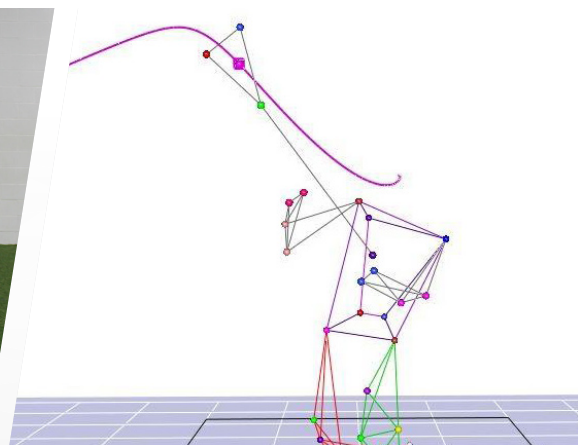




# 2017 RESEARCH REPORT



The Center for Sport Science at US Lacrosse serves as a national hub for the study and improvement of safety and performance in lacrosse. Created in 2016, the Center is devoted to research, education, collaboration, policy development, and best practices guidelines that benefit the safety and wellness of lacrosse players, with a particular focus on youth players.

The Center for Sport Science seeks to expand and elevate the safety initiatives that US Lacrosse has been committed to since its creation in 1998, with over \$1.5 million in health-related research funding since that time to improve the well-being of lacrosse participants at all levels of play.

Dr. Bruce Griffin serves as the director for the Center, with members of US Lacrosse's Sports Science and Safety Committee serving in an advisory role. Funded in part by grants from US Lacrosse, the research reports reflect the opinions of the authors and are not necessarily the opinions of US Lacrosse.



The ability of the Center for Sport Science to fund new research and safety initiatives is driven by the generous support of our donors and members. Please consider making a tax-deductible gift to help us further elevate and improve game safety and to enrich lives through lacrosse.

[USLACROSSE.ORG/DONATE](https://uslacrosse.org/donate)

## TITLE OF THE STUDY:

# Lacrosse Helmet Performance Degradation as a Function of Exposure

## RESEARCHERS:

Primary Investigator: Jesenia C. Velez, NTS-Chesapeake Testing Services; Co-Investigator: Erin Hanlon, Ph.D., Delaware Technical Community College

## PURPOSE:

To evaluate the effect of solar radiation on the performance of men's lacrosse helmets and establish a baseline for headgear expiration.

## WHY WE DID THIS RESEARCH:

Research involved with injuries to the head is crucial for protecting the safety of athletes. It is important to understand how helmets are performing over time so there can be established guidelines for an expiration date. The mechanical properties of materials can change over time and that could result in a less protective helmet, and a less protected athlete. Researchers have suggested an expiration date be applied to helmets used in lacrosse, however, without scientific justification that has not been implemented.

## WHAT IS KNOWN ABOUT THIS TOPIC:

There has been little prior research on this topic. Previous studies have evaluated the effect of age alone on the performance of helmets, however, they've neglected to evaluate the effect of weathering or consistent wear and tear. Helmets aren't intended to prevent all injuries, however, it's necessary to determine the reasons for the resulting failure. There could be a number of reasons as to why helmets fail to prevent athletes from injury, but it's necessary to rule out the possibility of material failure and its relation to helmet performance.

## WHAT THIS STUDY DID:

In a randomized-controlled trial, we chose six helmets of the same size, make, and model to be tested. Helmets were chosen that had a primary component of expanded polypropylene as the foam liner because researchers anticipated a greater risk for degradation due to UV exposure. The six helmets were randomly broken into two groups: a control group, and a weathering group. The three helmets of the control group were evaluated using the attenuation protocol outlined in NOCSAE Document 041. This protocol outlines the velocity, location, and pass/fail criteria of helmet drop tests utilizing the NOCSAE head forms. The three helmets in the weathering group were exposed to accelerated weathering conditions as outlined by the military standard, MIL STD 810G. Utilizing a Suntest XXL + weatherometer, helmets were exposed to accelerated weathering that has been determined to represent 2.5 days for every day in the chamber. The helmets spent 56 days in the chamber, resulting in a representation of 140 days of weathering. Following the exposure, the weathered helmets were evaluated in the same way as the control group helmets.

## WHY THIS MATTERS:

Research like this can help lacrosse players, parents, and coaches make informed decisions about the safety of the athlete. Men's lacrosse requires intensive game play, and these athletes should be fitted with the best equipment at all times. Guidelines for helmet storage can be established, knowing that weathering effects the degradation of helmets, and ultimately affects player safety. Visual examination saw that the weathered helmets began to deteriorate, and presented surface stresses on both the exterior and interior of the shell. Future studies are required to determine at which point UV radiation causes issues to players' helmets.



## **TITLE OF THE STUDY:**

# Contribution of Functional and Motion Factors Related to Lower Body Musculoskeletal Pain and Injury in Lacrosse (in progress)

## **RESEARCHERS:**

Heather K Vincent, Kevin R. Vincent, Jason L. Zaremski, Joseph Wasser, Cong Chen, Michelle Bruner; University of Florida, Department of Orthopedics and Rehabilitation, Gainesville, Fla.

## **PURPOSES:**

Purpose 1: To determine the relative contribution and interactions of lacrosse-related biomechanics on lower body musculoskeletal pain and injury.

Hypothesis 1a: We hypothesize that consistent kinematics from our battery of functional and performance tests will predict knee and back pain onset and ankle injury. These kinematic predictors will include peak hip adduction, knee abduction and large frontal plane excursion of the knee, and pelvic drop during the stance phase of the tests.

Hypothesis 1b: During throwing, low shoulder-to-pelvis crossover excursion and lower shoulder external rotation values will predict low back pain or injury over six months.

Purpose 2: Quantify the effect of holding a lacrosse stick on kinematics of key lacrosse motions.

Hypothesis 2a: We hypothesize that holding a lacrosse stick will adversely impact kinematics during running and drop jump landings compared to free hands.

Hypothesis 2b: Holding a heavier and longer defensive pole (D-pole) pole when running or jumping will create more kinematic aberrations (joint excursions to the ankle, knee and hip, postural sway) than a short stick or goalie stick.

## **WHY WE DID THIS RESEARCH:**

We do not fully understand the how lower body musculoskeletal pain and injury relate to biomechanics of lacrosse sport motions in young players, or how holding a lacrosse stick impacts kinematics of running and jumping. It is our intent to determine whether or not we can use specific functional tasks such as box drop jumps, single legged squat, double legged squat, 30 second single leg balance tests or running to identify players who develop musculoskeletal pain or injury during the subsequent six months.

If we can identify these factors, we can create preseason training programs that help younger players to be better prepared for intensive play. For year-round young players, we hope that training programs will improve movement strength and movement control to reduce the onset of musculoskeletal pain or injury.

## **WHAT IS KNOWN ABOUT THIS TOPIC:**

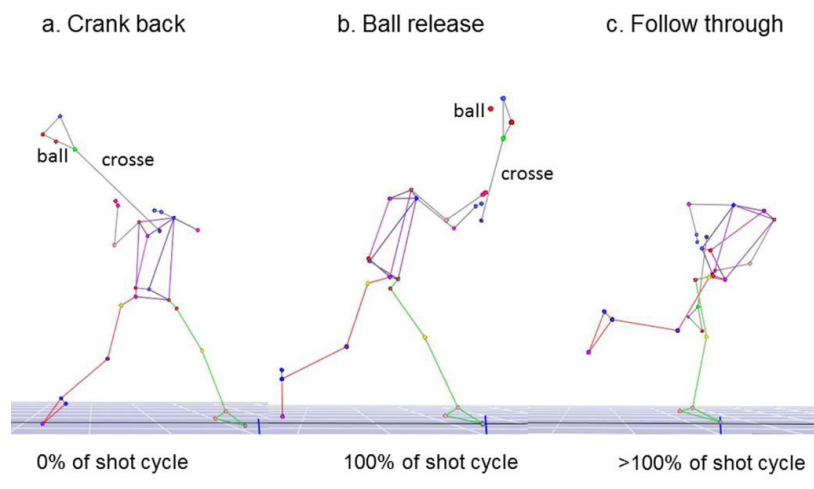
Optimal performance of sport motions involved in lacrosse requires skill and coordination. Appropriate development, transfer and regulation of the musculoskeletal forces produced during throwing and jump landing requires precise mechanical control to prevent injury. Lower body injuries can occur in lacrosse via non-contact mechanisms. In other sports, poor biomechanics or poor timing of muscular contractions contribute to lower body musculoskeletal pain or injury. Mechanical injury predictors have been identified in endurance sports (running) and in high-speed rotational sports (baseball, golf, cricket). What makes lacrosse unique among other sports is that both endurance and high speed rotation components occur, all while carrying crosses on a field surface. Some evidence suggests that holding a lacrosse stick during drop jumps can unfavorably change knee motion in lacrosse players.

### WHAT THIS STUDY IS DOING:

We currently have 30 participants finished and in February 2018 will obtain another 30 players. Staggered enrollment will also continue throughout the year to complete the target. For all players so far, we have obtained the following data: comprehensive lacrosse history and sport play; musculoskeletal pain (numerical pain rating scale values for all joints and body segments at baseline); physical exam tests: Thomas' hip flexor test, Ober's test for ITB band and iliopsoas, Ely test for quadriceps, and shoulder internal-external rotation while abducted at 90°; 3D motion analysis for the following motions: single legged squat, double legged squat, one legged balance, drop jump landings (bare hands, short crosse and long crosse), running with and without a crosse (single and dual handed holds), and throwing a ball at a goal; prospective tracking of musculoskeletal injury at months 2, 4 and 6. Presence of pain was reported using 11-point numerical pain rating scale. We have been successful in obtaining all data from all data points. As we are in the data collection phase, we do not yet have statistical output for the prediction models of injury.

### WHY THIS MATTERS:

We want to be a part of developing the standards of young athlete preparation for safe participation in lacrosse for life. This study will be the first comprehensive injury prediction study in younger lacrosse players using biomechanics of various sport motions – and the first step in determining area to target to best prepare young athletes to play safely. These findings can help with the development of therapy and training programs for these players to reduce risk of lower body injuries.



**TITLE OF THE STUDY:**

# US Lacrosse Level 1 Men's Coach Certification Program Survey

**RESEARCHERS:**

John Willse, PhD, University of North Carolina at Greensboro, Office of Assessment, Evaluation, and Research Services

**PURPOSE:**

The focus of this evaluation was to determine if the impact of the US Lacrosse Level 1 Men's Certification Program had noticeable differences between certified and uncertified men's coaching practices with respect to coach development, player development, player safety, tactical skills, and technical skills.

**WHY WE DID THIS RESEARCH:**

As the sport of lacrosse continues to grow, the need for educated coaches continues to grow proportionally. US Lacrosse's Level 1 Certification Program was launched in 2004, with the latest addition in 2013. After four years, the certification program requires evaluation to determine that the course material is appropriate for educating coaches and enhancing player experience.

**WHAT THIS STUDY DID:**

The US Lacrosse men's coaching survey was based upon expert review and item content from the Evaluation of US Lacrosse Level 1 Women's Certification Program. We developed a survey consisting of 10 demographic questions and 50 rating scale items, and released the survey to men's Level 1 certified and uncertified lacrosse coaches with US Lacrosse memberships. The 50 rating scale items were aimed to address five constructs that were presently being addressed in the course material for certification: Coach Development, Player Development, Player Safety, Tactical Skills, and Technical Skills. To best capture coaching practices across the domains being measured, three different types of rating scales were used: Agreement Type, Frequency Type, and Likelihood Type. To measure coaching practices, the following scores were generated: Total Scale Score, Coach Development Score, Player Development Score, Safety Subscale Score, Tactical Skills Subscale Score and Technical Skills Subscale Score.

**WHY THIS MATTERS:**

In order for US Lacrosse's educational programs to be successful, they must be evaluated from time to time. As the sport continues to grow, new coaches get involved, and new rules are developed. As the national governing body, US Lacrosse has the responsibility to provide resources to fuel the sport's growth and to provide educational resources for the enhancement of the sport. Well-educated coaches enhance the youth player experience and make the sport safer.

**TITLE OF THE STUDY:**

# Implementing LaxPrep: The Lacrosse Lower Extremity Injury Risk Reduction Program

**RESEARCHERS:**

Kelly Comolli, Lisa Hepburn PhD, MPH, Andrew Lincoln ScD, MS MedStar Sports Medicine

**PURPOSE:**

To characterize respondents who completed and implemented the LaxPrep training, their degree of implementation, and the implementation challenges among groups of users.

**WHY WE DID THIS RESEARCH:**

To get a better sense from our respondents on ways to improve both the quality of the program and ease of implementation. LaxPrep is a proven, research-based warm-up program that significantly decreases an athlete's risk of a lower extremity injury. It emphasizes core strength, balance, and proper landing techniques. Participants learn exercises and how to administer the cycles of the program safely and efficiently.

**WHAT IS KNOWN ABOUT THIS TOPIC:**

Injuries to the anterior cruciate ligament (ACL) are devastating and costly. At best, athletes are away from sport for 6 months, and in many cases the rehabilitation is much longer and athletes do not return to the same level of play as they had achieved before the injury. There is also evidence of long-term health effects, including a higher risk of arthritis in the affected knee. Researchers have shown that exercises that strengthen specific hip, leg and core muscles can reduce the risk of an athlete having an ACL injury. In addition, exercises such as these have been shown to improve overall leg strength which can improve speed and agility.

**WHAT THIS STUDY DID:**

This study was a web-based survey through Tonic Health. It was created and sent to 390 trainees who completed the online education LaxPrep course and indicated they intended to implement the program with their team.

**WHY THIS MATTERS:**

With these results, we can make changes to the LaxPrep program to increase the ease of implementation and in turn increase the amount of users of the program, with the ultimate hope of reducing ACL injuries in lacrosse athletes. The observations and results of the study support the implementation of age-specific neuromuscular-based warm up programs, starting at the youth level. The ultimate hope is to align LaxPrep with the LADM (Lacrosse Athlete Development Model). US Lacrosse is exploring an initiative to make the resistance bands more accessible, because they are essential to maximizing the benefits of the program.

## TITLE OF THE STUDY:

# Evaluation of Head Impact Sensor Systems in the Lacrosse Environment

## RESEARCHERS:

Primary Investigator: Cameron R. 'Dale' Bass, PhD, Duke University; Director, Injury Biomechanics Laboratory (IBL); Co-Investigator: Jason F. Luck, PhD, Duke University; Co-Investigator: Jason P. Mihalik, PhD, CAT(C), ATC, University of North Carolina at Chapel Hill

## PURPOSE:

Biomechanically validate existing head impact measurement devices wearable in both helmeted (male) and non-helmeted (female) lacrosse environments and establish their range of validity and reliability under wide-ranging impact conditions.

## WHY WE DID THE RESEARCH:

Mild traumatic brain injury (mTBI) – concussions – and sub-concussive head impacts are a significant issue for athletes of all ages and skill levels. Little is known about the dynamic severity of the head impacts that athletes experience during play. Researchers have attempted to study the forces and accelerations associated with athletic related head impacts. The measuring devices permeating the marketplace are incapable of being firmly affixed to the head, potentially limiting how accurately they measure head impact. With these limitations in mind it is paramount that investigations focused on quantifying the performance of these systems are done .

## WHAT IS KNOWN ABOUT THIS TOPIC:

Every year, millions of people suffer a traumatic brain injury (TBI), often sport-related, with the vast majority affecting youth and adolescents. Failure to properly diagnose and manage concussion can have catastrophic consequences, as evidenced in some cases of severe brain injury or death after a second injury is sustained before symptoms from the initial injury are fully resolved. There is increased discussion that sub-injurious or sub-concussive head impacts that do not result in an identifiable brain injury at the time of impact may lead to future neurological issues.

The ability to accurately measure the physical impact during possible concussive impacts, especially acceleration measurements of the head, is a crucial step in understanding head injury. Biomechanically, the best measurement would be 'strongly coupled' to the human head in the same way the upper front teeth are 'strongly coupled' to the head. Current devices that use acceleration measurements taken in helmets sitting on hair, attached to skin, or in mouthpieces, are more loosely coupled and may have limitations in measuring head kinematics.





### **WHAT THIS STUDY DID:**

Head impact and inertial loading experiments were performed with several impact locations or directions of loading (head/helmet regions). The head loading conditions were performed with the Cascade R helmet and with commonly available protective eyewear goggles across a range of exposure. The objective of the study was to evaluate how different head impact measurement systems, with variable coupling conditions, performed in both low-level (~10g) and higher level loading conditions. Four head impact measurement systems were evaluated: the X2 Biosystems xPatch, the gForce Tracker (GFT), the Triax SimG (Triax) and the DASHR. Three of the four systems studied (xPatch, GFT and Triax) are available either commercially or by request for research efforts. It is important to note that the DASHR was initially developed at Duke University and continues to be developed at Duke.

The study examined the resulting head kinematics measured by the four devices in comparison to reference measurements as a result of loading conditions that initiated from the following loading directions: frontal, frontal oblique, occipital (rear of head), occipital oblique, facemask, vertex (top of head), and right and left parietal (right and left side of head). The resulting magnitude of loading across these various directions ranged from low-level (~10g) to high-level (~130g). Over 300 individual data collection periods were completed that captured measurements from the four head impact measurement systems and accompanying reference measurements.

### **WHY THIS MATTERS:**

Understanding the performance of existing measurement systems under various impact scenarios is tantamount for accurate measurement and investigation of head impact exposure in athletes, designing gear to protect athletes, or evaluating the benefits of changes in play. The current findings reinforce the point that not all head impact measurement devices will measure a given impact event similarly. In some cases, the device may overestimate, while in others it may underestimate the severity of impact. The use of valid and reliable head impact measurement devices has the potential to identify athletes, especially youth and adolescent athletes, who display risky behavior on the field. Coaches and sports medicine clinicians can then intervene when risky behavior is identified. Furthermore, these devices have the potential to be used as a tool in diagnosing head injury or concussion. In concert with other assessments, on-field medical staff can be alerted when high-risk impacts occur and provide medical attention and diagnoses more quickly and with more.

## TITLE OF THE STUDY:

# A Biomechanical Analysis of the Protective Effect of Shoulder Pads in Preventing Major Shoulder Injury in Men's Lacrosse

## RESEARCHERS:

Theodore A. Blaine, MD; Elizabeth C. Gardner, MD; David Kovacevic, MD; Haffiz Kassam, MD; Steve Nelson, MD; Karen M. Sutton, MD; Steven Tommasini, PhD; Yale School of Medicine, Department of Orthopaedics and Rehabilitation. Lucien N. Blaine, Greenwich High School

## WHY WE DID THIS RESEARCH:

Major shoulder injuries, particularly clavicle fractures and acromioclavicular joint injuries, are common in men's lacrosse. While players are advised to wear shoulder pads during play, the efficacy of protective equipment in preventing major shoulder injury has not been previously investigated.

## WHAT IS KNOWN ABOUT THIS TOPIC:

There are very few published studies examining the efficacy of protective equipment for the shoulder. Published studies have suggested that padding of the shoulder does not reduce the occurrence of clavicle fracture in standardized biomechanical testing of cadaver specimens. This coincides with the epidemiological study published by this group, which showed high prevalence of shoulder injuries in collegiate men's lacrosse despite the use of shoulder pads.

## WHAT THIS STUDY DID:

To test the efficacy of the shoulder pads and their components, first we tested the pads on an aluminum rod (diameter = 60 mm). We tested two shoulder pad models to assess both the arched design compared to the larger designs that extend to cover the arm. The Under Armour Headliner elite shoulder pad relies solely on a shoulder arch design. The Under Armour VFT Plus shoulder pad includes protection of the shoulder cap, sub cap, and biceps guards. Four tests were run: 1) No pads; 2) UA Headline Elite; 3) UA VFT+ inner (medial soft pad); 4) UA VFT+ outer (lateral hard plastic pad). An initial pre-load of 5 N was used to ensure firm contact between the pad and the aluminum rod. Load was applied at a constant rate of 1 mm/s until 2,500 N was reached. The load vs. displacement was recorded.



Next, four male non-embalmed cadaver torsos were used to simulate a major shoulder injury to the clavicle, and to assess the effectiveness of shoulder protection equipment worn in men's lacrosse. The torsos were positioned on the Instron testing device and a force was applied to the clavicle adjacent to the acromioclavicular joint at a constant rate of 5 mm/s. Initial tests were performed to determine the amount of force required to reproducibly cause a clavicle fracture. Forces were measured using a 15,000 N capacity load cell.

To study clavicle fractures, the force was applied over the mid-shaft of the clavicle. The force and displacement were recorded and the difference in force between the shoulder pad side and the unprotected side was calculated. Statistical analysis was performed using one-way ANOVA to determine the effectiveness of the shoulder pads.

Each cadaver torso had one shoulder tested without shoulder pads and the other with shoulder pads, allowing each cadaver to act as its own internal control. We used four cadaver torsos to study clavicle fractures. Three tests were conducted for each torso: 1) No pads on right clavicle; 2) VFT+ on left clavicle; 3) Headline Elite on left clavicle. The padded shoulders were loaded to the same displacement that fracture occurred on the unprotected side. This ensured that the protected clavicle would not fracture before we could conduct tests on both sets of pads.

**WHY THIS MATTERS:**

This study informs future injury prevention strategies including product design, leading to strategies that reduce the overall number of shoulder injuries in men's lacrosse. Current shoulder pad designs reduce force by 27-29% at the clavicle, with greater force reductions noted from the hard plastic shell overlying the AC joint. Future shoulder pad design may incorporate hard materials that extend over the clavicle to reduce forces at the clavicle and mitigate fracture risk.

Men's lacrosse is a unique overhead, contact sport, which puts its players at risk for shoulder injuries. Although shoulder pads have become more robust in recent years, they remain thinner and more lightweight than those used in other contact sports. This biomechanical analysis of shoulder pads simulating these injuries determined the amount of force required to cause clavicle fractures and the protective effect of equipment at resisting them. The results of these findings inform future injury prevention strategies including product design and use. Ultimately, we hope that these results may lead to strategies that reduce the overall number of injuries to the shoulder in men's lacrosse, keeping more players on the field for the entire season.



#### **MISSION**

As the sport's national governing body, US Lacrosse provides national leadership, structure and resources to fuel the sport's growth and enrich the experience of participants.

**USLACROSSE.ORG**