



# ACL Rupture in Collegiate Athletes: Analysis of Familial Contribution to the Likelihood of Injury

Michael P Campbell<sup>1\*</sup>, Seth A Cheatham<sup>1</sup>, Daniel C Miranian<sup>2</sup>, Eric R Morga<sup>2</sup> and Robert A Perera<sup>3</sup>

<sup>1</sup>Department of Orthopaedic Surgery, Virginia Commonwealth University Health Systems, USA

<sup>2</sup>Virginia Commonwealth University School of Medicine, USA

<sup>3</sup>Department of Biostatistics, Virginia Commonwealth University, USA

\*Corresponding author: Michael P Campbell, MD Department of Orthopaedic Surgery Virginia Commonwealth University Health Systems PO BOX 980153 1200 East Broad Street Richmond, VA 23298 USA

Received:  February 03, 2020

Published:  February 14, 2020

## Abstract

**Objective:** Anterior cruciate ligament (ACL) injuries are a significant problem within collegiate sports. The question of whether a family history of ACL injury is associated with increased risk is incompletely understood, and it has never been studied at the collegiate level. By identifying those at risk, there is a potential to develop better prevention programs.

**Methods:** We surveyed approximately 1,500 collegiate athletes at 8 NCAA Division I, NCAA Division II, and NJCAA schools. Athletes were sent an electronic questionnaire through which they were asked about their age, sport, history of injury, and history of ACL reconstruction if applicable. Participants were asked the same information about their 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> degree relatives.

**Results:** A total of 304 athletes responded to the survey. Forty-eight (15.7%) athletes sustained an ACL injury. Fifteen athletes reported having a family member (1st, 2nd, or 3rd degree relative) with a history of ACL injury. Ten athletes reported having a first degree relative with an ACL injury. No significant association with family history was identified. There was found to be a lower associated risk of ACL injury in D1 athletes (OR 0.36).

**Conclusion:** There was no significant association with family history that could be identified. There was a lower associated risk of ACL injury in D1 athletes.

## Introduction

Approximately 200,000 people sustain anterior cruciate ligament (ACL) injuries annually in the United States [1]. Gender and sport have been implicated in increasing the risk of ACL injury, with female athletes being twice as likely to rupture an ACL compared to males [2]. In addition to gender and sport, there are potentially modifiable characteristics include sub-optimal conditioning, muscle recruitment patterns, and proprioception [3]. Non-modifiable risk factors have been studied as well, including joint laxity, limb alignment, ligament size, and notch size [4-6]. Although gender differences are seen in these non-modifiable traits, there may also exist an inheritable genetic component as well [7]. Few studies have looked at ACL injuries and the risk associated with a positive family history. Flynn et al. [8] performed a case-control study matched for gender, age, and sport in which they evaluated family history. They found that those individuals with an ACL injury were more than twice as likely to have a first

degree relative with a previous ACL injury. Goshima et al. [9] surveyed 316 patients that underwent ACL reconstruction for a positive family history of ACL tear. The only significant difference they found between the control group and family history group was that there was increased tibial slope in the family history group. Westin and Reeds-Lundqvist found an odds ratio of 1.95 of sustaining an ACL injury if the individual had a parent with a previous ACL rupture [10]. From our literature review, we found no studies that compared collegiate athletes with and without ACL tears that evaluated the association between family history and the risk of ACL injury. Knowledge of this information, if family history proves to be a significant factor, would be beneficial to coaches and athletes alike. Return to sport after ACL reconstructions can take anywhere between 6 to 12 months, with some athletes unable to return to play at all [11]. Athletes that do return frequently lose a year of playing eligibility depending on the timing of the injury. This can have devastating consequences on a collegiate athlete's career.

Although current research suggests prevention programs focused on strength and neuromuscular training in early adolescence are most effective at preventing ACL injuries [12], being able to specifically identify high risk athletes for ACL prevention programs would prove beneficial at the collegiate level.

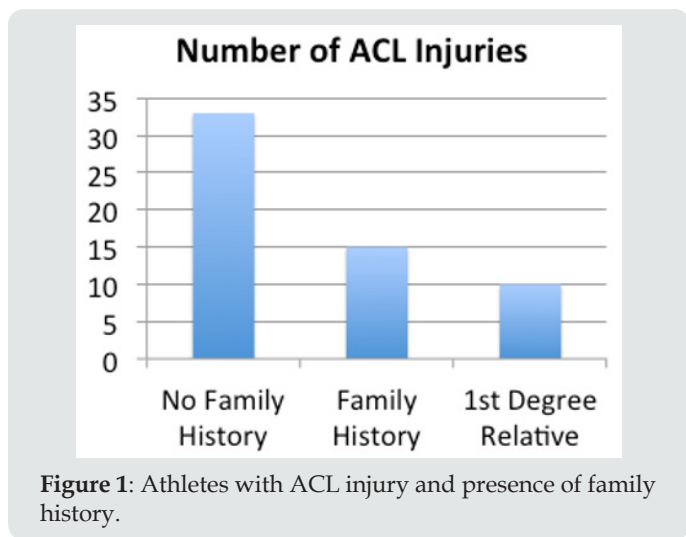
**Materials and Methods**

During the 2016-2017 season, approximately 1,500 collegiate athletes were surveyed regarding history of ACL injury. Our Institutional Review Board approved the study for exempt status. Student athletes at 8 NCAA Division I, NCAA Division II, and NJCAA schools were voluntarily surveyed. These included Virginia Commonwealth University (D1), Longwood University (D1), Winthrop University (D1), Liberty University (D1), St. Bonaventure University (D1), Virginia State University (D2), Virginia Union University (D2), and Richard Bland University (NJCAA). An 11-question voluntary survey was created and administered using RED Cap to securely collect data. This survey was pretested on 4 subjects for feedback on questionnaire’s layout and ease of use. Questions included age, sex, sport, history of ACL injury, presence of concomitant injuries at the time of ACL rupture, type of reconstruction, and whether any first degree, second degree, or third-degree relatives had a known injury. A total of 304 surveys were returned.

**Statistical Methods**

The count and proportion of participants with relatives who have experienced ACL tears are reported for each variable by ACL tear. To assess the relationship between family history of ACL tear and the likelihood of athletes tearing their ACL, logistic regression was used. Unadjusted and adjusted odds ratios, their corresponding 95% confidence intervals, and p-values were estimated each for variable. The adjusted model included each relative variable (e.g. first degree relative with ACL tear), and whether the participant was a Division 1 athlete. All analyses were completed using the R statistical software version 3.5.0 with an alpha of 0.05.

**Result**



**Figure 1:** Athletes with ACL injury and presence of family history.

A total of 304 surveys were returned. The distribution of athletes by sport and number of ACL injuries is displayed in Figure

1 and Table 1. A total of 48 athletes sustained ACL injuries (15.7%). There was the largest number of injuries basketball, soccer, and lacrosse. The distribution of athletes with an ACL injury and association with family history is displayed in Figure 1. Thirty-three athletes did not report a family history of ACL injury. Ten athletes reported a first-degree relative that sustained an ACL injury. No significant association was found between athletes with a history of ACL injury and a family history of ACL injury (Table 2). Those collegiate athletes participating in D1 athletics were found to have a lower associate risk of ACL injury.

**Table 1:** Responding athletes listed by sport and the number of ACL injuries.

Sports	Athletes	ACL Injury
Baseball	9	1
Basketball	31	9
Bowing	3	1
Cross country	30	0
Field Hockey	25	2
Football	8	4
Golf	7	0
Lacrosse	38	7
Soccer	56	12
Softball	33	4
Track & Field	35	5
Tennis	13	0
Volleyball	16	3

**Table 2:** Odds ratios of ACL injuries.

	Unadjusted		Adjusted			
	Odds Ratio	CI	P	Odds Ratio	CI	
First	1.98	0.86, 4.28	0.091	2.59	0.62, 9.11	0.155
Second	1.22	0.18, 5.14	0.806	1.23	0.17, 5.71	0.81
Third	1.03	0.33, 2.63	0.956	1.8	0.52, 5.40	0.315
Age	1.2	0.98, 1.46	0.074	1.2	0.92, 1.55	0.174
D1	0.51	0.25, 1.10	0.072	0.36	0.15, 0.91	0.026

**Discussion**

From our respondents, 15.7% reported a history of ACL injury. Basketball, lacrosse, and soccer had the highest number of ACL injuries. There was no significant association with family history that was identified. Surprisingly, Division I participation was associated with a lower risk of ACL injury. There are some limitations to this study. Because it is a voluntary survey, it is subject to lower than preferred response rate. Also, it is subject to recall bias, as we are asking busy student athletes to identify if a family member sustained an ACL injury. Finally, analyzing collegiate athletes is a small sample size. Our post-hoc power analysis demonstrated that we would need a total sample size of 3,120 athletes to achieve 80% power for detecting a significant effect of family history. These study limitations may affect the generalizability of our results. There have been few studies that have analyzed the effect of family history on

an individual's risk of ACL injury, and there is no prior study that we found that investigated collegiate athletes with ACL injuries and the relationship of a positive family history. This study attempted to review this association.

## Conclusion

From the 304 collegiate athletes that were surveyed at NCAA Division I, NCAA Division II, NJCAA schools, we were unable to identify a significant association between athletes with ACL injury and a positive family history of injury. We did find a lower associated risk of ACL injury in D1 athletes.

## This is a clinical study

The authors have not received grant support or research funding. The authors do not have any proprietary interests in the materials described in the article.

## Conflict of Interest

The authors have no conflicts to disclose.

## Acknowledgment

We would like to acknowledge the certified Athletic Trainers at the participating universities for their assistance in performing this study.

## References

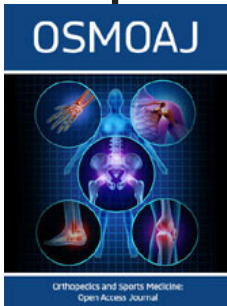
- Mall NA, Chalmers PN, Moric M, Tanaka MJ, Cole BJ, et al. (2014) Incidence and trends of anterior cruciate ligament reconstruction in the United States. *Am J Sports Med* 42(10): 2363-2370.
- Beynon BD, Vacek PM, Newell MK (2014) The effects of level of competition, sport, and sex on the incidence of first-time noncontact anterior cruciate ligament injury. *Am J Sports Med* 42(8): 1806-1812.
- Chappell JD, Creighton RA, Giuliani C, Yu B, Garrett WE (2007) Kinematics and electromyography of landing preparation in vertical stop-jump: risks for noncontact anterior cruciate ligament injury. *Am J Sports Med* 35(2): 235-241.
- Arendt E, Dick R (1995) Knee injury patterns among men and women in collegiate basketball and soccer: NCAA data and review of literature. *Am J Sports Med* 23(6): 694-701.
- Gwinn DE, Wilckens JH, Mcdevitt ER, Ross G, Kao TC (2000) The relative incidence of anterior cruciate ligament injury in men and women at the United States Naval Academy. *Am J Sports Med* 28(1): 98-102.
- Cowling EJ, Steele JR (2001) Is lower limb muscle synchrony during landing affected by gender? Implications for variations in ACL injury rates. *J Electromyogr Kinesiol* 11(4): 263-268.
- Kaynak M, Nijman F, van Meurs J, Reijman M, Meuffels DE (2017) Genetic variants and anterior cruciate ligament rupture: A systematic review. *Sports Med* 47(8): 1637-1650.
- Flynn RK, Pedersen CL, Birmingham TB, Kirkley A, Jackowski D et al. (2005) The familial predisposition toward tearing the anterior cruciate ligament: a case control study. *Am J Sports Med* 33(1): 23-28.
- Goshima K, Kitaoka K, Nakase J, Tsuchiya H (2014) Familial predisposition to anterior cruciate ligament injury. *Asia Pac J Sports Med Arthrosc Rehabil Technol* 1(2): 62-66.
- Westin M, Reeds-lundqvist S, Werner S (2016) The correlation between anterior cruciate ligament injury in elite alpine skiers and their parents. *Knee Surg Sports Traumatol Arthrosc* 24(3): 697-701.
- Daruwalla JH, Greis PE, Hancock R, Xerogeanes JW (2014) Rates and Determinants of Return to Play After Anterior Cruciate Ligament Reconstruction in NCAA Division 1 College Football Athletes: A Study of the ACC, SEC, and PAC-12 Conferences. *Orthop J Sports Med* 2(8): 1-6.
- Nessler T, Denney L, Sampley J (2017) ACL Injury Prevention: What Does Research Tell Us?. *Curr Rev Musculoskelet Med* 10(3): 281-288.



This work is licensed under Creative Commons Attribution 4.0 License

To Submit Your Article Click Here: [Submit Article](#)

DOI: 10.32474/OSMOAJ.2020.03.000167



**Orthopedics and Sports Medicine  
Open Access Journal**

**Assets of Publishing with us**

- Global archiving of articles
- Immediate, unrestricted online access
- Rigorous Peer Review Process
- Authors Retain Copyrights
- Unique DOI for all articles