Original Research

Research Dominance Definitions May Not Identify Higher Risk Limb for Anterior Cruciate Ligament Injury in NCAA D3 Student-Athletes

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Background/Purpose

Recent work has identified non-significant correlations of established limb dominance to the lower extremity (LE) at greater risk for Anterior Cruciate Ligament (ACL) injury in an active, non-athletic sample. The most common LE dominance definition is preferred leg to kick a ball. Athletes develop a unilaterality pattern different from their active, non-athlete peers. Therefore, the purpose of this study was to explore the correlation between the LE used to kick a ball with and the limb identified at greater risk of ACL injury in National Collegiate Athletic Association (NCAA) Division III athletes.

Design

An Observational Descriptive study design

Methods

Forty-six student-athletes that were active on their NCAA Division III football, field hockey, volleyball, and soccer team rosters were recruited. Upon completing consent, participants performed two tasks (kicking a ball; unilateral land) in a counterbalanced order. Data were entered into and analyzed with a commercial statistical software package where a phi coefficient and Chi-squared analysis were performed.

Results

Of the 46 student athletes who participated (Female=32, Male=14, 19.48±1.26years, 171.75±10.47cm, 77.26±18.74kg), 25 participants kicked and landed with the same limb. Twenty participants chose kicking and landing with different limbs. The Phi Coefficient (Φ= 0.001; P= 0.97) indicated little to no relationship between the LE a participant kicked and landed with. Likewise, the Chi-square statistic revealed no statistical differences between observed and expected frequencies ($\chi 2$= 0.001; p= 0.97).

Discussion/Conclusion

NCAA Division III athletes display a statistical absence of preferred limb predictability utilizing the most common dominance definition (kicking a ball) as it relates to identifying LE at risk of ACL injury. The results suggest that the prevalent LE dominance definition is problematic when exploring ACL injury risk in this population.

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INTRODUCTION

Decades of focused investigations have been conducted to better understand anterior cruciate ligament (ACL) injury risk factors.[1] Despite this, ACL injuries remain common,[2–6] costly,[7] and debilitating.[8] It has been estimated that 80,000 to 250,000 ACL injuries occur in the US each year,[3,9,10] with an appropriated total annual cost of between $8 and $18 billion.[11] ACL injury increases the likelihood of re-injury,[12,13] and the risk of developing knee osteoarthritis.[12] Furthermore, individuals often face psycho-sociological challenges during their time away from regular activity.[14,15] A preferred strategy then, would be to prevent rather than treat ACL injuries.

Injury prevention requires a precise understanding of the causal risk factor(s).[16] It has been established that ACL injuries occur more frequently with non-contact mechanisms,[2,4] and with single LE deceleration activities such as changing direction or landing from a jump.[17] These suggest that lower extremity (LE) biomechanics are affected at ground contact to increase injury risk. As such, unilateral landing tasks are commonly utilized to study non-contact ACL risk factors.[18,19]

Investigation of unilateral landing behaviors commonly collects data from the participant's dominant LE. Limb dominance is most frequently defined as the preferred LE to kick a ball.[20–23] The majority of ACL injuries however occur to the plant or landing LE.[21,24] It is unknown if the preferred leg to kick a ball is the lower extremity most commonly injured. Unless the preferred kicking LE is also the preferred plant or landing LE, this operational definition of LE dominance is potentially problematic. Given the epidemiological data, costs and long-term medical impacts, it is apparent choosing the appropriate LE for testing is imperative.

To date, only one investigation has been published exploring the relationship between the preferred kicking LE and the preferred landing LE.[25] This investigation indicated that there were weak correlations between these two measures of LE dominance in a sample of healthy, active college students. For a number of reasons explored in the literature, athletes demonstrate an elevated risk of orthopedic injury, than their healthy, but non-athlete peers.[26–29] In athletes however, the strength of correlation between LE dominance measures remains unknown. Optimal prediction of LE dominance for injury risk would benefit athletes even more than the values in a general, healthy population.

Therefore, the purpose of this study was to explore the correlation between the LE used to kick a ball with and the limb identified at greater risk of ACL injury in National Collegiate Athletic Association (NCAA) Division III athletes. The hypothesis was that these measures will indicate stronger correlations in athletes than reported in healthy non-athletes.[25]

METHODS

The authors utilized an observational, descriptive investigation design[30,31] with counterbalanced, repeated measures. This investigation was granted Institutional Review Board approval. Inclusion Criteria required participants to be 1) between the ages of 18-25 and 2) currently active on their NCAA Division III football, soccer, field hockey, volleyball, basketball, or lacrosse team roster. Athletes from the included sports were recruited to participate as they are at increased risk for non-contact ACL injury.[27–29,32,33] Participants were excluded from the study if within the prior six months they had: 1) utilized crutches for any LE injury or 2) missed a regularly scheduled intercollegiate competition due to a LE injury, 3) engaged in a rehabilitation program for a LE injury or 4) inability to demonstrate any of the required physical activities in the study. These exclusions were to assure unbiased LE function, and optimize participant safety.

An a-priori power analysis using publicly available freeware (G*Power v 3.1.9.2, Düsseldorf, Germany) indicated that a minimum sample size of 34 was needed to achieve a power of 0.80. To ensure that a Type II error was not committed, forty-six student-athletes healthy, NCAA D-III participants between the age of 18 and 25 were recruited for this investigation. Data were collected during a single session in the Westfield State University Biomechanics laboratory. Upon receiving written informed consent, height, weight, age, and sport team were recorded. The participant then performed two tasks (kicking a ball; unilateral landing) in a counterbalanced order.

KICKING TASK

Participants were asked to jog 300cm (3 meters) to kick a stationary soccer ball through a 100cm (1 meter) wide target, 300cm (3 meters) away. Each individual completed five trials of this activity. The LE the participant chose to kick a ball with three out of five trials was defined as their preferred kicking LE.[25] Participants were asked to jog and kick the ball rather than kick it from a stationary position as we felt this methodology more realistically represented how the activity would take place.

LANDING TASK

Participants were asked to stand on a box 30cm in height, and instructed to lean forward and drop from the box, landing on their preferred leg. Each individual completed five trials of this activity. The LE the participant chose to land with three out of five trials was defined as their preferred landing LE and is consistent with previous investigations.[25,34,35]

STATISTICAL ANALYSES

Pearson correlation coefficients were calculated (SPSS v26, IBM, Armonk, NY) to determine the relationship between preferred landing LE and preferred kicking LE. A Chi-square value was calculated to explore for observed and expected frequencies.

RESULTS

The forty-five participants represented six sports (football= 11, men's soccer= 1, women's soccer= 8, women's lacrosse=

Table 1. Frequencies of preferred dominance

		Preferred Kicking LE	
		Left	Right
Preferred Landing LE	Left	3	16
	Right	4	22

1, women's volleyball= 10, field hockey= 14). Thirty-three female, and 12 male participants completed the study (19.48±1.23years, 171.75±10.47cm, 77.26±18.74kg). Twenty-five participants kicked and landed with the same limb. Twenty participants chose kicking and landing with different limbs (Table 1). The Phi Coefficient (Φ= 0.001; *p*= 0.97) indicated little to no relationship between the LE a participant kicked and landed with. Likewise, the Chi-square statistic revealed no differences between observed and expected frequencies ($\chi 2= 0.001$; $p= 0.97$).

DISCUSSION

The purpose of this investigation was to correlate the preferred LE in kicking a ball, and the LE preferred from a drop landing in athletes. The investigators hypothesized the correlations would be stronger in athletes than the previous findings in healthy, active, non-athletes. The findings of this study did not support the stated hypothesis, as weaker correlations were seen in these athletes than in previous descriptions of healthy, active non-athletes.

There is little discrepancy for defining upper extremity dominance.[36,37] In contrast, previous investigations have utilized various definitions for LE dominance. Among the various singular strategies have been utilization of stance or weight-bearing LE,[19] the preferred single LE for landing task,[38] or through a battery of tests.[39] The most common operational definition in the literature however, involves the preferred LE for kicking a ball.[20–23]

The utilization of a consistent and task specific LE selection is essential for application of any research finding. Epidemiological evidence on ACL injury incidence contrasts with the rationale for LE selection in the majority of investigations. Data show ACL injuries occur more frequently with a unilateral landing,[24] during a non-contact mechanism,[1–4] and do not occur as frequently to the kicking LE.[17] The most frequent strategy for LE dominance selection then, seemingly is potentially problematic when attempting to understand ACL injury risk.

The hypothesis was generated from the understanding that athletes demonstrate a high level of motor skills as they perform at ever higher levels of competition. These motor skills often necessitate incredible unilateral control. Indeed, prior work in dancers has suggested level of expertise may affect preferred LE for skill performance, even where bilateralism is expected.[24] Previous work from two of the current investigation's authors (PAC, CRC)[25] explored the same correlation analysis in a group of healthy and active, but non-athletes. The results of that study indicated weak correlations between the preferred kicking and landing LE. The data in this study indicate even weaker, and statistically insignificant correlations in athletes. Given this, previous injury risk identification investigations may have obtained results from the LE less likely to be injured as a result.

Among the premises of this investigation are that athletes differ from healthy, active non-athlete individuals of a similar age. Of greater concern is that athletes demonstrate an elevated risk of ACL injury than their healthy, active, but non-athlete peers.[26–29] Another study limitation is that due to the selection of sport teams, data were collected on a higher number of females versus males. As females have demonstrated a greater incidence of ACL injury in the literature,[33,40,41] the authors feel that the data remain consistent with the purpose of this study. Finally, the exclusion criteria were selected to investigate these skills in only those who are currently performing at high levels of function and competition. Including individuals who had returned to a full function from LE surgery is more representative of a realistic scenario in the collegiate population, and has been previously utilized for that effort.[35,42] This is however, may be considered a limitation of this investigation.

The findings in this investigation raise several areas of interest for future investigations. Among these are exploring any connection between upper and lower extremity dominance. Additionally, exploration of the relationship of the lower extremity with greater likelihood of injury to the operational dominance definitions as seen in sports with an elevated need for bilateralism such as lacrosse and soccer is warranted.

CONCLUSION

NCAA Division III athletes display a statistical absence of predictability in definitions of LE dominance. Even though athletes develop greater unilaterality as level of competition increases, the results suggest that the most prevalent dominance definition (the limb with which one kicks a ball) may be problematic when exploring ACL injury risk in this population. As ACL injury risk is elevated in the preferred planting versus kicking limb, careful consideration should be given to the operational definition of LE limb dominance in future injury risk studies.

DISCLOSURES

There are no author disclosures regarding this investigation or preparation of this manuscript. There were no funding sources for this investigation.

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