

[Athletic Training]



Evaluation of Men's and Women's Gymnastics Injuries: A 10-Year Observational Study

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Background: Injuries are common in collegiate gymnasts. Most descriptive studies of injury patterns in collegiate gymnasts are limited in duration or are only inclusive of women.

Hypothesis: Injury patterns in men and women differ significantly; women sustain a higher rate of injuries than men.

Study Design: Descriptive epidemiology study.

Level of Evidence: Level 4.

Methods: Musculoskeletal and head injuries reported in the Sports Injury Monitoring System at a single National Collegiate Athletic Association institution for Division 1 men's and women's gymnastics teams between 2001 and 2011 were identified. The variables assessed included sex, injured body part, year of eligibility, injury severity, surgical procedures, missed time, and team activity at the onset of injury.

Results: From 2001 to 2011, 64 male gymnasts sustained 240 injuries, while 55 female gymnasts sustained 201 injuries. The injury incidence was 8.78 per 1000 athlete-exposures for men and 9.37 per 1000 athlete-exposures for women. Female gymnasts more commonly suffered major injuries compared with men, and more commonly underwent surgery after injury (24.4% of female injuries required surgery vs 9.2% in males). The anatomic region most often injured in men was the hand and wrist (24%). The anatomic region most often injured in women was the foot and ankle (39%). Overall, injury rates were highest in freshman-eligible athletes.

Conclusion: Injury rates, overall, were similar in men and women gymnasts. Female gymnasts more commonly underwent surgical procedures after injury. Injury rates were higher in freshman-eligible athletes and decreased with increasing year of experience.

Clinical Relevance: Specific attention should be given to gymnasts transitioning into collegiate-level gymnastics; injury prevention strategies should focus on the ankle and foot, as well as the elbow, wrist, and hand.

Keywords: gymnastics; sports injuries; athletic training; NCAA

Gymnastics is known as one of the most high-risk sports in the National Collegiate Athletic Association (NCAA), as extreme stresses may occur during characteristic maneuvers of the sport.⁵ Currently, there are 17 men's gymnastics programs and 82 women's gymnastics programs in the NCAA. The anatomic regions particularly affected by injury

vary by sex, most likely because of the diverse events in which male and female gymnasts compete.^{1,2,7} Ankle sprains are a particular concern.

The purpose of the current study was to describe the pattern of injuries for the men's and women's gymnastics teams over 10 seasons at a single Division 1 institution. Additionally, we aimed

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Table 1. Total number of gymnasts, number of injuries, athletic exposures, and injury rates (incidence) between groups^a

	Total Participants	Total Injuries	Athletic Exposures	Incidence	95% CI	Rate Ratio	95% CI
Male gymnasts	64	240	27,348	8.78	7.67-9.89		
Female gymnasts	55	201	21,453	9.37	8.07-10.66	1.07	0.89-1.29

^aAn athletic exposure was defined as 1 athlete participating in 1 game or practice.⁶ Rate ratio compares injury rates between men and women.

Table 2. Graphical representation of body part injured^a

	Male Injury Rate per 1000 AE (95% CI)		Female Injury Rate per 1000 AE (95% CI)		Rate Ratio
Head	0.44	(0.19-0.69)	0.19	(0.00-0.37)	0.42
Neck/clavicle	0.59	(0.30-0.87)	0.14	(0.00-0.30)	0.24
Shoulder	1.21	(0.79-1.62)	0.70	(0.35-1.05)	0.58
Elbow/forearm	0.62	(0.33-0.92)	0.70	(0.35-1.05)	1.12
Wrist/hand/finger(s)/thumb	2.12	(1.57-2.67)	0.61	(0.28-0.94)	0.29
Chest/abdomen	0.18	(0.02-0.34)	0.14	(0.00-0.30)	0.76
Back/spine	0.80	(0.47-1.14)	0.51	(0.21-0.82)	0.64
Hip/groin/thigh	0.07	(0.00-0.17)	0.65	(0.31-0.99)	8.92
Knee/leg	1.21	(0.79-1.62)	2.10	(1.48-2.71)	1.74
Ankle/foot/heel/toe(s)	1.54	(1.07-2.00)	3.64	(2.83-4.44)	2.37
Total	8.78	(7.67-9.89)	9.37	(8.07-10.66)	1.07

AE, athlete-exposure.

to investigate injuries according to sex, body part, severity, year of eligibility, team activity, as well as the surgical procedures performed during this 10-year period.

MATERIALS AND METHODS

This study received approval from the University of Iowa's Institutional Review Board. A retrospective review was conducted of athletic training room injury reports and physician records for the men's and women's gymnastics collegiate teams competing between August 1, 2001 and July 31, 2011. These injuries were documented into the Sports Injury Monitoring System (SIMS; FlanTech) by members of the athletic training staff. Methodology in utilizing this database for epidemiologic studies has been previously described.^{9,10,12} SIMS allows athletic training staff to efficiently record injuries, treatments, and physician visits among other information.

Data from the SIMS database was used for analysis of all male and female gymnasts for 10 consecutive seasons beginning August 1, 2001 to July 31, 2011. The recorded injuries during this time found in SIMS were reviewed for inclusion or exclusion. Statistical analysis was performed using Microsoft Excel (Microsoft Corp); and injury rates, 95% confidence intervals, risk ratios, and risk calculations were performed.⁶

RESULTS

From 2001 to 2011, a total of 119 gymnasts competed for the men's and women's gymnastics teams. A full description of the injuries sustained is available in Tables 1 through 5.

Of all injuries sustained by both male and female gymnasts, 56% resulted in time loss. The proportion of injuries suffered by male gymnasts that resulted in missed time was 123 of 240 injuries (52.3%). During this time, 19 males underwent a total of

Table 3. Male, female, and total gymnasts' injuries suffered stratified by participation year^a

	No. of Gymnasts	Gymnasts Suffering Injury (Risk %)	95% CI	Athletic Exposures	Total Injuries	Injury Rate	95% CI
Male gymnasts							
Freshman	50	34 (68)	55.07-80.93	8044	82	10.19	7.99-12.40
Sophomore	45	31 (69)	55.36-82.42	7239	67	9.26	7.04-11.47
Junior	37	23 (62)	46.53-77.79	5952	50	8.40	6.07-10.73
Senior	38	23 (61)	44.98-76.07	6113	41	6.71	4.65-8.76
Female gymnasts							
Freshman	45	31 (68)	55.36-82.42	6393	59	9.23	6.87-11.58
Sophomore	44	36 (82)	70.42-93.21	6251	60	9.60	7.17-12.03
Junior	36	22 (61)	45.19-77.04	5115	45	8.80	6.23-11.37
Senior	26	16 (62)	42.84-80.24	3694	37	10.02	6.79-13.24
Total							
Freshman	95	65 (69)	59.07-77.77	14,437	141	9.77	8.15-11.38
Sophomore	89	67 (75)	66.32-84.24	13,490	127	9.41	7.78-11.05
Junior	73	45 (62)	50.49-72.80	11,067	95	8.58	6.86-10.31
Senior	64	39 (61)	48.98-72.89	9807	78	7.95	6.19-9.72

^aRisk % represents the epidemiologic injury proportion, calculated by number of injured athletes/number of athletes on the team during the season. Injury rate is defined by total injuries/athlete-exposure.

22 surgical procedures. The majority of these procedures addressed upper extremity pathology (55%). For female gymnasts, 126 of 201 (62.7%) injuries resulted in time loss. During this time, 29 females underwent a total of 49 surgical procedures; 80% of these procedures addressed pathology in the lower extremity (hip, knee/leg, and ankle/foot) (Table 5). A complete listing of all surgical procedures is provided in the appendix (available at <http://sph.sagepub.com/content/suppl>).

DISCUSSION

Our study demonstrates similar injury rates overall between male and female gymnasts. This contradicts prior reports where women were found to be injured 4 times more often than men in intercollegiate gymnastics.⁷ This discrepancy may have been because of inadequate sampling. Lanese et al⁷ reported increased injuries in female gymnasts; however, their study was limited to a single season of participation. Females were found to suffer significantly more injuries resulting in missed participation time compared with men, and were twice as likely to undergo surgical management. Injuries were more prevalent in patients of younger eligibility overall.

In our study, men suffered significantly more injuries to the hand and wrist when compared with women. This may be, in part, representative of the different events male and female gymnasts participate in. Specifically, the high bar is associated with significant hand and wrist injuries in male gymnasts.^{1,11} Also, the pommel horse event may predispose athletes to hand and wrist injuries; this event is exclusively male. Female gymnasts suffer a significant number of injuries to the foot and ankle. This is consistent with other reports in the literature.^{3,4} In a study by Marshall et al,⁸ women were most commonly injured on the floor exercise (31%) and vault (27%). Female gymnasts participate in balance beam, which may subject athletes to higher rates of lower extremity injury.⁴ Caine et al² reported that 23.1% of injuries to female gymnasts occurred while participating in balance beam.

This is consistent with epidemiologic studies in other sports.¹² Interestingly, this trend was stronger in men than women. Senior-eligible women actually displayed the highest rate of injury, although this may be because of the low relative number of senior athletes competing in gymnastics. Also, female gymnasts are generally considered to peak competitively at a

Table 4. Severity of injuries suffered by gymnasts stratified by sex^a

Injury Severity	No. of Injuries	Injury Rate	95% CI
Male gymnasts			
Minor	169	6.18	5.25-7.11
Moderate	28	1.02	0.64-1.40
Major	43	1.57	1.10-2.04
Total	240	8.78	7.67-9.89
Female gymnasts			
Minor	120	5.59	4.59-6.59
Moderate	27	1.26	0.78-1.73
Major	54	2.52	1.85-3.19
Total	201	9.37	8.07-10.66
Total			
Minor	289	5.92	5.24-6.60
Moderate	55	1.13	0.83-1.42
Major	97	1.99	1.59-2.38
Total	441	9.04	8.19-9.88
Risk ratio			
Minor	0.91		
Moderate	1.23		
Major	1.60		
Total	1.07		

^aInjury rate is reported in total number of injuries divided by athlete-exposures. The rates for injury are reported per 1000 exposures. Risk ratios compare the incidence of injury between male and female gymnasts, calculated as female injury rate/male injury rate.

much younger age of 16 to 18 years than male gymnasts, who theoretically peak in their early 20s.

Surgical intervention often results in the athlete missing the rest of that season. Along these lines, our findings would be consistent with a study by Lanese et al⁷ comparing injuries in men's and women's intercollegiate sports, who found female gymnasts suffered a higher percentage of season-ending injuries when compared with male athletes.

This study has limitations that merit mention. First, this epidemiologic study evaluated data from 1 collegiate team over the course of 10 seasons, and therefore may lack generalizability. In addition, although our research illustrates the number of injuries that resulted in time loss, we were unable to determine exactly how much time was lost with a number of cases. Therefore, we cannot present an average time loss per

injury. Also, the database used characterized injuries by general categories (eg, leg and ankle injuries were combined), and specific breakdown by body part or type of injury was not readily available. Last, we were unable to accurately determine the events the gymnasts competed in (ie, uneven bars, floor, vault, rings) or on which event they were injured.

CONCLUSION

Overall, injury rates were similar between male and female gymnasts in our study (8.78 per 1000 athlete-exposures for men and 9.37 per 1000 athlete-exposures for women; rate ratio, 1.07; 95% CI, 0.89-1.29). Women, in general, suffered significantly more severe injuries and more frequently underwent operative management. The incidence of upper extremity injury was higher

Table 5. Injuries suffered as a factor of team activity

Team	Team Activity	Exposures	Injuries	Injury Rate	95% CI
Male gymnasts	Competition	1229	10	8.14	3.09-13.18
	Practice	19,395	162	8.35	7.07-9.64
	Conditioning	3094	5	1.62	0.20-3.03
	Scrimmage	31	0	0.00	0.00-0.00
	Unspecified activity	3599	63	17.50	13.18-21.83
	Total	27,348	240	8.78	7.67-9.89
Female gymnasts	Competition	643	11	17.11	7.00-27.22
	Practice	11,165	121	10.84	8.91-12.77
	Conditioning	1289	0	0.00	0.00-0.00
	Scrimmage	23	1	43.48	0.00-128.70
	Unspecified activity	8333	68	8.16	6.22-10.10
	Total	21,453	201	9.37	8.07-10.66
Total	Competition	1872	21	11.22	6.42-16.02
	Practice	30,560	283	9.26	8.18-10.34
	Conditioning	4383	5	1.14	0.14-2.14
	Scrimmage	54	1	18.52	0.00-54.81
	Unspecified activity	11,932	131	10.98	9.10-12.86
	Total	48,801	441	9.04	8.19-9.88

in men and lower extremity injuries were more common in women. Injuries were more common in freshman-eligible athletes. This information leads us to believe that special attention should be given to gymnasts transitioning into collegiate-level gymnastics and to female gymnasts as they progress throughout their college years. Training regimen adjustment and close assessment of freshmen athletes for signs of overuse injury may decrease injury occurrence and time loss resulting from injury. The data suggest that injury prevention strategies should focus on the ankle and foot as well as the elbow, wrist, and hand.

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