher intensities or total distance traveled in games compared to practices. GPS data can be used to prepare practice plans that reduce injury susceptibility and prepare players for game demands.

We received funding from US Lacrosse to complete this study.

Table. Means and standard deviations for intensity and total distance across positions in men's lacrosse. *Significant positional differences between practices and games

	Game		Practice	
Position	Intensity (AU)	Distance (m)	Intensity (AU)	Distance (m)
Attack (n=12)	40.06±19.23*	6855.19±2321.22*	34.68±13.89*	5735.81±1687.37*
O-Mid (n=14)	30.43±13.24	5550.45±1485.76	32.27±12.95	5279.37±1498.68
D-Mid (n=6)	43.96±17.84*	6663.50±1872.56*	32.15±13.74*	5101.32±1520.66*
FO(n=4)	23.29±14.56	4573.43±1658.29	26.14±12.01	4433.48±1398.22
Goalie(n=3)	18.5±6.87	4503.52±1240.34	22.23±12.03	4239.98±1288.43
Defense(n=14)	32.98±15.07	5962.37±1986.95*	33.71±13.49	5413.75±1547.85*

Association of the Acute:Chronic Workload and Injury Risk in Athletes: A Critically Appraised Topic

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Context: Consistent, varied, and structured training is essential to the physical performance and injury prevention of athletes. Consistency in training is often expressed by the acute:chronic workload ratio (ACWR). While many studies have reported on the physiological and performance outcomes of workload monitoring, few have examined the direct impact these variables have on injury risk. **Methods:** An electronic database search of CINAHL and PubMed was conducted in August of 2021 using the following PICOT strategy: (P)atient/Client Group: athletes competing in organized sport, (I)ntervention/Exposure: acute:chronic workload during erratic training periods, (C)omparison: acute:chronic workload during sustained/consistent training periods, (O)utcome: lower extremity injury, (T)ime frame: single competitive season. Specifically, the following Boolean search phrase was used: acute workload OR chronic workload OR acute:chronic workload OR acute:chronic training OR acute:chronic training load AND athlete OR athletic OR injury OR injury rate OR injury prevalence OR injury prediction OR injury risk. Quality appraisal was further assessed via the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. Specific inclusion criteria included: 1) original research, 2) using the ACWR to quantify workload, 3) reporting of injury rates or injury risk beyond performance data, 4) injury data reported by a certified athletic trainer or other sports medicine professional, 5) published within the last 5 years. Specific analysis measures of interest included ACWR and metrics of outcome/exposure injury surveillance data (e.g. Risk Ratio's (RR), Odds Ratio's (OR)). **Results:** The original search yielded 154 studies that were screened via title and abstract for inclusion criteria, resulting in 13 articles. Further screening via full-text was done to ensure proper outcome measures were used, yielding a final sample of 4 studies. While all studies reported workload by means of the ACWR, injury outcome data was reported in related, yet variable ways: 2 studies reported data by means of Risk Ratio's (RR), 1 study reported data as Odds Ratio's (OR), and 1 study reported data as Injury Rate (IR). Specifically, one study found that injury rates were significantly greater when there was a low workload magnitude in previous weeks prior to a high 1-week workload immediately before injury. Similarly, in two other studies RR was found to be significantly higher during acute spikes in workload (RR = 6.7 and RR = 2.24, respectively). The final study reported a significantly higher risk of injury during acute load increase (OR = 1.97). **Conclusions:** Given the higher injury rates reported in the literature, it is imperative to further explore the relationship between structured training and injury rates to quantify training loads and allow clinicians to quantify the risk of subsequent injury. Collectively, this data highlights the need for reintroduction periods following layoffs and a consistent return to play protocol for athletes.

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Training Loads Predict Day-to-Day Changes in Self-Reported Athlete Health Variables Following Collegiate Soccer Matches

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Context: Excessive training loads, measured via distance, training impulse (TRIMP), high speed activities, and heart rate, cause negative changes that lead to increased injury risk, however, there is limited research on the specific training load metrics that most correlate with negative changes after activity. Therefore, the purpose of the current study was to determine which training load measures best predicted day-to-day changes in self-reported athlete health variables in female collegiate soccer athletes. **Methods:** Twenty-nine female collegiate soccer athletes (age: 19.6 ± 1.4 years, height: 175.2 ± 14.5 cm, mass: 76.1 ± 15.8 kg) provided daily subjective athlete health measures each morning over an entire competitive season. Self-reported athlete health was captured on a mobile-compatible survey, with readiness rated from 0-100, fatigue, sleep quality, and stress rated from -5 to +5. Higher numbers indicated high readiness and sleep quality, and low fatigue and stress. Change scores were calculated for each athlete health measure by subtracting the following days score by the current day's score (Post-Pre). Participants wore heart rate and accelerometer straps around their chest (Beyond Pulse, Portland, OR), which provided measures of Banister TRIMP, distance, percentage of time in highspeed running (HSpct), average heart rate (HRave), and a proprietary measure called active participation (AP). Linear mixed models were calculated with individuals listed as random effects and workload variables listed as fixed effects to predict the change score of each athlete health measure. The strength of the associations was evaluated by the amount of variance predicted via the marginal R2 calculation. **Results:** There was a significant negative relationship between all workload measures and the measures of self-reported readiness and fatigue, ($p<0.001$, Table 1) excluding HSpct. Distance (R2 = 25%, 16%), and TRIMP (R2 = 21%, 14%) accounted for the most variance in readiness and fatigue, respectively. Distance, TRIMP, and AP all significantly predicted changes in stress or sleep quality, but accounted for less than 3% of the variance. **Conclusions:** Distance and Banister TRIMP were most associated with day-to-day changes in self-reported athlete health measures of readiness and fatigue. Clinicians may use this information to select specific workload monitoring devices to ensure they collect distance and Banister TRIMP. Additionally, if a clinician already has access to wearable devices, when these workload measures are at their highest, clinicians should be aware that athletes may be in a suboptimal subjective state the following day and suggest recovery interventions to mitigate negative changes. Future research should incorporate physical measures to identify if similar relationships are present. Additionally, assessing physical and athlete health measures over longer periods of time may provide a better understanding of how injuries develop due to high training loads, specifically high distances and Banister TRIMP.

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	Readiness	Fatigue	Stress	Sleep Quality
TRIMP	0.21*	0.14*	0.00	0.01*
Distance	0.25*	0.16*	0.00	0.02*
HSpct	0.01	0.01*	0.01	0.00
HRave	0.08*	0.05*	0.01	0.00
AP	0.06*	0.04*	0.00	0.01*

Table 1. Marginal R^2 values from the linear mixed models. Asterisk indicates that the workload fixed factor significantly predicted the wellness outcome variables.

Cumulative Loading Is Associated With Thicker Femoral Cartilage After ACL Reconstruction

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Context: Underloading during walking gait is consistently associated with poor knee joint health development post-ACLR. However, it is unclear if cumulative load which includes biomechanics and the number of steps taken also plays a role. The purpose of this study was to determine if cumulative loading at 4 months post-ACLR is associated with surgical limb femoral cartilage thickness at 6 months post-ACLR. **Methods:** Participants with primary ACLR between the ages of 16 and 35 years old were included in this prospective, cohort study. At 4 months post-ACLR, participants completed shod gait biomechanics and free-living daily step assessments. Gait biomechanics were captured with 3D motion capture and 2 embedded force plates while walking at a self-selected pace (gait speed=1.3±0.2 m / s). Knee extension moment (KEM) and knee abduction moment (KAM) were calculated during the first 50% of the stance phase and normalized to the product of body weight and height (Nm / kg*m). KEM and KAM were reported as positive values. Following the in-person data collection, a physical activity monitor affixed to the hip for one week, and worn during all waking hours to capture daily steps. A valid activity monitoring assessment was defined as 4 days with at least 8 hours of wear time (average valid days=6.2±1.5). At 6 months post-ACLR, participants underwent femoral cartilage imaging via ultrasound of their surgical knee. A semi-automated segmentation processing technique was used to measure average medial, central, and lateral femoral cartilage thickness. Linear regression models were used to assess the associations between cumulative loading (KEM, KAM, and daily steps) at 4 months post-ACLR with regional femoral cartilage thickness at 6 months post-ACLR. **Results:** Nineteen participants (53% female, age=20.8±5.8 years, body mass index=25.7±5.4 kg / m2, KEM=0.14±0.06 Nm / kg*m, KAM=0.05±0.03 Nm / kg*m, daily steps=6,028±1592) completed 4- and 6-month assessments. Cumulative loading accounted for 56% of the variance in medial femoral cartilage thickness (P=0.01). Specifically, individuals walking with lesser KEM, greater KAM, and more daily steps at 4 months post-ACLR demonstrated thicker medial femoral cartilage at 6 months post-ACLR (Table 1). Cumulative loading also accounted for 43% of the variance in lateral femoral cartilage thickness (P=0.03). However, only daily steps demonstrated statistically significantly associations with lateral femoral cartilage thickness indicating that individuals who engaged in more daily steps at 4 months post-ACLR demonstrated thicker lateral femoral cartilage at 6 months post-ACLR (Table 1). **Conclusions:** Individuals who take more daily steps and walk with lesser KEM and greater KAM demonstrate thicker femoral cartilage, which is theorized to be an indicator of cartilage swelling. Clinicians should consider addressing aberrant knee sagittal and frontal plane gait biomechanics through gait retraining during rehabilitation before integrating individuals into greater volumes of activity to minimize cartilage swelling and improve knee joint health.

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Table 1. Associations between factors of cumulative loading at 4 months post-ACLR and regional femoral cartilage thickness at 6 months post-ACLR

Cartilage Region	Model R^2	Model *P*-value	Factor	Unstandardized β	*P*-value
Medial Femur Cartilage Thickness	0.56	0.01			
			KEM	-5.77	0.00*
			KAM	8.27	0.05*
			Daily Steps	0.00	0.01*
Central Femur Cartilage Thickness	0.38	0.06			
			KEM	-3.77	0.19
			KAM	8.84	0.18
			Daily Steps	0.00	0.01*
Lateral Femur Cartilage Thickness	0.43	0.03			
			KEM	-1.67	0.17
			KAM	2.29	0.41
			Daily Steps	0.00	0.01*

*= statistically significant (*P*<0.05) Abbreviations: KEM = knee extension moment, KAM = knee abduction moment

Enhanced Strength and Function at 1-Year Post-Reconstruction for Participants Who Underwent Bridge-Enhanced ACL Repair

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Context: Novel surgical techniques for improving ACL reconstruction (ACLR) are always in development. Athletic trainers should know what to expect for the outcomes from these techniques. The bridge-enhanced ACL repair (BEAR) is a relatively new surgical procedure for reconstructing the ACL. In patients who undergo ACLR[P], does the BEAR technique[I] compared to the traditional ACLR (tACLR)[C] yield enhanced strength and functional performance[O] at 1 and 2 years post-reconstruction[T]? **Methods:** PubMed and EBSCOHost (Academic Premier, CINAHL, Medline, SportDiscus) were searched through September 2021. Search terms included iterations of "ACL", "surgery", "operation, "bridge", and "reconstruction". The search was limited to studies published in the past 5 years in English. Selection criteria required that studies included 1) patients who had undergone ACL reconstruction using BEAR or tACLR; 2) objective strength measures; and 3) functional test outcomes. The PEDro scale was used to assess potential threats to internal validity. Data extracted included sample sizes and means±SD for lower extremity strength [hamstrings (HS), quadriceps (Quads) and hip abductors (H.Abd)], and lower extremity function [single-limb hop test (Hop1), triple hop test (Hop3), 6m timed hop test (6mTimed), and crossover hop test (Crossover). Strength and functional tests were reported as a percentage of the contralateral side and documented at 1 year and 2 years post-reconstruction. For BEAR and tACLR, a sample-size adjusted weighted mean (wtX), weighted SD (wtSD) were calculated for each outcome. These weighted variables were used to calculate Hedges' g effect sizes[95%CI] (ES) to determine the magnitudes of the difference between BEAR and tACLR for each outcome. ES were interpreted as weak (<0.4), moderate (0.4-0.8), and strong (>0.8). **Results:** Three studies met inclusion criteria. PEDro scores ranged from 6 to 10. The most commonly missed criteria were nonrandomization and no patient blinding. At <1 year post-reconstruction, the BEAR demonstrated more strength for the HS (ES=2.7 [2.3,3.1]), Quads (ES=3.5[3.0,4.0]), and H.ABD (ES=2.0[1.6,2.4)]. The BEAR also demonstrated better side-side symmetry for the Hop1 (ES=1.8[1.2,2.4), Hop3 (ES=3.1[2.5,3.7]), 6mTimed (ES=1.8[1.2,2.4], and Crossover (ES=3.0[2.4,3.6]). At 2 years, only HS strength remained increased for BEAR (ES=1.7[1.3,2.1]), but was similar between groups for Quads (ES=-0.2[-0.6,0.2]) and H.Abd (ES=0.0[-0.4,0.4]). Functional test performance remained improved for BEAR for 6mTimed (ES=0.6[0.2,1.1]), but not for the Hop1 (ES=0.0[-0.5, 0.4]), Hop3 (ES=-0.3[-0.7,0.2]), and Crossover (ES=0.1[-0.4,0.5]). **Conclusions:** Compared to tACLR, the BEAR strength and functional performance outcomes at 1-year post-reconstruction were substantially greater. These effects were essentially washed out by 2-years post-reconstruction, with both groups demonstrating adequate symmetry across most outcomes. The BEAR-related improvements in strength and functional performance at 1 year may indicate greater readiness for increasing functional demands earlier in the rehabilitation process. All 3 studies were from the same author group, so these results should be validated through independent investigations using the similar outcomes.

None of the authors have any financial disclosures.

Hip Strength Recovery During Rehabilitation After ACL Reconstruction

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Context: Persistent lower extremity muscle weakness is common after anterior cruciate ligament reconstruction (ACLR) surgery. Performance evaluations and rehabilitation programs in patients recovering from ACLR generally target the knee extensors however, hip muscles such as the abductors and adductors play an important role in recovery from ACLR. Hip muscle strength evaluations over the course of ACLR recovery may help inform treatment prescriptions. The purpose of this study was to examine hip abduction (AB) and adduction (AD) strength changes during the course of rehabilitation after ACLR. **Methods:** Eighty-six patients with primary, unilateral, and uncomplicated ACLR (39 Males/47 Females, 22.93±9.85yrs, 172.17±10.19cm, 77.43±18.05kg) were tested at 2 time-points after surgery (time post-ACLR Visit1: 4.86±1.5mo, Visit2: 8.23±2.23mo). During each visit, maximal isometric hip AB and AD strength was measured bilaterally in supine with hips and knees flexed to 45- and 90-degrees respectively. Participants completed three, 5-second contractions for AB and AD (total 6 repetitions). Peak torque from each trial was calculated, normalized to body mass (Nm/kg) and averaged for analysis. A 2X2 repeated measures ANOVA (limb-by-time) was used to compare AB and AD strength between limbs and over time. Post hoc paired samples t-test were used where appropriate. Effect sizes were calculated as Cohen's d. Alpha level was set at $\alpha \leq 0.05$ for all tests. **Results:** A significant limb-by-time interaction ($F(1,85)=6.817$, $p=0.01$) for hip AB was observed (Figure 1). At Visit 1, the ACLR limb exhibited significantly weaker AB strength than the contralateral limb (ACLR: 1.80±0.45 Nm/kg, Contralateral: 1.86±0.44 Nm/kg, $p<0.001$, Cohen's $d = 0.51$). At Visit 2 the ACLR limb remained significantly weaker than the contralateral limb (ACLR: 1.88±0.46 Nm/kg; Contralateral: 1.91±0.45 Nm/kg; $p=0.04$, Cohen's $d = 0.19$) but to a lesser magnitude. There was a significant difference in the strength values for hip AB strength from across visits for the ACLR limb (Visit1: 1.80±0.45 Nm/kg, Visit2: 1.88±0.46 Nm/kg; $t(85)=-2.64$, $p<0.01$), but no significance was found for the contralateral limb. There was no significant limb-by-time interaction observed for hip AD, however, hip AD strength bilaterally was significantly greater at Visit2 (ACLR: 1.82±0.48 Nm/kg; Contralateral: 1.76±0.47 Nm/kg) compared to Visit1 (ACLR: 1.70±0.48 Nm/kg, $t(85)=-3.95$, $p<0.01$; Contralateral: 1.67±0.47, $t(85)=-3.31$, $p<0.01$). **Conclusions:** In patients recovering from ACLR, hip AB weakness improved bilaterally overtime, but the ACLR limb hip AB strength increased to a greater extent compared to the contralateral limb. Despite the increases in ACLR limb strength over time, significant deficits in strength were still present in the ACLR limb compared to the contralateral limb on average 8 months post ACLR. Clinicians should consider evaluation of hip AB and AD throughout the recovery process to identify persistent hip muscle weakness.

None of the authors have any financial disclosures.

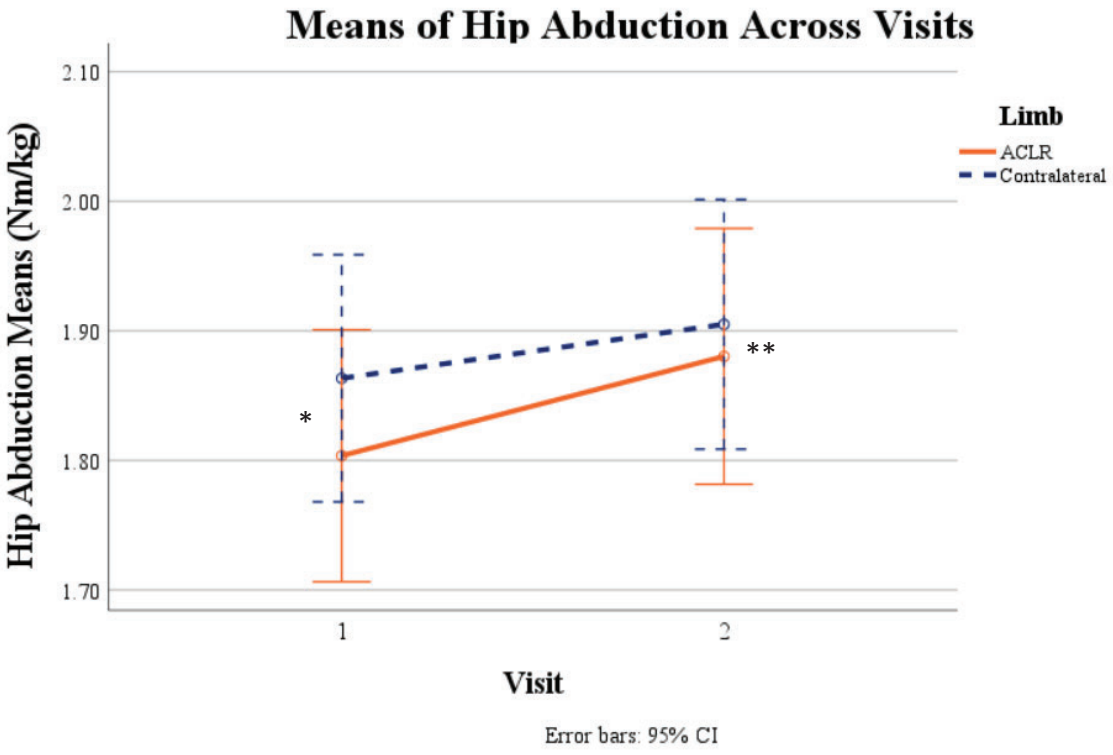

Figure1. Mean hip abduction strength changes across Visit1 and Visit2. (*Significant difference at Visit1 between ACLR and Contralateral limbs, $p<0.001$; **Significant difference at Visit2 between ACLR and Contralateral limbs, $p=0.04$)

Knee Kinetics During Change of Direction After ACL Reconstruction

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Context: The incidence of second ACL injury after return to sport in those with primary ACL reconstruction (ACLR) remains high despite use of return to sport (RTS) criteria to identify individuals at risk for a second injury. The most common RTS criteria includes single leg vertical jumps but omits change of direction (COD), a leading cause of ACL injury. Given the risk to the graft during COD post-ACLR, there is a need to evaluate assessments that impose unique demands that more readily identify those susceptible to second ACL injury. Therefore, our purpose was to assess the relationship between biomechanical outcomes (i.e. ground contact time, vertical ground reaction force (vGRF), and reactive strength index (RSI)) between a single leg drop vertical jump (SLV) and a single leg crossover hop (SLC) involving COD among individuals with unilateral ACLR. The SLC served as a model to assess knee biomechanics of the push-off limb during a 45° COD and assess the relationship with the SLV. We hypothesize the relationship between tasks will be strong during the decent phase but will be weak to moderate during the transition and ascent phases. **Methods:** Fifty-two individuals (Female=35, 67.31%; age=22.8±5.0 years; months since surgery=38.2±23.9) participated in this cross-sectional laboratory study. A biomechanical analysis using a 3D motion capture system and embedded force plate was conducted while participants completed the SLV and SLC from a 30-cm box positioned 40 cm from the force plate. For analysis, tasks were divided into 3 landing phases (descent; transition; and ascent) to identify occurrence of peak vGRF, which has been reported to coincide with peak ACL strain. The RSI (SLV RSI= jump height/ground contact time; SLC RSI=hop distance/ground contact time) was assessed to evaluate stretch-shortening cycle performance, a key factor in jump and COD performance. Pearson's product moment correlation coefficients with 95% confidence intervals were used to assess the relationship between tasks. The a-priori alpha-level was set at 0.05. **Results:** Strong relationships ($r \geq 0.70$, $p<0.05$) were found between tasks during the decent phase, while moderate ($r=0.40$-0.60, $p<0.05$) relationships were found during the transition and ascent phase (Table 1). **Conclusions:** Task performance differed during the transition and ascent phases, corresponding to when between task relationships were weakest. Peak vGRF occurred during the decent phase in both tasks, however, the decent phase was on average 46ms longer during the SLC, indicating the ACL is under peak strain for a longer duration during COD compared to a traditional SLV. The RSI was moderately correlated between tasks, but the values were lower than those reported in healthy individuals and potentially indicates persistent deficits in stretch-shortening cycle performance. COD may impose unique demands compared to traditional RTS criteria; however further investigation for clinical use is warranted.

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Table 1. Between Task Correlation Coefficients

	ACL		Contralateral	
	r	95%CI	r	95% CI
Peak vGRF (x BW)	0.79*	0.65, 0.87	0.64*	0.44, 0.78
$vGRF_{descent}$ (x BW)	0.79*	0.66, 0.87	0.64*	0.44, 0.78
$vGRF_{trans}$ (x BW)	0.56*	0.33, 0.72	0.46*	0.19, 0.66
$vGRF_{ascent}$ (x BW)	0.69*	0.52, 0.81	0.66*	0.47, 0.80
GCT (ms)	0.61*	0.40, 0.76	0.67*	0.47, 0.80
Descent time (ms)	0.53*	0.29, 0.71	0.60*	0.38. 0.76
Transition time (ms)	0.43*	0.16, 0.64	0.55*	0.30, 0.72
Ascent time (ms)	0.55*	0.31, 0.71	0.56*	0.34, 0.73
RSI (m/s)	0.64*	0.44, 0.77	0.66*	0.47, 0.80
SLC Hop distance, SLV jump height (m)	0.64*	0.44, 0.78	0.58*	0.35, 0.74

Descent phase=initial ground contact (vGRF>10 N) to time the center of mass (COM) reached its lowest point; Transition phase=end of decent phase to time when COM position increased 0.01 m; Ascent phase=end of transition phase to takeoff (vGRF<10 N); SLC=single leg crossover hop; SLV=single leg drop vertical jump; BW=body weight in newtons; vGRF=vertical ground reaction force; $vGRF_{descent}$=peak vGRF during descent; $vGRF_{trans}$=peak vGRF during transition; $vGRF_{ascent}$=peak vGRF during ascent; RSI=reactive strength index; SLC RSI=hop distance/ground contact time; SLV RSI=jump height/ground contact time; weak correlation $r<0.39$; moderate correlation $r=0.40$-0.69; strong correlation $r\geq0.70$; *=significant finding ($p<0.05$)

Personal and Social Correlates of Physical Activity in Individuals With a History of ACL Reconstruction

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Context: Despite the goals to return to sport and physical activity (PA) after anterior cruciate ligament reconstruction (ACLR), only 65% of patients return to previous levels of sport and many perform less moderate-to-vigorous PA and take fewer daily steps compared to their healthy counterparts. While physical and psychosocial factors (e.g. pain, self-efficacy) have been identified as contributing factors to decreased return to sport and PA in this population; additional personal, social, and environmental factors that may serve as facilitators for PA have yet to be explored. Specifically, factors such as physical literacy, health literacy, and social support may influence PA engagement after ACLR and may be critical in the development of targeted intervention strategies to improve PA outcomes in this population. Therefore, the purpose of this study was to identify personal and social correlates of PA in participants with a history of ACLR. **Methods:** A cross-sectional, web-based survey was designed to examine physical literacy, health literacy, social support, knee function, and PA in individuals with a history of unilateral or bilateral ACLR. A total of 71 participants (age: 28.0±5.0years, height: 169.4±10.6cm, weight: 71.0±14.0kg) who were an average 5.9 years (±2.6) post-ACLR participated. The PLAYSelf, eHealth Literacy Scale (eHEALS), Sallis Social Support for Exercise Scale, Knee Injury and Osteoarthritis Outcome Score (KOOS), Godin Leisure-Time Exercise Questionnaire (GLTEQ) were used to quantify physical literacy, health literacy, social support, knee function, and self-reported PA respectively. A stepwise linear regression model was used to determine if the patient-reported outcome scores predicted PA. The PLAYself subsections (Environment, Self-description, Literacy, Numeracy, Physical Literacy), PLAYself Total, Sallis Family, Sallis Friend, eHEALS, KOOS-Symptoms, KOOS-Pain, KOOS-ADL, KOOS-Sport, and KOOS-QOL served as predictor variables and the GLTEQ moderate-to-vigorous leisure activity score served as the dependent variable. **Results:** Summary statistics for all variables can be found in Table 1. Bivariate analysis determined that KOOS-QOL, PLAYself Environment, PLAYself Self-description, PLAYself Literacy, and the PLAYself total score were associated with self-reported PA (Table 1). Strong collinearity was observed between the PLAYself total score and Self-description subsection. The KOOS-QOL, PLAYself Environment, PLAYself Self-description, and PLAYself Literacy were selected for the model. The final stepwise linear regression model demonstrated that the PLAYself Self-description subsection accounted for 12.8% of the variance of self-reported PA in individuals with a history of ACLR. **Conclusions:** The physical literacy self-description score was the only predictor variable that significantly correlated with self-reported PA. This subsection is designed to assess self-efficacy and motivation related to PA which may be especially important for promoting PA in individuals with a history of ACLR. Future research should investigate how physical literacy impacts return to sport and long-term PA engagement in individuals with a history of ACLR.

The authors report no relevant financial disclosures.

Table 1: Predictor Variable Summary Scores and Spearman Correlations

Variable	Median	Interquartile Range	Correlation to GLTEQ MVPA
KOOS-Symptoms	82.14	17.86	.094
KOOS-Pain	94.44	11.11	.187
KOOS-ADL	98.53	4.69	.160
KOOS-Sport	85.00	20.00	-.022
KOOS-QOL	75.00	18.75	.299*
Sallis Family	18.00	14.00	.098
Sallis Friend	20.00	19.00	.118
eHeals	32.00	5.00	.149
PLAYself Environment	275.0	75	.301*
PLAYself Self-description	835.0	234	.311*
PLAYself Literacy	234.0	99	.214
PLAYself Numeracy	234.0	99	.178
PLAYself Physical Literacy	267.00	99	.153
PLAYself Total	71.96	15.73	.379**

Abbreviations: ADL: Activities of daily living; eHeals: eHealth Literacy Scale; GLETQ: Godin Leisure-Time Exercise Questionnaire; KOOS: Knee Injury and Osteoarthritis Outcome Score; MVPA: Moderate-to-vigorous physical activity; QOL: Quality of life

*Statistically significant at P<0.05
**Statistically significant at P<0.01

Single-Limb Fatigue and Postural Control in Individuals With ACL Reconstruction

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Context: ACL reconstruction (ACLR) injuries are associated with an increased risk for subsequent contralateral and secondary knee injuries. A potential risk factor in sustaining subsequent knee injuries may be rate of limb fatigue and neuromuscular control following fatigue. Our objective was to evaluate the limb differences in single-limb fatigue and static postural control in patients with unilateral ACLR injuries. **Methods:** A cross-sectional study was conducted in a research laboratory to investigate primary, unilateral ACLR patients (5M/3F; 23±4.0 years; 75.4±15.6 kg, 167.2±11.9cm; Physician clearance for return to sport 12.9±3.6 months). Data was collected over two visits. During each visit, participants completed six successful (three eyes open and three eyes closed), 10-second, unilateral static postural control trials on a force platform before and after a single-limb fatigue protocol. Ground reaction forces were recorded at 50 Hz and used to calculate center of pressure (COP) and time-to-boundary (TTB) outcomes: COP mean velocity, COP SD, COP range of excursion, range of COP used, TTB absolute minimum, TTB mean of the minima, and TTB SD of the minima. The test limb (ACLR, uninjured) assessed was randomized. The fatigue protocol consisted of a single-limb cycling maximum oxygen consumption test on a Monark ergometer. Participants cycled with their assigned test limb and a counterweight was attached to the spindle on the crank arm opposite the test limb. During the test, power output began at 40W for males and 30W for females and increased 10W every minute until maximal volitional fatigue (inability to maintain a pedaling rate of 60rpm). Single-limb aerobic capacity outcomes (VO2 max, ventilatory threshold, maximum watts cycled, and time to fatigue) were assessed between limbs using paired samples t-tests. Postural control outcomes for both eyes open and eyes closed were evaluated through a 2x2 repeated measures ANOVA with time (pre-fatigue, post-fatigue) and limb (ACLR, uninjured) factors. Alpha was set a priori at $\alpha \leq 0.05$. Cohen's d effect sizes (between ACLR and uninjured limbs) were also calculated. **Results:** There was no significant differences between the ACLR and uninjured limbs for aerobic capacity outcomes (VO2 max $p=0.67$; ventilatory threshold $p=0.87$; maximum watts cycled $p=0.95$; time to fatigue $p=0.68$). Results for the force platform outcomes are presented in Table 1. There was no significant interaction for any postural control outcomes ($p>0.05$) in either the eyes open or the eyes closed conditions. Large effect sizes occurred between limbs pre-fatigue for eyes closed COP SD in the mediolateral direction ($d=0.868$) and between limbs post-fatigue COP range of excursion in the mediolateral ($d=0.802$) and anteroposterior ($d=0.834$) directions. **Conclusions:** Overall findings of the study were inconclusive. Future work should continue to advocate for more conclusive evaluation of bilateral limb deficits after ACLR.

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The Effect of Visual Disruption on Dynamic Postural Stability in ACL Reconstructed Individuals

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Context: Both surgical and therapeutic interventions are believed to restore mechanical instability to the knee after ACL injury. Despite these efforts, those who return to sport are at an increased risk of experiencing a second ACL injury. A potential explanation for the increased risk of injury may be persistent somatosensory dysfunctions following both surgery and rehabilitation. As a result of these lingering deficits, sensory reweighting by the central nervous system to rely on visual feedback may occur to ensure appropriate neuromuscular control of the lower limb. Therefore, the aim of this study was to investigate the proposed visual reliance in ACL reconstruction (ACLR) individuals using dynamic postural stability measures. We hypothesized there would be greater instability, due to visual disruption, in the ACLR injured limb compared the uninjured limb. **Methods:** Twelve physically active ACLR individuals volunteered for this study (F=7, 19.8±1.2 years, 1.71±0.09 m, 76.0±8.3 kg, 28.0±10.1 months since surgery). In a laboratory setting, participants were asked to complete three trials of a single-limb dynamic hopping task, landing on a force plate, while simultaneously wearing vision disrupting eyewear. The hopping task consisted of both a horizontal jump distance of 40% of the participant's body height and vertical jump distance to an overhead target set at 50% of the participant's max jump height. Individuals were required to maintain postural stability after landing for 30 seconds. Three visual conditions were selected for this study based on previous research: 1) eyes-open (EO), 2) low visual disruption (LVD), and 3) high visual disruption (HVD). Dependent variables selected were directional variables associated with both the Dynamic Postural Stability Index (DPSI) and the sequential average Time to Stability (TTS) measures. An average of the hopping trials was used to calculate each dependent variable. Multiple 2x3 repeated measures ANOVA's were used to assess the differences between the ACLR participants limbs (injured limb vs. uninjured limb) and across visual conditions (EO, LVD, HVD). **Results:** Contrary to our initial hypothesis, no limb differences or interaction effects were observed for any of the DPSI or TTS dependent variables. A significant vision main effect was found for MLSI ($p < 0.01$). ACLR Individuals displayed increased MLSI in the LVD (0.040±0.009) and HVD (0.041±0.009) conditions compared to the EO (0.036±0.007) condition. **Conclusions:** ACLR individuals sampled in this study, who are on average two years removed from surgery and who engage in regular physical activity, do not display lingering neuromuscular deficits in the ACLR limb compared to the uninjured limb. The results suggest that ACLR individuals may have some level of neuromuscular recovery at the knee after return to sport. Additionally, due to increased MLSI when vision is disrupted, it may be beneficial to incorporate visual disruptive eyewear when assessing postural stability before returning to sport.

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The Effects of Imagery on Psychological Factors in Those With Anterior Cruciate Ligament Reconstruction History

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Context: Individuals with ACL reconstruction (ACLR) may continue to experience psychological issues such as fear of reinjury and diminished confidence, long after their physical functions have returned to normal. Imagery training has been used to improve confidence and self-efficacy for performance enhancement. However, there is limited research on imagery and how it could influence those psychological measures beyond returning to activity (RTA) after ACLR. The purpose of this study is to investigate the effects of imagery on psychological measures in those who have been RTA after ACLR. **Methods:** Nine college-aged individuals (8F/1M, age= 20.00±1.48) participated in the study. All participants underwent ACLR within 2 years (average time since surgery= 18.78±5.74 months) and have been cleared for RTA within 1 year (average time since RTA= 8.22±4.12 months). Participants completed a 7-week imagery intervention and completed questionnaires before and after the intervention period. Three different psychological inventories were utilized for participants to self-evaluate fear of reinjury and self-efficacy, including Tampa Scale for Kinesiophobia (TSK), Psychological Readiness to Return to Sport (PRRS), and ACL Return to Sport after Injury Scale (ACL-RSI). Each week of imagery training consisted of listening to audio recordings (adapted from guided imagery scripts by Support for Sport, supportforsport.org) 3 times a week. Week 1 served as a training period for improving vividness and manipulation of imagery exercises. In the following 6 weeks, imagery exercises were modified every two weeks to progressively integrate more challenging movements into the imagery session. The independent variable was time (pre- and post-test). The dependent variables were the scores of TSK, PRRS, and ACL-RSI. For each dependent variable, a separate paired t-test was used with the level of significance set apriori to $p<0.05$. **Results:** The TSK score (pre= 36.33±4.58, post= 32.33±4.56; t=2.932, p=0.019) and PRRS score (pre= 41.94±13.75, post= 47.94±9.02; t=-2.845, p=0.022) significantly improved after intervention. Although ACL-RSI seemed to have improved after intervention (pre= 55.56±21.65, post= 65.46±13.98), the improvement was not statistically significant (t=-2.088, p=0.070). **Conclusions:** Our results support imagery intervention as a potential means to decrease kinesiophobia and increase psychological readiness to return to sport for ACLR participants, even after being cleared physically to RTA. These findings may support patients' and healthcare providers' decision to implement imagery as a supplementary component of their rehabilitation plan after ACLR. It is important to note that pre-test scores were below what would be expected as psychologically ready to RTA, even though participants have been fully cleared to RTA physically. This may raise a concern that confidence and self-efficacy in ACLR patients may not be fully restored despite satisfactory physical performance. We suggest that future studies utilize a larger sample size and investigate the correlation between improved psychological status and physical performance improvements.

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