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TITLE

Exploring Predictors of Primary ACL Injury Risk in Military Cadets: The Role of Lower Extremity Strength and Demographics

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Exploring Predictors of Primary ACL Injury Risk in Military Cadets: The Role of Lower Extremity Strength and Demographics

Context: Anterior cruciate ligament (ACL) injuries are prevalent in active populations, posing significant health risks. Despite advancements in surgery and rehabilitation, effectively preventing long-term health complications remains a significant challenge, underscoring the critical importance of developing effective ACL injury prevention strategies. Existing research into the risk of ACL injuries, in relation to lower extremity strength and demographic factors, often presents conflicting findings. These studies are frequently limited by small sample sizes or a narrow focus on specific muscle groups.

Objective: To explore the association between lower extremity strength, as measured by maximum voluntary isometric contraction (MVIC), demographic factors, and the risk of ACL injuries in a large sample of military cadets.

Design: Prospective Cohort Study

Setting: Military service academies

Patients or Other Participants: A total of 2,187 female and 3,432 male military cadets were recruited from three US military service academies.

Intervention(s): Cadets underwent baseline testing in the summer prior to their freshman year. Testing included demographics and MVICs for six muscle groups including the quadriceps, hamstrings, gluteus maximus, gluteus medius, and hip internal and external rotators. Cadets were prospectively followed for primary ACL injury incidence, from date of enrollment to graduation from service academy.

Main Outcome Measure(s): Multivariable logistic regression analyses were conducted to examine the association between MVIC values and primary ACL injury risk while controlling for demographic factors.

Results: There were 101 (38 females, 63 males) cadets that went on to sustain a primary ACL injury within their time at the academy. The results of this study found that greater gluteus maximus strength (OR = 0.32; *P* = 0.007) was associated with a decreased risk of ACL injury in military cadets. Cadets matriculating with higher BMI (OR = 1.09, *P* = 0.01) was associated with an increased risk of primary ACL injury in military cadets. All other factors were not statistically significant for predicting primary ACL injury risk.

Conclusion: This study suggests that greater gluteus maximus strength may have a protective effect against prospective ACL injury. Conversely, higher BMI appears to be a risk factor for prospective ACL injury. These findings may have important implications for the identification of at-risk individuals for targeted ACL injury prevention programs in military cadet populations.

Key Words: Anterior cruciate ligament injuries, military cadets, isometric lower extremity strength, risk factors.

Word Count ~4,100

Key Points: These results highlight the importance of assessing gluteus maximus strength and BMI when identifying individuals at risk for primary ACL injury. Greater gluteus maximus strength may have a protective effect against prospective ACL injury since it controls motion in three planes**.**

Introduction

Anterior cruciate ligament (ACL) injuries, notably prevalent in athletic populations, present significant challenges by impacting individual health and overall team performance both immediately and long-term.[1,2] In the United States, there are annually between 100,000 and 200,000 cases of ACL injuries.[3] Despite advancements in surgical techniques and rehabilitation, these interventions have been insufficient in preventing long-term morbidity, underscoring the critical need for primary prevention strategies.[1,2] Particularly concerning is that over two-thirds of ACL injuries result from non-contact mechanisms[8]—such as cutting, pivoting, decelerating, or landing[9]—suggesting that many of these injuries, often a consequence of suboptimal movement patterns, could potentially be preventable.[10]

ACL injuries are not only a concern for athletes but also pose significant challenges in military populations. Military service members experience a 10-fold higher incidence of ACL injuries compared to the general population due to the physically demanding aspects of military duties.[11] These injuries can significantly impact a service member's career and long-term physical readiness. Given the high injury burden, optimizing ACL injury prevention in military cadets is essential to preserving long-term health, ensuring operational readiness, and reducing medical discharges.

Research has identified that ACL injury risk stems from a blend of extrinsic factors (e.g., competition type, playing surfaces, weather conditions) and intrinsic factors (including age, sex, neuromuscular control, biomechanics, and physiological characteristics).[12,13]

These risk factors are further categorized as either non-modifiable (such as age and sex) or modifiable (like neuromuscular control deficits and poor biomechanics), with the latter offering opportunities for injury risk reduction through targeted interventions.[14] Among non-modifiable factors, sex is well-established, with females generally showing a higher incidence of ACL injuries compared to males in similar sports and activities.[2] Body mass index (BMI), while modifiable, has shown mixed results in its association with ACL injury risk, with some studies reporting higher BMI as a risk factor,[15] while others found no significant relationship.[12]

Given the importance of modifiable risk factors, previous research has primarily focused on improving intrinsic factors, particularly those related to biomechanics and muscular strength.[13] Altered biomechanics are thought to influence both passive and dynamic stabilizers of the knee, affecting knee stability and injury risk.[16] Biomechanical models have shown that the ACL is most vulnerable during movements involving anterior tibial translation, knee valgus loading, and tibial internal rotation.[17] However, evidence directly linking knee biomechanics with future ACL injury risk is inconsistent.[18] Despite this inconsistency, altered movement patterns are consistently implicated as a primary risk factor for ACL injuries.[19]

Although possessing modifiable risk factors may increase an individual's susceptibility to an ACL injury, it does not guarantee injury occurrence. Nevertheless, the emphasis on reducing the risk of ACL injury remains paramount. Given the protective potential of dynamic knee stabilizers, considerable research has investigated the impact of muscular strength in the hip and knee muscles on ACL injury risk. Studies have examined various muscle groups including the quadriceps,[20] hamstrings,[21] gluteus medius,[22] gluteus maximus,[22] and hip rotators.[22] Greater muscle strength may improve joint alignment[23] and reduce injury-associated forces,[21] potentially minimizing reliance on passive structures like the ACL.[21] However, evidence linking decreased muscular strength to ACL injury risk remains inconclusive, with studies often limited by small sample sizes, cross-sectional or case-control designs, and inconsistent outcomes.[24]

Thus, it is not clear whether decreased muscular strength or other modifiable factors such as BMI independently contribute to primary ACL injury risk. Therefore, the primary purpose of this study was to examine the relationship between maximal lower extremity isometric strength, BMI, and the risk of primary non-contact ACL injuries within a cohort of military cadets. By assessing multiple lower extremity muscle groups and BMI in a large, prospectively followed population, we aimed to identify specific risk factors that could inform targeted ACL injury prevention strategies. We hypothesized that reduced gluteus medius and hamstring muscle strength, due to their roles in frontal and sagittal plane stability of the knee, along with higher BMI, which may contribute to increased joint loading and greater forces to control during movement, would be associated with increased primary ACL injury risk.

Methods

The methods utilized in this study aimed to investigate the association between lower extremity maximum isometric strength predictors and primary anterior cruciate ligament (ACL) injury risk in a large sample of military cadets. The military cadets were enrolled in the JUMP-ACL (Joint Undertaking to Monitor and Prevent ACL Injury) cohort study from 2004-2008, across three military academies (US Military Academy, US Air Force Academy, and the US Naval Academy). Females, on average, represent approximately 16-21% of the military academy populations[25] were oversampled in the JUMP-ACL cohort in order to obtain sufficient numbers for adequate representation of both sexes.[26]

Participants

A total of 5,908 (2,279 Females) military cadets were included in the parent study if they were between the ages of 18 and 25 and were free from any lower extremity injuries or conditions that would affect their ability to perform the isometric strength and jump-landing tests. Additionally, only complete cases were kept for analysis (**Figure 1**). Missingness accounted for <3% of the dataset. After applying these criteria, 5,619 cadets (2,187 Females) were included in the final analysis.

[Insert Figure 1 about here]

Data Collection

Participants underwent a battery of lower extremity strength tests, including maximal voluntary isometric contraction (MVIC) tests for their quadriceps, hamstrings, gluteus maximus, gluteus medius, and hip internal and external rotators. Additionally, participants' height, weight, and BMI were collected. A survey collected demographic information, such as age and sex, as well as information on any past ACL and other knee ligamentous injuries.

MVIC Collection process

The strength of the lower extremity muscles, including the quadriceps, hamstrings, gluteus medius, gluteus maximus, and hip internal and external rotators was evaluated using a hand-held dynamometer (Figure 2; NexGen Ergonomics, Quebec, Canada). At the time of data collection, the testing was carried out by a team of Certified Athletic Trainer Research Assistants, each of whom underwent a standardized training regimen and successfully passed a comprehensive validation assessment to ensure their competence. Previous research has shown their intra-rater reliability ($ICC_{2,k}$) of the testing positions to range from 0.73 to 0.98.[27] These specific testing positions were selected to minimize participant movement while ensuring efficient assessment of strength, given that strength testing was integrated into the procedures of a large-scale data collection. In all included participants, the dominant limb, defined as the preferred leg to kick a ball, was used for testing. The dominant limb was selected for testing to maintain the highest standards, as the dominant limb is known to be as strong or stronger than the non-dominant limb.[28] Participants were asked to push into the dynamometer as hard as they could for five seconds. The mean force measurements from two 5-second trials were averaged. The recorded strength was measured in Newtons and then converted to torque by multiplying the force by the participant's lever arm length, which was measured as the distance from lateral femoral epicondyle of knee to location of the dynamometer for the quadriceps, hamstrings, and hip internal and external rotators and from the superior aspect of the greater trochanter location of the dynamometer for the gluteus maximus and gluteus medius. Finally, the torque was normalized to the participant's body mass (Nm/kg).

[Insert Figure 2 about here]

Data Analysis

The binary outcome variable was whether the participant sustained a non-contact primary ACL injury during their 4 years at their respective military academy (Figure 1). Only non-contact ACL injuries were included in this analysis to align with our focus on intrinsic risk factors. The independent predictor variables and the covariates were graphically analyzed for normality.

Descriptive statistics were calculated to summarize the sample characteristics, including means, standard deviations, and 95% confidence intervals for MVIC values. The strength variable distributions are shown in Figure 3 raincloud plot, split into Uninjured and ACL Injured groups. Multivariable logistic regression analyses were then conducted to examine the association between MVIC values and ACL injury risk while controlling for demographic factors.

[Insert Figure 3 about here]

Statistical Analysis

The main outcome of interest was the occurrence of primary ACL injury during the 4-year follow-up period. Initially, means and standard deviations were calculated for continuous variables, and frequencies and proportions were calculated for categorical variables (Table 1). The associations between baseline body mass index (BMI) and lower extremity isometric strength measures and the subsequent primary ACL injury rate were examined for each individual strength measure. A multivariable logistic regression model was used to estimate the association between baseline BMI and lower extremity isometric strength measures and the odds ratio (OR) of primary ACL injury during follow-up. We interpreted that an OR greater than 1.0 would indicate an increased risk for primary ACL injury while an OR less than 1.0 would indicate a decreased risk. The model statistically controlled for the influence of potential confounding variables, including sex and age. All analyses were conducted using the Scikit-learn and Statsmodels frameworks within Python (v3.7). The significance level was set at $P<0.05$ for all analyses.

Results

A total of 5,908 military cadets across the three service academies were eligible for inclusion into this study. 289 cadets that were excluded for analyses had either 1) a history of at least one ACL injury or 2) were missing ≥1 strength variable. This resulted in 5,619 cadets being included in the final analysis, out of which 101 cadets sustained primary ACL injuries. In other words, 1.8% of military cadets in our sample went on to sustain an ACL injury during their 4-year time at their respective military academy.

The final study cohort consisted of 39% (2,187) females and 61% males (3,432). At baseline, participants had a mean age (±SD) of 18.7 ± 0.9 years and a mean body mass index of 23.9 ± 2.9 kg/m^2. The demographics of the participants are broken down by group in Table 1. The descriptive statistics are displayed in Table 1 and were grouped by those that went on to sustain a primary ACL injury (ACL Injured) and those that did not (Uninjured).

[Insert Table 1 about here]

Baseline strength values (mean and SD) were provided for each group in Table 1 and further visualized in Figure 3, which illustrates the distribution of strength values across groups. For all but one muscle group, there were no demonstrable differences in baseline strength between those that went on to sustain an ACL injury and those that did not. However, there was a statistical difference in gluteus maximus strength, where cadets that went on to sustain an ACL injury had lower gluteus maximus strength than those that did not go on to injure their ACL (0.98 Nm/kg and 1.04 Nm/kg, respectively, P=0.05, Table 1). Additionally, on average the ACL injured group had higher BMI than the uninjured group (24.5 kg/m^2 and 23.8 kg/m^2, respectively, P=0.01, Table 1).

Upon analysis of the multivariable logistic regression model and its associated odds ratios (Table 2.), BMI and gluteus maximus strength were the only variables associated with ACL injury risk. Controlling for other variables, the odds ratio and 95% confidence interval was 1.09 (1.02, 1.17; p=0.01; Table 2) for BMI and 0.32 (0.14, 0.73; p=0.007;

Table 2) for gluteus maximus strength. These results indicated that for every one-unit increase in matriculating cadets' BMI there was an associated 9% increase in the odds of sustaining an ACL injury during their 4-year time at their service academy. In contrast, for every 1 Nm/kg increase in matriculating cadet's gluteus maximus strength there was an associated 68% reduction in the odds of sustaining an ACL injury during their 4-year time at their service academy. Sex and age did not demonstrate predictive relationships with ACL injury risk in military cadets.

[Insert Table 2 about here]

Discussion:

This study, to our knowledge, is one of the largest investigations examining the relationship between maximal isometric strength of lower extremity muscles, BMI, and primary non-contact ACL injury risk. With a substantial sample size (5,517 uninjured and 101 ACL-injured cadets), we used standardized isometric strength assessments across six muscle groups, all performed in a prone position. This approach enhances measurement reliability and clinical feasibility, as it minimizes position changes, enabling efficient strength testing in time-constrained settings.

While ACL injury risk is multifactorial, our findings indicate that gluteus maximus strength and BMI are independent modifiable risk factors for ACL injury, emphasizing their importance in injury risk screenings and prevention strategies. In contrast, gluteus medius and hamstring strength were not significantly associated with ACL injury risk, contrary to our hypothesis.

Muscle Strength:

Muscular strength is a modifiable injury risk factor and plays a critical role in dynamic knee stability, reducing reliance on passive structures like the ACL. Inadequate muscle strength may lead athletes to adopt compensatory strategies, potentially resulting in abnormal loading on the knee joint and an increased risk of ACL injury.[21,22]

Gluteus Maximus strength and primary ACL injury risk:

In this study of military cadets, a one-unit (1 Nm/kg) increase in maximal isometric gluteus maximus strength resulted in a 68% reduction in the odds of ACL injury. The ACL-injured group demonstrated a lower mean gluteus maximus torque (0.98 ± 0.27 Nm/kg) compared to the uninjured group (1.04 ± 0.31 Nm/kg). While this difference is small, even modest improvements in glute max strength may help reduce ACL injury risk. For example, an average cadet (74 kg body mass, 0.39 m lever arm) increasing their gluteus maximus strength from 1 Nm/kg (19.5 kg / 42.8 lbs) to 1.5 Nm/kg (29.1 kg / 64.0 lbs), would see an estimated 34% decrease in ACL injury odds, all other factors being equal. These findings highlight the importance of assessing gluteus maximus strength in ACL injury screenings. Targeted interventions to improve gluteus maximus strength may help reduce ACL injury risk, but additional research is needed to determine the most effective strength training approaches for injury prevention.

There are several plausible mechanistic reasons for this strength variable to have been a significant risk factor. The gluteus maximus contributes to knee stability through multiple mechanisms. It stabilizes the pelvis,[29] allows for increased trunk flexion, which in turn reduces the quadriceps moment.[30] It also enhances hip extension, enabling the hamstrings to control knee motion, thereby reducing anterior tibial shear.[31] Additionally, it limits tibial internal rotation and knee valgus through its role as a hip abductor and its connection to the knee via the Iliotibial band.[32] Deficient strength may lead to loss of these stabilizing functions, increasing ACL loading during dynamic movements.

Prior research has shown gluteus maximus strength can influence knee position[33] and landing biomechanics[34], but its direct link to ACL injury risk has been inconsistent. Contrary to our findings, Warren et. al did not find a significant association between preseason gluteus maximus isometric strength and lower body non-contact injury risk, including ACL injury risk.[35] Similarly, gluteus maximus strength was not associated with non-contact ACL injury in high school and college athletes.[36] These differences may stem from variations in study populations, as previous research focused on high school and college athletes with a greater proportion of female participants (64% vs. 38% in our study). Future prospective studies are needed to further clarify this relationship across different athletic groups.

Quadriceps and hamstrings strength and ACL injury risk:

Quadriceps and hamstrings contribute to dynamic knee stability, particularly in controlling anterior tibial translation.[12,20] In this study, maximal isometric quadriceps and hamstring strength were not statistically associated with primary ACL injury risk. One explanation is that these muscles primarily function in the sagittal plane, whereas the ACL greatest strain occurs with multiplanar loading.[17]

Our findings align with prior studies that found no association between quadriceps or hamstrings strength and ACL injury risk,[12,24] even up to four years after initial testing.[12] In contrast, Myer et al. found that female athletes who sustained an ACL injury had weaker hamstrings compared to male controls, but not compared to female controls.[37] Furthermore, they found that the female control group had weaker quadriceps compared to male controls, while the females who went on to sustain an ACL injury did not.[37] However, this study only looked at females who sustained an ACL injury (n=22), with injuries potentially occurring up to 24 months after initial testing, and used isokinetic muscle strength testing at 300 degrees/second.

Gluteus medius strength and ACL injury risk:

The gluteus medius contributes to hip and trunk stability, helping to control knee valgus and reduce excessive hip motion.[22,24,38–40] In the current study, maximal isometric gluteus medius strength was not associated primary ACL injury risk.

Our findings align with prior studies that found no association between gluteus medius strength and primary ACL injury risk in athletic female populations.[24,36,38] In contrast, Shimozaki et al. reported that greater gluteus medius strength was linked to increased ACL injury risk.[40] These discrepancies may stem from differences in study populations, as their study followed high school basketball players for three years, whereas others analyzed college or multi-sport athletes over longer periods.[24,36]

Hip internal and external rotator strength and ACL injury risk:

Hip rotators influence knee joint loading in the frontal and transverse planes, which may impact ACL stress.[41] While several studies have explored the effect of these muscles on lower extremity biomechanics,[27,41] our study found no association between hip external or internal rotator muscle strength and primary ACL injury risk.

These findings are consistent with Vacek et. al., who also found no association between hip rotation strength and primary non-contact ACL injury in male or female athletes.[36]

BMI:

Higher BMI has been linked to altered biomechanics[29] and knee-joint laxity[42], both of which may increase ACL injury risk. This study found that higher BMI was significantly associated with increased risk of primary non-contact ACL injury (OR= 1.09, p-value = 0.01). This indicates that for every one-unit increase in BMI, the odds of sustaining a primary ACL injury increased by 9%. To put this into perspective, a cadet with a BMI of 30 would have approximately 18% higher odds of ACL injury compared to a cadet with a BMI of 28, all other factors being equal. This trend aligns with previous findings in both females[12,15,36,40] and males.[15]

While these findings suggest that BMI should be considered in injury screenings and prevention programs, BMI alone does not account for body composition which may more directly influence ACL injury risk. Rather than focusing solely on BMI reduction, strategies aimed at optimizing body composition may be more effective in mitigating injury risk.[43] Future research should explore how fat and lean mass distribution contribute to ACL injury susceptibility and determine the best approaches for integrating body composition into injury prevention program.

Clinical Implications

ACL injuries result from multiple factors, but this study highlights gluteus maximus strength and BMI as key modifiable risk factors in military cadets. While prior research has linked muscular strength to movement patterns,[44–46] this study establishes a direct association between baseline gluteus maximus strength, BMI, and future ACL injury. Assessing gluteus maximus strength and BMI in injury screenings may help identify athletes at higher risk, and future studies should explore whether targeted inventions can reduce ACL injury rates.

Although quadriceps, hamstrings, gluteus medius, and hip rotator strength were not significant predictors, this does not discount the role of muscle function in ACL injury risk. Other factors, such as rate of force development and neuromuscular activation patterns, may be more relevant in reducing ACL strain and safeguarding against injury. and should be examined in future research.[47] As such, ACL injury prevention programs incorporating muscular strength exercises are readily accessible and are recommended for integration into regular training routines.[48]

A major strength of this study is its large sample size and prospective design, which improve generalizability. Additionally, the use of handheld dynamometry for field-based strength assessments enhances clinical feasibility, offering a quick, reliable, and practical method for sports medicine professionals conducting ACL injury screenings.

Limitations

There are several limitations to this study. First, strength and BMI were assessed only at baseline, while ACL injuries occurred throughout the cadets' time at the academy. Consequently, it is not known whether the subjects' muscular strength or BMI changed between data collection and the time of injury. Second, because military cadets are required to participate in sports, they may be fitter and more motivated than the general population, limiting generalizability beyond military and athletic settings. Third, we did not control for sport type, which could influence ACL injury risk. For example, sports like football often involve higher BMI athletes and increased ACL injury rates[49], potentially confounding the observed BMI-injury relationship. Fourth, this study used isometric strength testing with average torque measures, which may differ from other research that utilizes peak torque or dynamic strength assessments. Finally, while numerous muscles of the lower extremity were investigated, other potentially relevant muscles that may influence ACL injury risk such as hip adductors,[50] gastrocnemius,[51] or soleus[51] were not examined.

Conclusion

This study suggests that gluteus maximus strength and BMI are important modifiable risk factors for primary non-contact ACL injury in military cadets, whereas other thigh and hip muscle strengths were not significantly associated with injury risk. These findings underscore the importance of incorporating gluteus maximus strength assessments and BMI considerations into ACL injury screenings.

Future research should evaluate the effectiveness of targeted gluteus maximus strengthening and body composition optimization programs to determine the most effective training strategies for reducing ACL injury risk.

Ethical Considerations

The study was approved by the institutional review board and all participants provided informed consent. All data were kept confidential, and all participants were debriefed about the results of the study.

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Legends to Figures

Figure 1. Flow Diagram for enrollment and group allocation

Figure 2. Maximum voluntary isometric contraction positions for lower extremity muscles.

Figure 3. Raincloud Plot of Normalized Torque for Uninjured and ACL Injured Cadets. Left plots represent uninjured cadets (N = 5,518). Right plots represent cadets that later injured their ACL (N = 101). Each row compares uninjured to ACL injured cadet groups, with each plot presenting the distribution (half violin) and quartile ranges (box and whisker) of the represented data. Notes: Newtons, N; Meters, M; Kilograms, Kg.

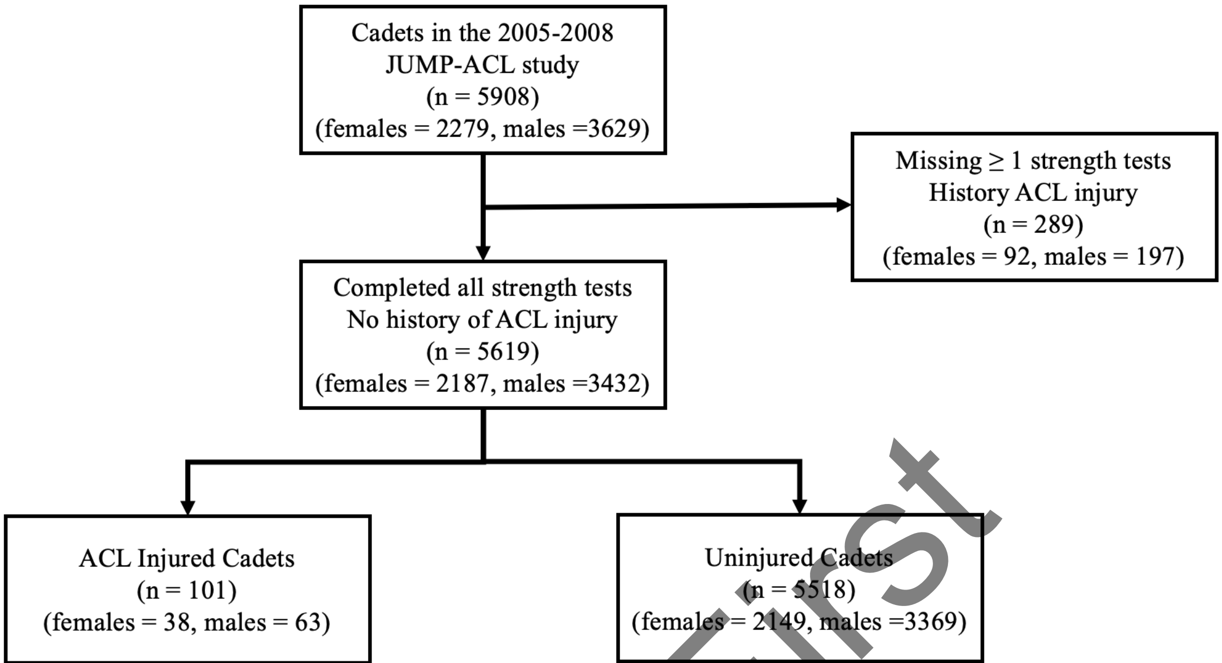
Table 1. Demographic and Sample Statistics (N = 5,619)

Note: Body Mass Index, BMI; Standard Deviation, SD; Confidence Interval, CI.

Table 2. Multivariable Logistic Regression of Predictors on ACL Injury Risk.

Body Mass Index, BMI; Confidence Interval, CI; * indicates statistical significance at the $a = 0.05$ level.

** indicates statistical significance at the $a = 0.01$ level



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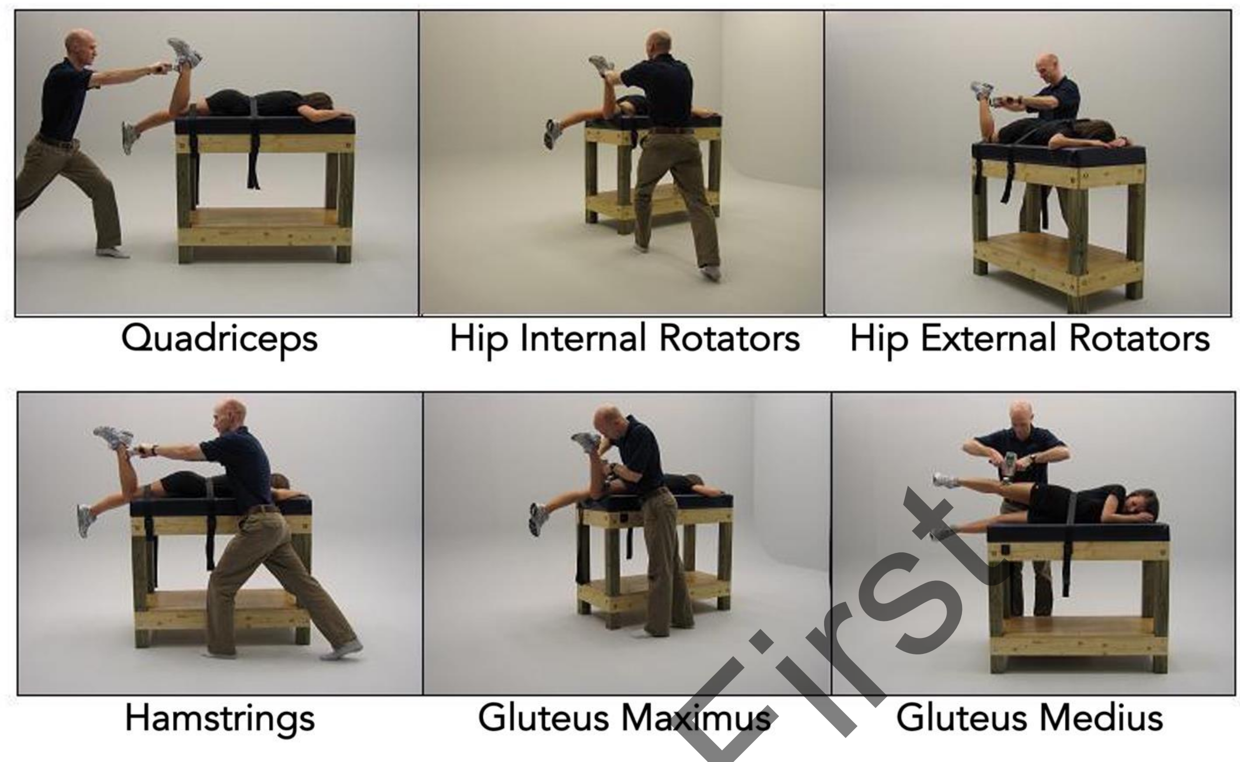

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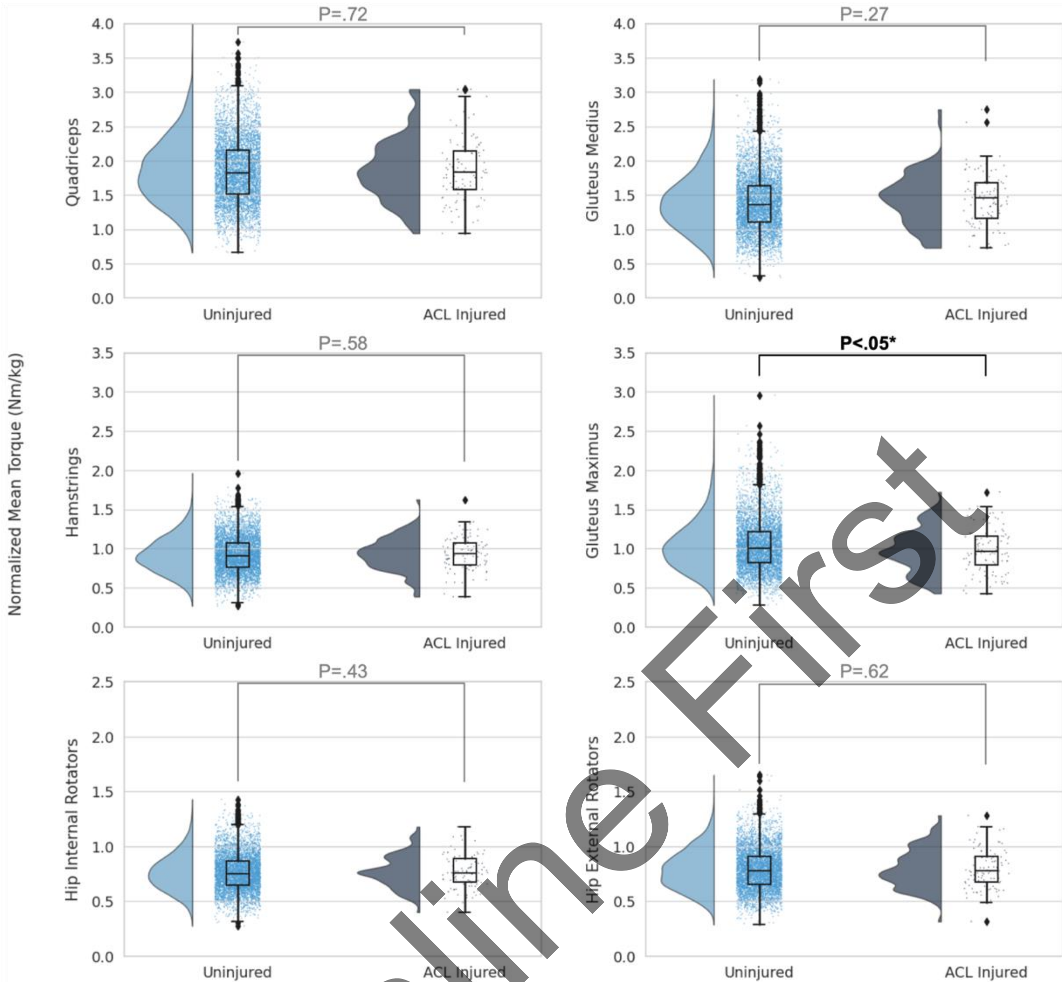

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Table 1. Demographic and Sample Statistics (N = 5,619)

	ACL Injured Cadets		Uninjured Cadets		
	n	%	n	%	P-value
Females	38	37.6%	2149	38.9%	0.78
Males	63	62.4%	3369	61.1%	
	Mean (SD)	95% CI	Mean (SD)	95% CI	P-value
Age (years)	18.72 (0.91)	18.54, 18.90	18.75 (0.91)	18.73, 18.77	0.75
Height (cm)	173.2 (9.4)	171.3, 174.9	173.2 (9.3)	172.9, 173.5	0.93
Mass (kg)	74.0 (13.6)	71.4, 76.7	71.8 (12.9)	71.5, 72.1	0.09
BMI (kg/m^2)	24.5 (2.87)	23.97, 25.09	23.8 (2.93)	23.72, 23.88	0.01
Quadriceps (Nm/kg)	1.87 (0.45)	1.78, 1.96	1.85 (0.46)	1.84, 1.86	0.72
Hamstrings (Nm/kg)	0.94 (0.21)	0.89, 0.98	0.92 (0.23)	0.92, 0.93	0.58
Gluteus Medius (Nm/kg)	1.43 (0.38)	1.36, 1.51	1.39 (0.40)	1.38, 1.40	0.27
Gluteus Maximus (Nm/kg)	0.98 (0.27)	0.92, 1.03	1.04 (0.31)	1.03, 1.05	0.05

Hip External Rotators (Nm/kg)	0.80 (0.18)	0.76, 0.83	0.79 (0.18)	0.78, 0.79	0.62
Hip Internal Rotators (Nm/kg)	0.77 (0.15)	0.75, 0.80	0.76 (0.16)	0.76, 0.77	0.43

Note: Body Mass Index, BMI; Standard Deviation, SD; Confidence Interval, CI.

Table 2. Multivariable Logistic Regression of Predictors on ACL Injury Risk.

	Odds Ratio	95% CI	P-Value
Sex	1.13	0.65, 1.98	0.66
BMI	1.09	1.02, 1.17	0.01*
Age	0.92	0.73, 1.16	0.48
Quadriceps Torque	0.83	0.44, 1.58	0.57
Hamstrings Torque	1.89	0.52, 6.83	0.33
Gluteus Medius Torque	1.56	0.83, 2.96	0.16
Gluteus Maximus Torque Hip	0.32	0.14, 0.73	0.007**
External Rotators Torque	0.93	0.16, 5.59	0.94
Hip Internal Rotators Torque	2.70	0.47, 15.67	0.27

Body Mass Index, BMI; Confidence Interval, CI; * indicates statistical significance at the *a* = 0.05 level.

** indicates statistical significance at the *a* = 0.01 level