

Increased Acute Lower Extremity Musculoskeletal Injury Rates Following Concussion



Robert C. Lynall, MS, ATC; Timothy C. Mauntel, MA, ATC; Darin A. Padua, PhD, ATC, FNATA;
Jason P. Mihalik, PhD, CAT(C), ATC



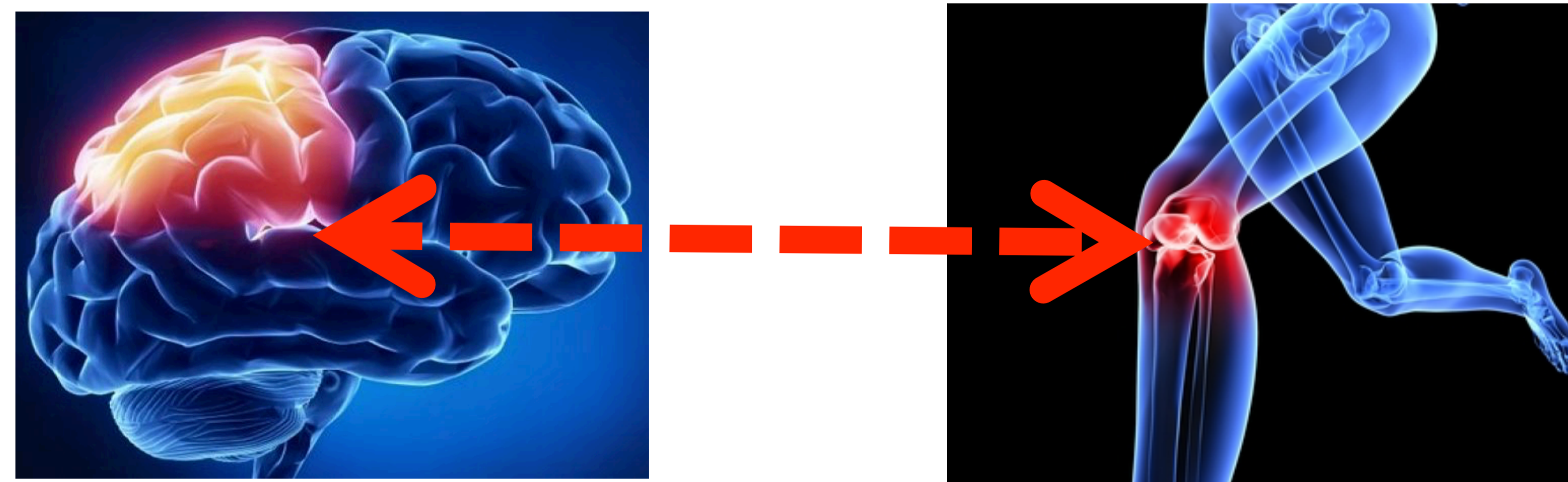
The University of North Carolina, Chapel Hill, NC

BACKGROUND

- Sport-related concussion results in measurable neurocognitive and static postural control deficits.¹ Dynamic postural control deficits during gait² along with increased motor evoked potential latency and decreased amplitude^{3,4} have been reported to persist beyond an athlete's return-to-play following concussion.
- Incomplete brain trauma recovery may increase the athlete's risk of acute lower extremity musculoskeletal injury as has been previously reported in a cohort of professional European soccer players.⁵

PURPOSE

- To describe acute lower extremity musculoskeletal injury rates before and after concussion in concussed and matched control collegiate athletes.
- We hypothesized acute lower extremity injury rates would increase 1) Within the concussed group following brain injury, and 2) Compared to a matched control group.



METHODS

- A random sample of physician diagnosed concussed college athletes was identified after examining Sports Medicine electronic medical records over a 3-year period.
- Each concussed athlete was matched to 1 or more control athletes who had not suffered a concussion in their collegiate career based on the following criteria: 1) Sex, 2) Sport, 3) Age, and 4) Competition exposure (Table 1).
- Competition exposure was determined by analyzing game statistics for each athlete based on the sport played using statistics available online (e.g. basketball=minutes per game, football=games played, wrestling=total matches, etc.).
- Acute lower extremity musculoskeletal injury data were collected over a 2-year window; up to 365 days prior to and after the concussion. Control participants' 2-year window for exposure and injury data were anchored to their injury match's concussion injury date.
- Athlete exposure was defined as 1 day of data collection. This definition was chosen as college athletes participate in sports-related activities outside of their defined season, meaning they are exposed to injury beyond their competitive season.
- If an athlete left the university or the team within the 365 day window following the concussion, their exposure was truncated at the date at which they no longer participated in varsity athletics.
- Injury rates were calculated for the pre-injury and post-injury time periods for both study cohorts. Injury risk ratios were calculated to determine differences between our comparisons of interest. Injury risk ratios with associated 95% confidence intervals not containing 1.0 were considered to be statistically significant.

RESULTS

- The concussed group was 1.97 times more likely to suffer an acute lower extremity musculoskeletal injury post-concussion than prior to the concussion (Figure 1 and Table 2) and 1.57 times more likely to suffer an acute lower extremity musculoskeletal injury than the uninjured matched cohort (Table 3).
- There were no significant differences between the two time points within the control group or between the concussed and control groups at the pre-concussion time point.

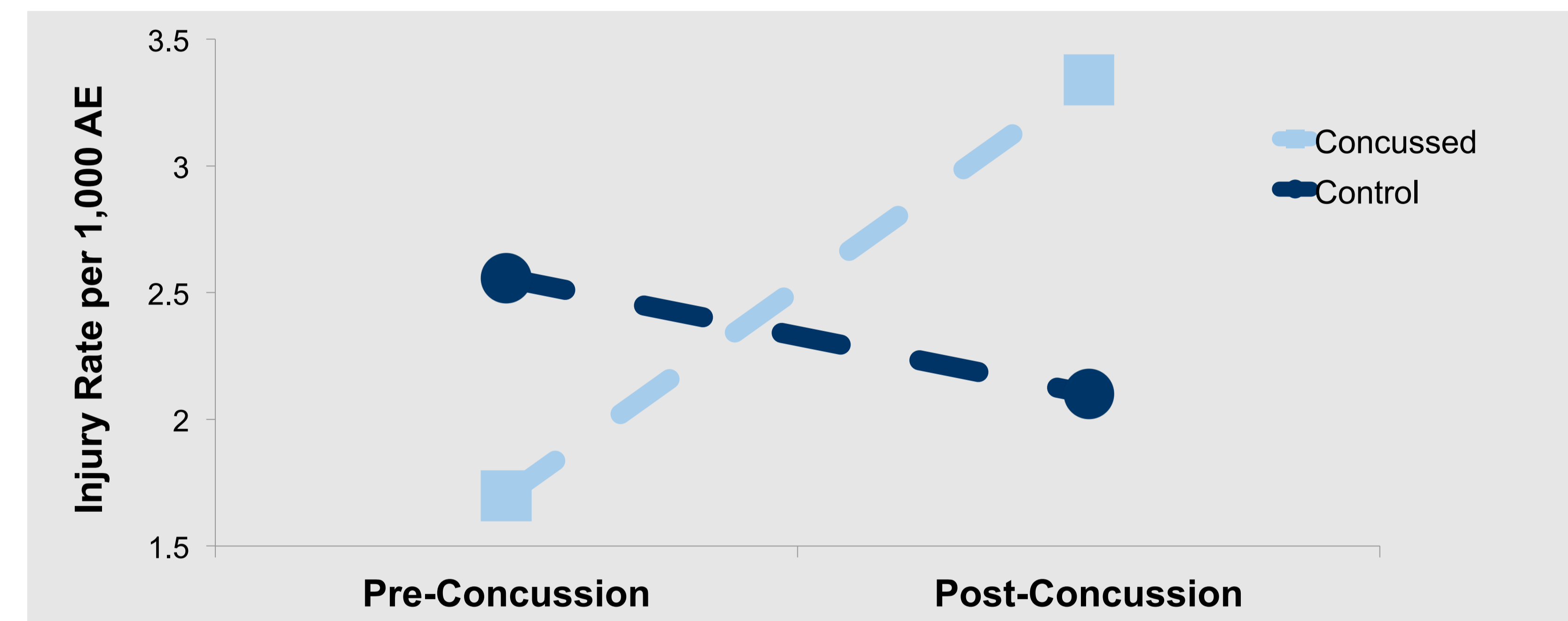


Figure 1. Comparison of pre- and post-concussion acute lower extremity musculoskeletal injury rates between concussed and control groups. AE = Athlete Exposure.

Table 1. Descriptive statistics for each group.

	Concussed (n = 41)	Control (n = 54)
Age (yrs)	20.0 (1.2)	20.4 (1.3)
Female (n)	16 (39%)	19 (35%)
Male (n)	25 (61%)	35 (65%)
AE Pre-Concussion	272.8 (122.5)	275.3 (123.7)
AE Post-Concussion	321.1 (75.6)	305.3 (94.9)
Sport		
Basketball	2 (5%)	2 (4%)
Cross Country	1 (2%)	2 (4%)
Field Hockey	4 (10%)	5 (9%)
Football	9 (22%)	11 (20%)
Lacrosse	5 (12%)	9 (17%)
Rowing	3 (7%)	4 (7%)
Soccer	5 (12%)	5 (9%)
Softball	2 (5%)	3 (6%)
Swim/Dive	4 (10%)	5 (9%)
Tennis	1 (2%)	1 (2%)
Wrestling	5 (12%)	7 (13%)

Table 2. Within group rate and risk ratios (Post/Pre).

	Injury Rates		
	Pre	Post	Risk Ratio (95% CI)
Concussed	1.70	3.34	1.97 (1.15, 3.37)
Control	2.56	2.12	0.83 (0.53, 1.31)

Table 3. Between group rate and risk ratios (Conc/Cont).

	Injury Rates		
	Conc	Cont	Risk Ratio (95% CI)
Pre	1.70	2.56	0.66 (0.38, 1.15)
Post	3.34	2.12	1.57 (1.01, 2.45)

CONCLUSIONS

- The increased acute lower extremity musculoskeletal injury rates following concussion suggest normal functional movement and dynamic postural control may not be fully restored when concussed athletes return to play.
- Previous literature has detailed dynamic postural control deficits in standard gait following return to play after concussion² as well as increased motor evoked potential latency and decreased amplitude.^{3,4} These findings suggest the brain may be unable to coordinate movement as it did prior to the concussion. This motor control deficit may become more pronounced with the dynamic movements required for sport.
- In combination with previous reports⁵ along with our findings of increased acute lower extremity musculoskeletal injury rates following concussion, this underscores functional movement and dynamic postural control assessments may be a valuable addition to the concussion injury assessment protocol employed by athletic trainers and other medical professionals.
- Future research should explore musculoskeletal injury rates following concussion in other skill and age cohorts. More investigation is needed to determine the exact mechanism(s) behind the increased rate of acute lower extremity musculoskeletal injury following concussion. If this mechanism can be better understood, clinicians and researchers may be able to develop rehabilitation methods to mitigate the increased risk of injury following concussion.

REFERENCES

1. Guskiewicz KM, Ross SE, Marshall SW. Postural Stability and Neuropsychological Deficits After Concussion in Collegiate Athletes. *J Athl Train*. 2001;36(3):263-273.
2. Howell DR, Osternig LR, Chou LS. Dual-Task Effect on Gait Balance Control in Concussed Adolescents. *Arch Phys Med Rehabil*. 2013.
3. Livingston SC, Saliba EN, Goodkin HP, Barth JT, Hertel JN, Ingersoll CD. A preliminary investigation of motor evoked potential abnormalities following sport-related concussion. *Brain Inj*. 2010;24(6):904-913.
4. Livingston SC, Goodkin HP, Hertel JN, Saliba EN, Barth JT, Ingersoll CD. Differential rates of recovery after acute sport-related concussion: electrophysiologic, symptomatic, and neurocognitive indices. *J Clin Neurophysiol*. 2012;29(1):23-32.
5. Nordstrom A, Nordstrom P, Ekstrand J. Sports-related concussion increases the risk of subsequent injury by about 50% in elite male football players. *Br J Sports Med*. 2014;48(19):1447-1450.



CONTACT INFORMATION



POSTER E-COPY

