Systematic Review

A Sport-specific Analysis of the Epidemiology of Hip Injuries in National Collegiate Athletic Association Athletes From 2009 to 2014

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Purpose: To describe the injury rates, mechanisms, time loss, and rates of surgery for hip/groin injuries in National Collegiate Athletic Association (NCAA) athletes across 25 collegiate sports during the 2009/10 to 2013/14 academic years. **Methods:** Data from the 2009/10 to 2013/14 academic years were obtained from the NCAA Injury Surveillance Program (ISP). Rates of hip/groin injuries, mechanism of injury, time lost from competition, and surgical treatment were calculated. Differences between sex-comparable sports were quantified using rate ratios and injury proportion ratios. A sport-specific biomechanical classification system, which included cutting, impingement, overhead/asymmetric, endurance, and flexibility sports, was applied for subgroup analysis. **Results:** In total, 1,984 hip injuries were reported in 25 NCAA sports, including 9 male and female sports, 3 male-only sports, and 4 female-only sports between the years 2009/10 and 2013/14, resulting in an overall hip injury rate of 53.1/100,000 athletic exposures (AEs). In sex-comparable sports, (basketball, cross-country, lacrosse, ice hockey, indoor track, outdoor track, soccer, swimming, and tennis), men were more commonly affected than women (59.53 vs 42.27 per 100,000 AEs respectively; rate ratio, 1.41; 95% confidence interval, 1.28-1.55). Subgroup analysis demonstrated that the highest rate of hip injuries per 100,000 AEs occurred in impingement sports (96.9). Endurance sports had the highest proportion of injured athletes with time lost >14 days (9.5%). For impingement-type sports, the most common mechanism of injury was no apparent contact (48.2%). The rate of athletes undergoing surgery per 100,000 AEs was highest in impingement-type sports (2.0). **Conclusions:** We have identified that impingement-type sports are most frequently associated with hip injuries. Additionally, this study demonstrates that hip injuries sustained in athletes who played impingement-type sports had a significantly higher rate of surgical intervention than other sport classifications. **Level of Evidence:** Level III, prognostic study.

See commentary on page 2733

Hip pathology is increasingly being recognized and treated in athletes, especially adolescents.[1-3] Hip pathology includes muscle strains or tears, snapping hip syndrome, intra-articular labral tears, stress fractures, and femoroacetabular impingement (FAI). Our understanding of the factors that put athletes at risk for hip pathology has remained limited. Multiple studies have shown increased incidence of hip injuries in specific sports, including soccer, basketball, and ice hockey.[4-9] Additionally, it has been reported that hip pathology is more common in white males with a family history of hip surgery; however, until recently, analysis of risk factors for hip pathology has been lacking.[2,10] Nawabi et al.[10] recently defined a sport-specific biomechanical classification system of hip injuries to examine outcomes after hip arthroscopy. The authors separated sports into 6 groups based on the biomechanical demands placed on the hip during typical movements of each sport. Sports were classified as cutting, impingement, flexibility, asymmetric/overhead, contact, and endurance types. The authors demonstrated that

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athletes who played cutting sports were more likely to undergo bilateral hip arthroscopy for FAI and tended to be younger than athletes in other biomechanical classifications.[10]

Recently, there has been an increased awareness of hip pathology in athletes, which can lead to chronic pain that can end or limit athletic careers.[1,2,10] One of the most commonly studied pathologies is FAI syndrome, which is characterized by abnormal contact between the proximal femur and the acetabulum. It has been postulated that FAI is secondary to either abnormal bony morphology or excessive range of motion in otherwise normal anatomy.[1,3,10,11] Current evidence suggests that athletic participation during adolescence influences the pathogenesis of FAI.[10,12-15] Recent reports have shown that elite adolescent athletes have an increased prevalence of FAI-type deformities compared with age-matched controls.[12,13,16] Additionally, previous literature has shown that the mean alpha angles were significantly greater in impingement sports. Strong data support that in other sports, including Little League player's shoulder and gymnast's wrists, vigorous sporting activity affects the openthe physis. This finding has led to limiting the pitch count for youth baseball pitchers in an attempt to decrease long-term outcomes. This evidence suggests that the anatomic changes may be a response to repetitive stress at the proximal femoral physis secondary to athletic activity during skeletal growth periods, which may be preventable.

Our study aims to further elucidate differences in the epidemiology of hip injuries by examining hip and groin injuries in National Collegiate Athletic Association (NCAA) athletes in the context of these biomechanical classifications. An enhanced understanding of the sport-specific demands placed on the hip can potentially improve prevention, early diagnosis, and treatment options. The purpose of this study is to describe the injury rates, mechanisms, time loss, and rates of surgery for hip/groin injuries in NCAA athletes across 25 collegiate sports during the 2009/10 to 2013/14 academic years. We hypothesize that different impingement-type sports will have the highest rate of surgical intervention and most significant time lost (TL) from sport.

Methods

After Institutional Review Board approval, this study was approved by the NCAA Research Review Board. Data were obtained from the Datalys Center for Sports Injury Research and Prevention, a private, independent nonprofit research organization that manages the NCAA Injury Surveillance Program (ISP).

Data Collection

ISP data were derived from a sample of amateur collegiate varsity sports teams from all 3 NCAA divisions. Twenty-five total sports were analyzed: 9 male and female sports, 3 male-only sports, and 4 female-only sports. Both male and female sports included soccer, ice hockey, basketball, indoor track, outdoor track, swimming, tennis, lacrosse, and cross-country. Male-only sports included football, baseball, and wrestling. Female-only sports included softball, gymnastics, field hockey, and volleyball. At participating programs, an athletic trainer (AT) reported injury data to the Datalys Center either via the school's own electronic health records or the Datalys Center's in-house Injury Surveillance Tool. Of note, the 2009/10 to 2013/14 data set used in this project included non—time loss injuries. This was in contrast to prior data sets, which only included injuries that resulted in playing TL. For each injury event, the AT completed a standardized reporting document that included detailed information describing the injury and exposure, such as the number of athletes participating in the session, event type (i.e., competition or practice), body part, and mechanism of injury. The AT also logged any TL from competition and whether the athlete underwent surgery. After all the data were recorded, the data were completely deidentified and transferred to an aggregate database hosting all national data. Multiple human and automated verification processes were used to ensure that data were consistent, and no invalid values were included. For this study, data were pooled from all sport-specific data sets to provide information on hip and groin injuries in the NCAA ISP database.

Definitions

A reportable injury in the ISP was defined as an injury that (1) occurred as a result of participation in an organized intercollegiate practice or competition and (2) required attention from an AT or physician.

A reportable athletic exposure (AE) was defined as 1 student-athlete participating in 1 NCAA-sanctioned practice or competition in which he or she was

Table 1. Classification of Sports for High-Level Athletes Based on Predominant Biomechanical Force on the Hip and Groin Described by Nawabi et al.[10]

Cutting	Flexibility	Contact	Impingement	Asymmetric/Overhead	Endurance
Soccer	Gymnastics	Football	Ice hockey	Baseball	Track
Basketball		Wrestling		Softball	Cross-country
Lacrosse				Tennis	Swimming
Field hockey				Volleyball	

Table 2. Total Hip/Groin Injury Rates (per 100,000 Athletic Exposures) by Sport 2009/10 to 2013/14

	Hip/Groin Injuries, n			Injury Rate per 100,000 Athletic Exposures						Rate Ratio	
				Overall		Competition		Practice			
Sport	Overall	Competition	Practice	Rate[a]	95% CI	Rate	95% CI	Rate	95% CI	Ratio	95% CI
Men's soccer	177	69	108	110.84	[94.51, 127.17]	202.69	[154.86, 250.52]	85.96	[69.74, 102.17]	2.36	[1.74, 3.19]
Men's ice hockey	297	155	142	104.90	[92.97, 116.83]	226.78	[191.08, 262.49]	66.11	[55.24, 76.99]	3.43	[2.73, 4.31]
Women's ice hockey	87	21	66	76.88	[60.73, 93.04]	70.43	[40.31, 100.56]	79.19	[60.08, 98.29]	0.889	[0.54, 1.45]
Women's cross-country	29	5	24	65.16	[41.44, 88.88]	128.77	[15.90, 241.64]	59.08	[35.44, 82.72]	2.18	[0.83, 5.71]
Women's soccer	140	45	95	64.89	[54.14, 75.64]	86.30	[61.09, 111.52]	58.07	[46.39, 69.74]	1.49	[1.04, 2.12]
Men's football	564	188	376	62.72	[57.54, 67.90]	215.80	[184.95, 246.65]	46.30	[41.62, 50.98]	4.66	[3.91, 5.55]
Men's basketball	132	39	93	61.17	[50.73, 71.60]	83.98	[57.62, 110.34]	54.91	[43.75, 66.07]	1.53	[1.05, 2.22]
Men's tennis	14	4	10	54.56	[25.98, 83.14]	72.78	[1.46, 144.10]	49.59	[18.85, 80.33]	1.47	[0.46, 4.68]
Women's tennis	14	4	10	44.24	[21.07, 67.41]	51.12	[1.02, 101.23]	41.98	[15.96, 68.00]	1.22	[0.38, 3.88]
Women's outdoor track	31	7	24	43.59	[28.25, 58.94]	57.08	[14.79, 99.36]	40.78	[24.47, 57.10]	1.40	[0.60, 3.25]
Men's lacrosse	65	17	48	40.50	[30.66, 50.35]	63.33	[33.23, 93.44]	35.92	[25.76, 46.08]	1.76	[1.01, 3.07]
Women's field hockey	15	2	13	40.24	[19.88, 60.61]	22.19	[-8.56, 52.93]	46.00	[20.99, 71.01]	0.482	[0.11, 2.14]
Men's outdoor track	33	16	17	38.09	[25.10, 51.09]	129.45	[66.02, 192.88]	22.89	[12.01, 33.77]	5.66	[2.86, 11.19]
Women's gymnastics	17	2	15	37.51	[19.68, 55.34]	48.26	[-18.63, 115.15]	36.43	[17.99, 54.86]	1.32	[0.30, 5.79]
Women's indoor track	38	5	33	37.44	[25.54, 49.35]	54.02	[6.67, 101.38]	35.78	[23.57, 47.98]	1.51	[0.59, 3.87]
Women's volleyball	56	9	47	35.74	[26.38, 45.10]	19.92	[6.90, 32.93]	42.15	[30.10, 54.20]	0.473	[0.23, 0.96]
Women's lacrosse	37	7	30	35.06	[23.76, 46.35]	33.90	[8.79, 59.01]	35.34	[22.69, 47.98]	0.959	[0.42, 2.18]
Women's basketball	65	9	56	33.36	[25.25, 41.47]	19.64	[6.81, 32.48]	37.57	[27.73, 47.41]	0.523	[0.26, 1.06]
Men's wrestling	26	12	14	33.02	[20.33, 45.72]	144.67	[62.81, 226.52]	19.88	[9.46, 30.29]	7.28	[3.37, 15.74]
Women's softball	53	15	38	32.83	[23.99, 41.67]	23.36	[11.54, 35.18]	39.09	[26.66, 51.52]	0.598	[0.33, 1.09]
Men's indoor track	34	1	33	31.47	[20.89, 42.04]	9.81	[-9.42, 29.04]	33.72	[22.22, 45.23]	0.291	[0.04, 2.13]
Men's baseball	36	21	15	20.23	[13.62, 26.83]	31.58	[18.07, 45.09]	13.45	[6.65, 20.26]	2.35	[1.21, 4.55]
Men's cross-country	7	1	6	15.13	[3.92, 26.34]	24.82	[-23.83, 73.47]	14.21	[2.84, 25.58]	1.75	[0.21, 14.51]
Women's swimming	10	2	8	8.21	[3.12, 13.30]	17.85	[-6.89, 42.59]	7.24	[2.22, 12.25]	2.47	[0.52, 11.62]
Men's swimming	7	2	5	7.23	[1.87, 12.59]	24.17	[-9.33, 57.67]	5.65	[0.70, 10.60]	4.28	[0.83, 22.06]
All Men's teams	1,392	525	867	59.53	[56.40, 62.65]	138.91	[127.03, 150.80]	44.22	[41.28, 47.17]	3.14	[2.82, 3.50]
All women's teams	592	133	459	42.27	[38.86, 45.67]	42.17	[35.00, 49.33]	42.30	[38.43, 46.17]	0.997	[0.82, 1.21]
Total	1984	658	1326	53.06	[50.73, 55.40]	94.90	[87.65, 102.15]	43.54	[41.19, 45.88]	2.18	[1.99, 2.39]

CI, confidence interval.

[a]Sorted in descending order according to overall injury rate.

Table 3. Total Hip/Groin Injury Rates (per 100,000 Athletic Exposures) Subclassified by Injury Category for 25 National Collegiate Athletic Association Sports from 2009/10 to -2013/14

	Overall						Competition						Practice					
	Men		Women		Combined		Men		Women		Combined		Men		Women		Combined	
Injury Category	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI	Rate	95% CI
Cutting	69.78	[62.71, 76.85]	46.44	[40.76, 52.12]	57.92	[53.40, 62.44]	116.47	[96.05, 136.89]	49.36	[37.17, 61.55]	80.02	[68.58, 91.46]	58.09	[50.88, 65.31]	45.56	[39.15, 51.97]	51.85	[47.02, 56.67]
Flexibility	—	—	37.51	[19.68, 55.34]	37.51	[19.68, 55.34]	—	—	48.26	[-18.63, 115.15]	48.26	[-18.63, 115.15]	—	—	36.43	[17.99, 54.86]	36.43	[17.99, 54.86]
Contact	60.33	[55.46, 65.20]	—	—	60.33	[55.46, 65.20]	209.62	[180.56, 238.67]	—	—	209.62	[180.56, 238.67]	44.19	[39.80, 48.58]	—	—	44.19	[39.80, 48.58]
Impingement	104.90	[92.97, 116.83]	76.88	[60.73, 93.04]	96.90	[87.21, 106.59]	226.78	[191.08, 262.49]	70.43	[40.31, 100.56]	179.30	[152.81, 205.78]	66.11	[55.24, 76.99]	79.19	[60.08, 98.29]	69.77	[60.29, 79.25]
Asymmetric/ overhead	24.55	[17.75, 31.36]	35.17	[28.95, 41.38]	31.26	[26.60, 35.92]	34.73	[21.11, 48.34]	23.88	[15.04, 32.73]	28.01	[20.47, 35.55]	18.99	[11.54, 26.43]	40.85	[32.64, 49.07]	32.95	[27.05, 38.84]
Endurance	23.98	[18.76, 29.20]	31.87	[25.86, 37.88]	27.93	[23.95, 31.92]	57.38	[32.23, 82.53]	51.91	[28.57, 75.25]	54.58	[37.45, 71.70]	20.14	[15.09, 25.19]	29.44	[23.33, 35.56]	24.79	[20.82, 28.75]

CI, confidence interval.

exposed to the possibility of athletic injury, regardless of the time associated with that participation.

Classification Criteria

The sport-specific biomechanical classification system previously described by Nawabi et al.[10] was used in our study. Athletes participating in the sports outlined in Table 1 were classified based on the predominant biomechanical force demands placed on the hip and groin. Data provided by the ISP were not broken down into specific swim stroke or specific positions. Therefore, our analysis classified all swimmers as endurance and all baseball players as asymmetric/overhead. Although this classification has not been validated, we found it to be a useful way to describe the stressors across the hip (Table 1).

Statistical Analysis

Data were analyzed using Microsoft Excel 2016 software (Microsoft, Redmond, WA). Statistical analyses included calculation of the overall rate of hip injuries, the rate of hip injuries in each individual sport in both competition and practice, and the rate of injuries across sex-specific sports. Injury rates were calculated as the ratio of injuries per 100,000 AEs. Rate ratios (RRs) were calculated to quantify sex differences in injury rates in comparable sports. Likewise, injury proportion ratios were used to compare injury rates during competition versus practice. Ninety-five percent confidence intervals (CIs) were calculated to assess statistical significance, with any CI not containing the value 1.00 considered statistically significant. TL is reported as the percentage of athletes who missed more than 14 days of activity compared with total injuries in that biomechanical category.

Results

Overall Frequencies and Rates

In total, 1,984 hip injuries were reported in 25 NCAA sports between the years 2009/10 and 2013/14, resulting in an overall hip injury rate of 53.06/100,000 AEs. The sports with the highest rates of hip injuries per 100,000 AEs were men's soccer (110.8), men's ice hockey (104.9), and women's ice hockey (76.9; Table 2). Subgroup analysis by sport-specific biomechanical stress demonstrated that the highest rate of hip injuries per 100,000 AEs occurred in impingement sports (96.9), followed by contact sports (60.3) and cutting sports (57.9). The lowest rate of hip injuries per 100,000 AEs occurred in endurance sports (27.9; Table 3). In sex-comparable sports (basketball, cross-country, lacrosse, ice hockey, indoor track, outdoor track, soccer, swimming, and tennis), men were more commonly affected than women per 100,000 AEs (59.53 vs 42.27, respectively; RR, 1.41; 95% CI, 1.28-1.55). When evaluating sex differences of hip injuries

within categories, male cutting athletes had significantly higher injury rates than their female counterparts (95% CI, 62.7, 76.8 men; 95% CI, 40.8, and 52.1 women). Additionally, men had higher rates of injury in impingement sports compared with women, which was not significant. There were no statistically significant differences in injury rates in asymmetric/overhead sports and endurance sports between male and female athletes (Table 4).

TL

Overall, endurance sports had the highest proportion of injured athletes with TL >14 days (9.5%), followed by impingement (7.8%) and cutting sports (5.1%). For male athletes, impingement-type sports had the highest rate of TL >14 days (9.7%). For female athletes, endurance sports had the highest rate of TL >14 days (11.1%), followed by flexibility sports (5.1%; Fig 1).

Mechanism of Injury

In impingement-type sports, the most common mechanism of injury was no apparent contact (48.2%), followed by gradual/overuse injury (20.1%; Fig 2).

Rate of Surgery

The rate of athletes undergoing surgery per 100,000 AEs was highest in impingement-type sports (2.0), followed by contact (0.82) and cutting sports (0.64), which was statistically significant ($P = .049$). Sex-specific analysis shows that the highest rate of surgery for both men and women occurred in impingement sports, 2.12 per 100,000 AEs and 1.77 per 100,000 AEs, respectively. The highest proportion of surgery per injury occurred in impingement-type sports (2.1%), followed by contact (1.3%) and cutting (1.1%).

Table 4. Frequency of Reported Hip/Groin Injuries, 2009/10 to 2013/14

Injury	Total
Adductor (groin) tear, partial or complete	486
Hip flexor tear, partial or complete	365
Iliopsoas/sartorius tear, partial or complete	252
Internal rotators (groin) tear, partial or complete	185
Other hip injury	159
Hip contusion	154
Hip pointer	130
Abductor muscle tear, partial or complete	53
Hip impingement	28
Greater trochanteric bursitis/snapping hip syndrome	28
Hip spasm	28
External rotators (piriformis) tear, partial or complete	19
Adductor tendonitis	18
Adductor (groin) spasm	18
Hip articular cartilage injury	16
Adductor (groin) contusion	10
Hip subluxation	8
Iliopsoas bursitis	7
Hip avulsion fracture	3
Hip dislocation	3
Hip osteoarthritis	3
Hip/groin bone spur	3
Hip abrasion	2
Hip capsulitis	2
Adductor (groin) myositis ossificans	1
Apophysitis of the iliac crest	1
Hip laceration	1
Hip neuroma	1
Total	1,984

Discussion

In our analysis, we found that the highest rate of hip injuries reported in the NCAA ISP occurred in impingement-type sports. Additionally, we determined that endurance sports had the highest rates of significant TL; however, impingement sports required a significantly higher rate of surgical intervention compared with other biomechanical categories. The data support our hypothesis that impingement-type sports would have the highest rate of surgical intervention; however, the data did not support our hypothesis that impingement-type sports would also have the highest rate of TL from sport.

Biomechanical demands placed on the hips of NCAA athletes were classified based on the methods described by Nawabi et al.[10] In their original study, the authors found that the most common sports played by athletes undergoing bilateral hip arthroscopy were soccer, hockey, and football. Additionally, Nawabi et al.[10] classified swimming the breast stroke and playing catcher in baseball as impingement-type exposures. However, our analysis groups all swimmers into endurance sports and all baseball players into asymmetric/overhead sports. Therefore, some injuries classified as endurance or asymmetric/overhead sports may in fact truly be caused by impingement biomechanical demands. Our analysis supports Nawabi et al.'s original findings and provides further insight into the rates of hip/groin injuries stratified by the biomechanical forces placed on the hip. Our study used Nawabi's classification system; however, within each sport, athletes that play different positions experience different stressors across the hip. Therefore, we cannot conclude which positions within a given sport are more likely to result in hip/groin injuries.

This study demonstrates that hip injuries most frequently occurred in impingement sports (e.g., ice hockey), followed by contact sports (e.g., football and wrestling), and cutting sports (e.g., soccer, basketball, lacrosse, and field hockey). Analysis of TL due to injury revealed that a greater proportion of impingement athletes spent >14 days sidelined from practice and competition than other categories. Additionally, we demonstrated that impingement sports had the highest rate of injuries per 100,000 AEs and the highest proportion of surgical intervention, followed by contact and cutting sports. This finding was relatively consistent with

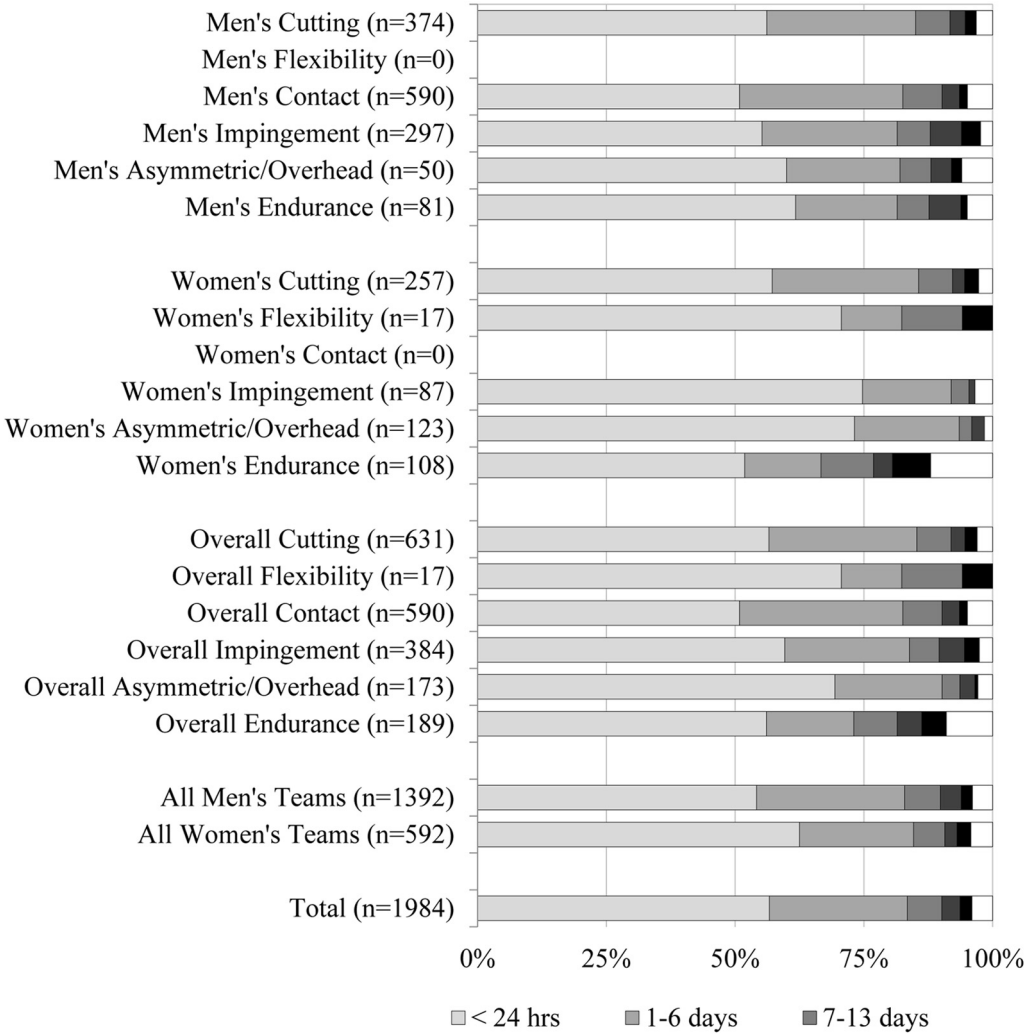

Fig 1. Time loss for men and women and overall hip/groin injuries subclassified by biomechanical category for 25 National Collegiate Athletic Association sports from 2009/10 to 2013/14.

the previous study by Nawabi et al.,[10] which found that injuries resulting from cutting sports led to similar proportions of arthroscopic intervention to our findings regarding surgical rates in cutting sports. However, injuries sustained playing ice hockey, an impingement-type sport, have also been shown to be associated with higher rates of arthroscopic intervention than other sports.[2,6,7,17-19] A review of the literature characterizing the relationship between biomechanics and the rate of hip injury demonstrated higher injury rates in sports involving sudden changes in direction, twisting, turning, and rapid accelerations and decelerations.[11,12,16,20] These movements are very common in impingement-type sports, which aligns with our finding of higher hip injury rates in these sports.

Consistent with previous reports, we found that men's and women's ice hockey had the second and third highest rates of hip injuries of all NCAA sports in the ISP database.[4,6,7,21,22] These findings proportionally increased the overall rates of hip injuries observed in the impingement-type sports category. Hockey skating mechanics are unique and place the hip in demanding positions of flexion, abduction, and external and internal rotation. Epstein et al.[7] retrospectively reviewed the National Hockey League injury surveillance database for injuries sustained between 2006 and 2010 and found that 10.6% of all hip and groin injuries were identified as intra-articular and that FAI accounted for 5.3% of the reported injuries. Additionally, the authors found that injuries per 1,000 games played were significantly higher in goaltenders than in all other on-ice positions, with an RR of 4.8.[7] A meta-analysis published by Nepple et al.[23] found an increased risk of developing a bony prominence on the anterolateral femoral-neck junction, termed cam morphology, in certain sports with intensive impact, including ice hockey.[1] Additionally, Philippon et al.[22] compared the alpha angle in 61 asymptomatic youth ice hockey players with 27 competitive youth skier controls who had dedicated similar time to their sport, ages 10 to 18 years. The authors found ice hockey players to have

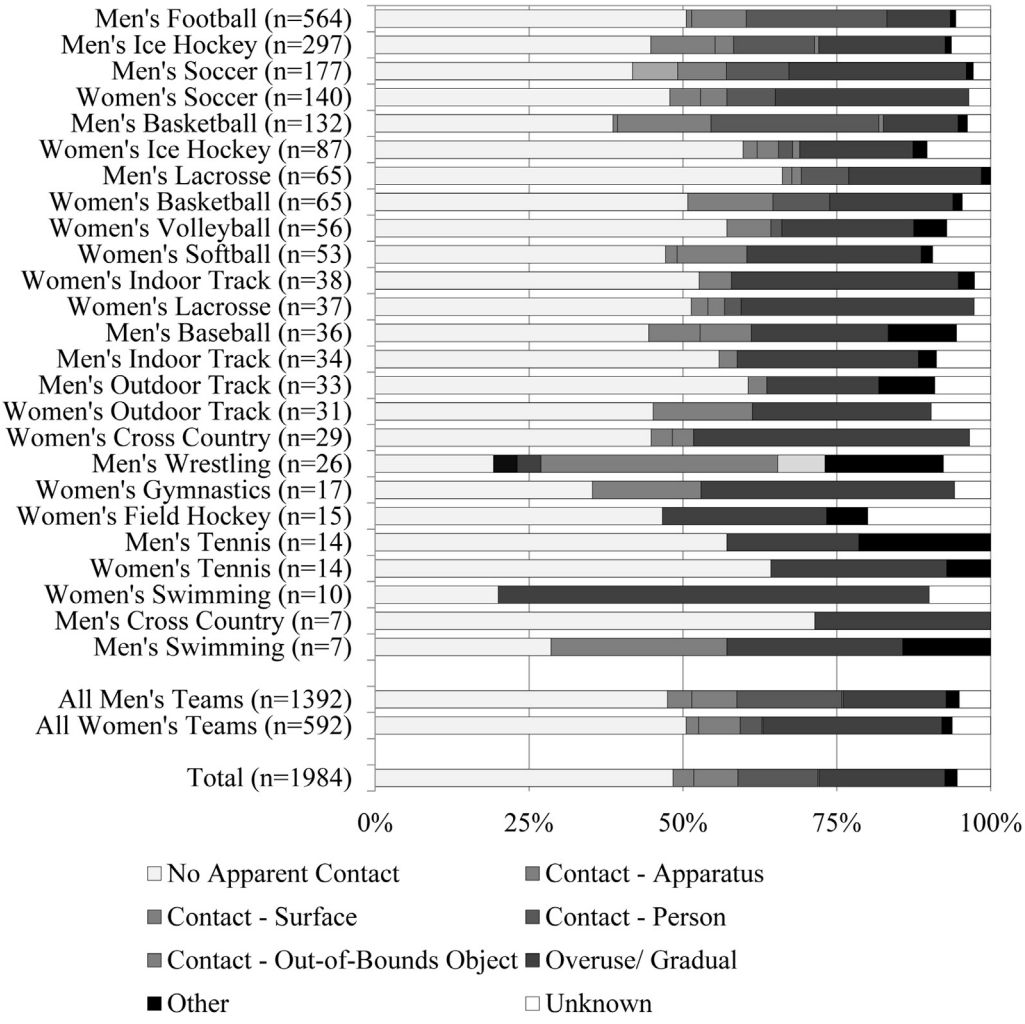

Fig 2. Mechanism of hip and groin injury by biomechanical category for 25 National Collegiate Athletic Association sports from 2009/10 to 2013/14.

alpha angles >55° significantly more often than controls. Our analysis of the collegiate athlete demographic is a chronological middle ground between youth and professional athletes, suggesting that early anatomical variants coupled with chronic athletic stressors can lead to repetitive injuries throughout an athletic career. Therefore, early limitations on the amount of time hockey goaltenders spend in the butterfly position, screening with range of motion and flexion, adduction, and internal rotation provocative testing, as well as radiographic screening of youth hockey players may be beneficial in the prevention of progressive hip pathology.

Cutting-type sports had the second highest rate of hip injuries; however, soccer, a cutting sport, had the highest overall rate of hip injuries of any sport. Improved understanding of hip injury pathophysiology has demonstrated that stresses across the hip joint during development contribute to deformities of the proximal femur and acetabulum.[24] Additional studies have also shown that cutting sports, soccer in particular, have a higher incidence of hip pathology than other sports.[8,25,26] Repeated sprinting and kicking, which is required during a soccer match, requires strong contraction of the rectus femoris. This repetitive contraction has been hypothesized to correlate with microavulsions of the anterior inferior iliac spine as well as traction apophysitis.[26-28] This, in turn, leads to hypertrophy of the anterior inferior iliac spine, which can extend to the acetabulum, contributing to subspine impingement.[27,28]

Limitations

This study has several limitations. First, the NCAA ISP provides very limited positional breakdown in the reported data. Some sports (e.g., baseball and swimming) exhibit different stressors about the hip depending on position. For example, a baseball catcher's hips are under much different stress than those of a baseball pitcher. In our analysis, all baseball players were included in the overhead/asymmetric group and all swimmers were included in the endurance group. Nawabi et al. found that the biomechanical demands

placed on baseball catchers and breast stroke swimmers fit into the impingement group. Therefore, these specific positions may have falsely increased injury rates in their respective subgroups. Additionally, the sample sizes vary significantly between sports and may have limited power for assessing statistical significance. The NCAA ISP does not provide information on the specific surgery performed; therefore we cannot conclude that impingement-type sports were associated with any specific type of surgical intervention. Additionally, the ISP does not provide information on whether diagnoses made by ATs were confirmed by imaging or by a physician. Our study is therefore unable to confirm whether diagnoses made without a physician or relevant imaging were correct. Additionally, 92% of diagnoses were made by ATs, while only 7.4% were made by medical doctors. Our study has limited generalizability due to the fact that only NCAA athletes were included. Finally, there is no standardized diagnostic algorithm for hip and groin injuries; therefore the diagnostic criteria may differ between ATs and physicians in the acute setting.

Conclusions

We have identified that impingement-type sports are most frequently associated with hip injuries. Additionally, this study demonstrates that hip injuries sustained in athletes who played impingement-type sports had a significantly higher rate of surgical intervention than other sport classifications.

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