A Decade of Hip Injuries in National Collegiate Athletic Association Football Players: An Epidemiologic Study Using National Collegiate Athletic Association Surveillance Data

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Context: The complex, high-energy nature of football puts players at risk for hip injuries.

Objective: To analyze National Collegiate Athletic Association (NCAA) Injury Surveillance Program data for men's football hip injuries from 2004–2005 through 2013–2014.

Design: Descriptive epidemiologic study.

Setting: National Collegiate Athletic Association football teams.

Patients or Other Participants: Data on collegiate football players was provided by the NCAA Injury Surveillance System from 2004–2005 through 2013–2014.

Main Outcome Measure(s): The incidence, risk factors, rates, and distribution of hip injuries over the 10-year period from 2004–2005 through 2013–2014 were determined. Rates and distribution of injuries were analyzed by injury type, time loss, event type, time of season, recurrence, mechanism of injury, player position, and if surgery was required. Injury rate ratios were calculated to compare rates between event types and by time of season.

Results: A total of 1618 hip injuries occurred during 3121380 athlete-exposures (AEs), resulting in an overall hip injury rate of 5.18 per 10000 AEs. Adductor strains (38.63%) were the most common type, followed by hip-flexor strains (28.55%) and hip contusions (18.23%). Players were 3.56 (95% confidence interval [CI] = 3.19, 3.98) times more likely to sustain a hip injury during competitions compared with practices. They were 2.37 (95% CI = 2.15, 2.62) and 3.56 (95% CI = 2.49, 5.08) times more likely to sustain a hip injury during the preseason than in-season or the postseason, respectively.

Conclusions: During the 10-year period, NCAA football players sustained higher rates of hip injuries during competitions and the preseason. The majority were noncontact injuries, resulted in time loss of less than 6 days, and did not require surgery. The injuries varied with player position and occurred most often to defensive backs. Muscle strains were the most frequent group of hip injuries, while adductor strains, hip-flexor strains, and hip contusions were the most common injury types.

Key Words: athletes, collision sports, injury surveillance

Key Points

- Football players were at a higher risk of hip injury during competitions and the preseason.
- Adductor and hip-flexor strains were the most common hip injuries among football players.

ootball is one of the most widely played sports in the United States. With more than 60 000 collegiate athletes, it represents the greatest proportion of student-athletes among all National Collegiate Athletic Association (NCAA)-sponsored sports, with another 1 million high school athletes participating in the sport.^{1,2} One of the most popular sports, it is also one of the most injury prone and the leading cause of sport-related injuries per exposure, nearly double the rate of the next highest sport, basketball (8.1 versus 4.8 injuries per 1000 athlete-exposures [AEs], respectively).^{3–5} The complex, highenergy nature of the sport leads to a high likelihood of athletic injury from contact and noncontact mechanisms.¹ Football players are at an increased risk of all types of hip injuries, including strains, contusions, avulsions, subluxations, and labral tears.¹ Whereas the lower extremity encompasses the majority of injuries seen in football athletes (56.8%), injuries to the hip and groin have not been as well studied.^{2,6}

Previous authors⁵ have shown that the rates of hip injuries in high school and NCAA football players were 9.3% and 17.3%, respectively. Among NCAA athletes, men's soccer players had the highest rates of hip-flexor and hip-adductor strains (3.77 per 10 000 AEs and 3.15 per 10 000 AEs, respectively), although football players had the highest absolute numbers (964 and 674, respectively).⁷ The rate of hip injuries among NCAA football players has been reported, but research on the specific incidence of and risk factors for hip injuries in football players has been limited to professional athletes. In a National Football League (NFL) study,¹ hip injuries were a small but relevant percentage of the injuries incurred, accounting for 3.1% over a 10-year period. The advent of increasingly accurate magnetic resonance imaging, specifically magnetic resonance imaging arthrography, and improved procedures for physical examination of the hip has led to increased awareness of hip injuries, especially intra-articular disorders, among football players.⁸ It is important to understand not only the incidence but also the causes of hip injuries in this vulnerable population. The purpose of our study was to analyze male football players' hip injuries reported to the NCAA Injury Surveillance Program (NCAA-ISP) from the 2004–2005 through 2013– 2014 academic years and determine the incidence, risk factors, rates, and distribution. We hypothesized that the incidence among and risk factors for NCAA football players would be similar to those found in NFL players.

METHODS

The study was approved by the Institutional Review Board and the Research Review Board of the NCAA. The NCAA-ISP database was queried for hip injuries during the 10 years from 2004–2005 through 2013–2014. The combined 10-year dataset was composed of two 5-year sets (2004–2009 and 2009–2014). Hip injuries were analyzed for injury type, time loss, event type, time of season, recurrence, mechanism of injury, player position, and whether surgery was required. The NCAA-ISP is a prospective injury-surveillance program managed by the Datalys Center for Sports Injury Research and Prevention, Inc (Indianapolis, IN), an independent nonprofit research organization.⁸ The methods of the NCAA-ISP have been described in depth^{7–11} and are briefly summarized here.

Data Collection

The NCAA-ISP database depends on a convenience sample of varsity teams with athletic trainers (ATs) voluntarily reporting injury and exposure data to an online database. Due to the voluntary nature of the data collection, the number of football programs participating in the program varied from year to year. During the 2004–2009 and 2009–2014 data-collection periods, an average of 60 and 25 football programs, respectively, participated. Football programs from each NCAA division were represented in the sampling.

Athletic trainers working with each football program were responsible for recording injury and exposure data via each institution's electronic health record system. Data were collected only from varsity-level organized practices and competitions during the preseason (all formal team practices and exhibition games conducted before the first regular-season competition), regular season (all practices and competitions from the first regular-season competition through the last regular-season competition), and postseason (all practices and competitions after the last regularseason competition through the last postseason competition). For each injury occurrence, an AT or physician completed a detailed report on the injury as well as the surrounding circumstances.9 Injury data included the anatomic site, diagnosis, and circumstances of the injury and event type.^{9,12} Athletic trainers also recorded the number of student-athletes participating in each practice and competition to determine exposure.

Combination of Datasets

To better evaluate the trends and incidence of hip injuries, we used a 10-year dataset composed of two 5-year NCAA-ISP datasets (2004–2009 and 2009–2014). With the NCAA-ISP's transition to a common data element in 2009, a few variables were recorded in one 5-year dataset and not the other, while some injuries were renamed or recoded. For example, the 2004–2009 dataset included iliopsoas/ sartorius injuries, which were renamed *hip-flexor injuries* in the 2009–2014 dataset. These renamed injuries were grouped wherever appropriate for the combined 10-year dataset. Variables that were recorded in 1 dataset and not the other were not included in the analysis of the combined 10-year dataset.

Definitions

A *reportable injury* in the NCAA-ISP was an injury that (1) occurred as a result of participation in an organized intercollegiate practice or competition, (2) required attention from an AT or physician, and (3) resulted in restriction of the student-athlete's participation for 1 or more days beyond the injury.⁸ Multiple injuries occurring from 1 injury event could be included. If an off day followed the injury event, the AT was asked to assess whether the injured athlete would have been able to participate.⁸ A *hip injury* was defined as any injury to the body part/system hip or hip/groin as defined by the NCAA-ISP.

An *athlete-exposure* (AE) was defined as 1 studentathlete participating in 1 NCAA-sanctioned practice or competition in which he or she was exposed to the possibility of athletic injury, regardless of the time associated with that participation.⁸ Only athletes with actual playing time in a competition were included in competition exposures.⁸ Athlete-exposures were limited to varsity-level, NCAA-sanctioned practices and competitions occurring in the preseason, regular season, or postseason.⁸

Time loss was defined as the time between the original injury and return to play at a level that would allow competition participation.⁸ A *recurrent injury* was defined as a similar injury that had been sustained by an athlete in the same or a previous academic year. *Mechanism of injury* was defined as the method by which that injury occurred: noncontact (injury occurred in the absence of interaction with another player), contact with another player (such as tackling, being tackled, blocking, or being blocked), other contact injuries (such as with the ground), or overuse/gradual injuries.

Statistical Analysis

We analyzed the data to assess the rates and patterns of hip injuries sustained by collegiate football players. The *rate of hip injury* was defined as the number of hip injuries divided by the number of AEs. The rates were reported as the ratio of injuries per 10 000 AEs and as an overall rate as well as individual rates by event type (competitions versus practices) and time of season (preseason, in-season, postseason). Injury rate ratios (IRRs) were calculated to compare rates between event types and by time of season, as they are useful for determining whether 1 participation type had an increased rate of injury compared with another. The following is an example of an IRR comparing injury



Figure 1. Time loss from hip injuries in National Collegiate Athletic Association football players. (Injuries with unknown time loss are not shown.)

rates between competitions and practices:



All 95% confidence intervals (CIs) not containing 1.0 were considered statistically significant. Time loss was reported as intervals (0–6 days, 7–13 days, 14–29 days, 30+ days), and descriptive data were presented as percentages of injuries (recurrence, mechanism of injury, player position, and whether surgery was required).

RESULTS

During the 10-year period, a total of 1618 hip injuries in NCAA football players were reported during 3 121 380 AEs. The overall rate of hip injuries among NCAA football players was 5.18 per 10 000 AEs. The average time loss from a hip injury was 5.93 days. The vast majority of these injuries resulted in time loss of 0 to 6 days (66.69%, n = 1079), followed by 7 to 13 days (18.79%, n=304), 14 to 29 days (6.80%, n=110), and 30 or more days (1.79%, n=29; Figure 1). Almost all of these injuries were new (91.53%, n = 1481) versus recurrent (8.47%, n = 137); only a few required operative management (1.1%, n = 18), and most did not (98.33%, n = 1591).

Hip Injuries by Type

Muscle strains (75.28%) were the most common hip injury. This was followed by contusions (18.23%), other hip injuries (5.07%), and intra-articular injuries (1.42%). Other hip injuries included those coded by the NCAA-ISP that did not correspond with commonly described and previously published types of hip injuries (eg, hip capsulitis, hip infection, ilioinguinal nerve entrapment).¹ Two muscle strain injuries, adductor strains and hip-flexor strains, along with hip contusions were the 3 most common injuries to the hip over the 10-year period. These 3 injuries accounted for more than 85% of the injuries over the 10 years.

Adductor strains were the most common and made up 38.63% of the 1618 hip injuries. The time loss from these injuries was most frequently between 0 and 6 days. The next most common hip injuries were hip-flexor strains (28.55%), followed by hip contusions (18.11%). Similar to adductor strains, time loss from hip-flexor strains and hip contusions most often was between 0 and 6 days. Hip subluxations or dislocations were the eighth most common injury (0.80%) but had the highest proportion of time loss of 30 days or more (7.69% of hip subluxations/dislocations; Table 1).

Event Type

Approximately three-fourths of the hip injuries occurred during practices (74.23%, n = 1201), with the remaining taking place during competitions (25.77%, n = 417). More than 90% of AEs were recorded during practices (91.12%, n = 2.844235) and the remainder during competitions (8.88%, n = 277145). Although injuries and AEs were less common during competitions than practices, the injury rate was higher during the former (15.05 per 10.000 AEs versus 4.22 per 10.000 AEs). Football players were 3.56 (95% CI = 3.19, 3.98) times more likely to sustain a hip injury during competitions than during practices (Table 2).

Time of Season

Almost all hip injuries were sustained during either the preseason (53.15%, n = 860) or in-season (44.93%, n = 727). The remaining 1.92% (n = 31) were incurred during the postseason. The greatest number of AEs occurred inseason (63.99%, n = 1.997.493) followed by the preseason

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Table 1.	Time Loss by	Type of Hip Injury for	National Collegiate Athletic	: Association Football Plavers	. 2004–2005 Through 2013–2014
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	Total Injuries (%) ^a	Days Lost (%)			
Injury		0–6	7–13	14–29	30 +
Adductor strain	625 (38.63)	387 (61.92)	150 (24.00)	50 (8.00)	12 (1.92)
Hip flexor strain	462 (28.55)	309 (66.88)	89 (19.26)	39 (8.44)	6 (1.30)
Hip contusion	293 (18.11)	229 (78.16)	41 (13.99)	6 (2.05)	2 (0.68)
Internal-rotator strain	79 (4.88)	49 (62.03)	12 (15.19)	3 (3.80)	3 (3.80)
Other hip injury	71 (4.39)	51 (71.83)	5 (7.04)	5 (7.04)	2 (2.82)
Gluteus or abductor strain	32 (1.98)	27 (84.38)	1 (3.13)	2 (6.25)	0 (0.00)
External-rotator strain	20 (1.24)	13 (65.00)	3 (15.00)	1 (5.00)	1 (5.00)
Hip subluxation or dislocation	13 (0.80)	4 (30.77)	1 (7.69)	1 (7.69)	1 (7.69)
Articular lesion	12 (0.74)	4 (33.33)	0 (0.00)	1 (8.33)	2 (16.67)
Greater trochanteric bursitis or snapping hip syndrome	10 (0.62)	6 (60.00)	2 (20.00)	2 (20.00)	0 (0.00)
Labral tear	1 (0.06)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)

^a The days lost for 96 injuries were unknown. Therefore, the number and percentage of injuries for each time-loss interval may not sum to the total.

 Table 2.
 Injury Rate Ratios Comparing Event Type and Time of Season

Comparison	Injury Rate Ratios (95% Confidence Interval)
Competitions versus practices	3.56 (3.19, 3.98)
Preseason versus postseason	3.56 (2.49, 5.08)
In-season versus postseason	1.5 (1.05, 2.15)

(31.91%, n = 996177) and postseason (4.09%, n = 127711). This resulted in an injury rate that was highest during the preseason (8.63 per 10000 AEs). The injury rates for in-season and the postseason were 3.64 per 10000 AEs and 2.43 per 10000 AEs, respectively. When we compared sport seasons, football players were 2.37 (95% CI = 2.15, 2.62) times more likely to experience a hip injury during the preseason than in-season and 3.56 (95% CI = 2.49, 5.08) times more likely than during the postseason. The risk of hip injury in-season was 1.5 (95% CI = 1.05, 2.15) times more than during the postseason (Table 2).

Mechanism of Injury

Of the possible injury mechanisms, most injuries recorded across event types were due to noncontact or contact with another player. The most common mechanism of injury was noncontact (61.62%, n = 997). Contact with another player accounted for 20.95% (n = 339) of the injuries. This was followed by overuse/gradual injuries (7.91%, n = 128) and other contact injuries (6.86%, n = 111).

Player Position

The athlete's position when the injury took place was recorded only for competition exposures. Defensive backs (20.86%) had the most injuries followed by receivers (15.83%), linebackers (14.15%), defensive linemen (13.43%), and running backs (10.31%; Figure 2).

DISCUSSION

Our analysis of the NCAA-ISP database revealed several important findings that can lead to a better understanding of hip injuries among athletes. Over the 10-year study period, NCAA football players sustained 5.18 hip injuries per 10000 AEs. Most of these injuries were minor and did not require surgery. As football games are played once a week, players who incurred a hip injury most likely did not miss more than 1 game. With an average time loss of 5.93 days, they would be recovered in time for the next competition, depending on the day of the week when the injury occurred. The event type and time of season of the exposure played a significant role in the risk of a hip injury. We found that NCAA football players were 3.56 times more likely to sustain a hip injury during competitions than during practices. The athletes were also more prone to injure their hips before the season started. They were 2.37 and 3.56 times more likely to injure the hip during the preseason than during the in-season or postseason, respectively. The risk of an in-season hip injury was 1.5 times more than during the postseason. Most hip conditions were adductor



Figure 2. Distribution of hip injuries by player position. (Injuries with unknown player position are not shown.)

strains, hip-flexor strains, and hip contusions, accounting for more than 85% of the injuries. We observed that a majority (61.62%) of the injuries were due to a noncontact mechanism and that player position may have influenced the likelihood of a hip injury.

Muscle strains made up over 75% of the hip injuries in NCAA football players. Another study¹ among NFL players also showed they were the most common hip injury, accounting for 59% of hip injuries and 1.7% of all injuries; hip-flexor strains were the most frequent type. In our study, adductor strains occurred most often, followed by hip-flexor strains. Together, these 2 injuries accounted for more than 67% of the hip injuries over the 10-year period. In contrast to our results, hip-flexor strains were more common than adductor strains in both NFL¹ and NCAA⁷ football players, which may have reflected different methods and survey years. Previous researchers⁷ determined that although NCAA football players had the highest annual estimates of adductor and hip-flexor strains, the highest incidence rates were in ice hockey and soccer athletes. An interrelationship between these injuries has been hypothesized, and thus, they may occur more often together than on their own.⁷

In our study, adductor (82.4%) and hip-flexor (72.29%) strains occurred most frequently from noncontact injuries. An explanation could be the forceful concentric and eccentric contraction of these muscles during acceleration, deceleration, and cutting.⁷ Even though the most common mechanism of injury among NCAA football players was contact with another player, earlier authors^{1,2,7} studying the NFL and NCAA found that most adductor and hip-flexor injuries were attributed to noncontact mechanisms. These movements are common in the defensive backfield, and defensive backs in our study as well as those in the NFL were most often affected by adductor and flexor strains.¹ One should keep in mind that exposure varies by the number of players at each position for each play. Strains of the adductors and hip flexors were relatively minor injuries that resulted in less than 1 week of time loss and did not require surgery.^{2,7} This is pertinent to ATs and physicians

when determining the likelihood that a player will be able to return for the next competition. Previous investigators^{13,14} suggested a high recurrence rate of adductor and hip-flexor strains. Recurrent injuries accounted for 12% of adductor strains and 8.66% of hip-flexor strains in our study, confirming the high recurrence rate seen earlier.⁷ A history of adductor strain and decreased range of motion in hip abduction were significant predictors of a new adductor strain.¹⁵ Among professional hockey players, those who sustained an adductor strain had preseason hip-adduction strength that was 18% lower than that of uninjured players.¹⁶ Adduction strength was found to be 95% of abduction strength in uninjured players but only 78% of abduction strength in injured players.¹⁶ A dedicated hipstrengthening program decreased the incidence of hip strains in these athletes.¹⁷ Therefore, a dedicated preseason hip-strengthening and -stretching program may be beneficial in reducing the rate of these injuries in NFL players, and we suggest this should be extrapolated to NCAA football players.¹

Contusions of the hip were the third most common hip injury among NCAA football players. These injuries result from direct trauma or crushing and are typical in contact sports. As one would expect, hip contusions most frequently resulted from a contact mechanism. Contact with a person was responsible for the vast majority of hip contusions (73.38%), with most of the rest occurring from contact with objects rather than another player (21.50%). Interestingly, most of the hip contusions were new injuries (98.64%) that occurred during competitions (63.14%) in season (76.79%). This is in contrast to the majority of injuries that occurred during practices in the preseason. Most athletes recovered quickly from a hip contusion and did not miss a game. The mean time lost because of a hip contusion in NFL players was 5 days,¹ and the NCAA players in our study usually returned to participation in less than 6 days (78.16%). Only 2 athletes missed more than 30 days from the injury. Higher rates of hip contusions were seen among receivers (17.30%), defensive backs (16.22%), linebackers (15.14%), and running backs (15.14%). This could be attributed to the increased distance from the line of scrimmage for these positions, allowing for increased velocity to build before contact with another player.

Injury rate ratios are useful for determining whether 1 participation type had an increased rate of injury compared with another. Our finding that hip injuries were 3.56 times more frequent during competitions is consistent with the current literature. Previous authors^{2,5,6,18–20} assessing football players at multiple levels determined that competition injury rates were higher than practice rates. An epidemiologic review⁵ of high school and collegiate football injuries showed that injuries were 6 times more prevalent during games as compared with practices. Also, the game injury rate was 9 times higher than the in-season practice rate over a 16-year period of NCAA football.⁶ Earlier researchers³ attributed the increase in injury rates during competitions to the less predictable playing environment, with greater speed and intensity leading to more collisions. The effect of the increased intensity on the injury rate was demonstrated in studies^{2,3,21} showing higher rates of injury during practices that were scrimmages compared with walk-throughs.

The time of season of the athlete's exposure changed the risk of injury to the hip. The overall rate of NCAA football injuries was greater during the preseason than the regular season.^{6,13} A 16-year review⁶ of NCAA football injuries identified a rate of injury more than 2 times higher during spring than fall practices. The higher rate of preseason injuries may be attributed to some student-athletes entering the preseason less conditioned and prepared for the intensity of these practices.² Rule changes, including limiting the amount of full-contact spring practices and instituting acclimatization periods during the first days of spring practices, have been implemented in an attempt to decrease the injury rate disparity.⁶ These modifications have lowered the preseason injury rates by 1.2 times, but a disparity remains between preseason and in-season rates.⁶

Several limitations are associated with the NCAA-ISP database. The NCAA-ISP depends on a convenience sample of NCAA collegiate football programs. Thus, our findings may not be generalizable to all collegiate football programs in the country or to different levels of competition. The database also relies on injury reporting by ATs, and hip injuries may have gone unreported or underreported at some institutions. However, earlier investigators,²² retrospectively evaluating injuries using the last 10 years of available data, determined that 88.3% of all time-loss injuries in soccer players were captured by the database. It is possible that with the increasing knowledge of hip injuries, prevention programs have already been implemented and the current rate of hip injuries is less than we found in our study.

CONCLUSIONS

During the 2004–2005 and 2013–2014 academic years, NCAA football players experienced higher rates of hip injuries during competitions compared with practices and during the preseason compared with in-season or the postseason. The majority were due to noncontact mechanisms, resulted in time loss of less than 6 days, and did not need surgery. The injuries varied by player position and were most common among defensive backs. Muscle strains were the most frequent group of hip injuries, while adductor strains, hip-flexor strains, and hip contusions were the specific types seen most often.

REFERENCES

- Feeley BT, Powell JW, Muller MS, Barnes RP, Warren RF, Kelly BT. Hip injuries and labral tears in the National Football League. *Am J Sports Med.* 2008;36(11):2187–2195.
- Kerr ZY, Simon JE, Grooms DR, Roos KG, Cohen RP, Dompier TP. Epidemiology of football injuries in the National Collegiate Athletic Association, 2004-2005 to 2008-2009. Orthop J Sports Med. 2016;4(9):2325967116664500.
- Dragoo JL, Braun HJ, Durham JL, Chen MR, Harris AHS. Incidence and risk factors for injuries to the anterior cruciate ligament in National Collegiate Athletic Association football: data from the 2004–2005 through 2008–2009 National Collegiate Athletic Association Injury Surveillance System. *Am J Sports Med.* 2012;40(5):990–995.
- Powell JW, Barber-Foss KD. Injury patterns in selected high school sports: a review of the 1995–1997 seasons. J Athl Train. 1999;34(3):277–284.
- 5. Shankar PR, Fields SK, Collins CL, Dick RW, Comstock RD. Epidemiology of high school and collegiate football injuries in the

United States, 2005–2006. Am J Sports Med. 2007;35(8):1295–1303.

- Dick R, Ferrara MS, Agel J, et al. Descriptive epidemiology of collegiate men's football injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003– 2004. J Athl Train. 2007;42(2):221–233.
- Eckard TG, Padua DA, Dompier TP, Dalton SL, Thorborg K, Kerr ZY. Epidemiology of hip flexor and hip adductor strains in National Collegiate Athletic Association athletes, 2009/2010–2014/2015. *Am J Sports Med.* 2017;45(12):2713–2722.
- Kerr ZY, Dompier TP, Snook EM, et al. National collegiate athletic association injury surveillance system: review of methods for 2004– 2005 through 2013–2014 data collection. J Athl Train. 2014;49(4):552–560.
- 9. Dick R, Agel J, Marshall SW. National Collegiate Athletic Association Injury Surveillance System commentaries: introduction and methods. *J Athl Train*. 2007;42(2):173–182.
- Kerr ZY, Hayden R, Dompier TP, Cohen R. Association of equipment worn and concussion injury rates in National Collegiate Athletic Association football practices: 2004–2005 to 2008–2009 academic years. *Am J Sports Med.* 2015;43(5):1134–1141.
- Westermann RW, Kerr ZY, Wehr P, Amendola A. Increasing lower extremity injury rates across the 2009–2010 to 2014–2015 seasons of National Collegiate Athletic Association football: an unintended consequence of the "targeting" rule used to prevent concussions? *Am J Sports Med.* 2016;44(12):3230–3236.
- Anderson K, Strickland SM, Warren R. Hip and groin injuries in athletes. *Am J Sports Med.* 2001;29(4):521–533.
- Kerr ZY, Marshall SW, Dompier TP, Corlette J, Klossner DA, Gilchrist J. College sports-related injuries - United States, 2009–10

through 2013–14 academic years. *MMWR Morb Mortal Wkly Rep.* 2015;64(48):1330–1336.

- Kerr ZY, Marshall SW, Simon JE, et al. Injury rates in age-only versus age-and-weight playing standard conditions in American youth football. Orthop J Sports Med. 2015;3(9):2325967115603979.
- Malina RM, Morano PJ, Barron M, Miller SJ, Cumming SP, Kontos AP. Incidence and player risk factors for injury in youth football. *Clin J Sport Med.* 2006;16(3):214–222.
- Albright JP, Powell JW, Martindale A, et al. Injury patterns in Big Ten conference football. *Am J Sports Med.* 2004;32(6):1394–1404.
- Emery CA, Meeuwisse WH, Powell JW. Groin and abdominal strain injuries in the National Hockey League. *Clin J Sport Med.* 1999;9(3):151–156.
- Hawkins RD, Fuller CW. A prospective epidemiological study of injuries in four English professional football clubs. *Br J Sports Med.* 1999;33(3):196–203.
- Arnason A, Sigurdsson SB, Gudmundsson A, Holme I, Engebretsen L, Bahr R. Risk factors for injuries in football. *Am J Sports Med.* 2004;32(suppl 1):5S–16S.
- Tyler TF, Nicholas SJ, Campbell RJ, McHugh MP. The association of hip strength and flexibility with the incidence of adductor muscle strains in professional ice hockey players. *Am J Sports Med.* 2001;29(2):124–128.
- Tyler TF, Nicholas SJ, Campbell RJ, Donellan S, McHugh MP. The effectiveness of a preseason exercise program to prevent adductor muscle strains in professional ice hockey players. *Am J Sports Med.* 2002;30(5):680–683.
- Kucera KL, Marshall SW, Bell DR, DiStefano MJ, Goerger CP, Oyama S. Validity of soccer injury data from the National Collegiate Athletic Association's Injury Surveillance System. J Athl Train. 2011;46(5):489–499.

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