Original Article

Injury in the Women's National Basketball Association (WNBA) From 2015 to 2019

Hayden Baker, M.D., Andrew Rizzi, M.D., and Aravind Athiviraham, M.D.

Purpose: To provide an overview of the injuries suffered by Women's National Basketball Association (WNBA) athletes and to analyze the demographic data, injury rates, and games missed as a result of individual injuries. **Methods:** Using publicly available data on WNBA player's injury history, we generated a database cataloguing the quantity, location, frequency, and longitudinal impact of injuries sustained during the WNBA regular season from 2015 to 2019. We analyzed the data using SPSS-25 data manipulation software to assess the number of injuries per athletic exposure. **Results:** Lower-extremity injuries (n = 143, 73%) were the most common injury by body area and resulted in the greatest number of games missed (n = 1189, 88%). Lateral ankle sprains were the most frequent injury (n = 39, 20%), with a rate of 1.19 injuries per 1000 athletic exposures. Torn anterior cruciate ligaments (n = 18, 9.2%) were the most devastating, resulting in the greatest number of games missed (n=376, 28%). **Conclusions:** Our findings corroborate previous notions that lower-extremity injuries are the greatest source of injury in this population. Ankle injuries were the most frequent injury reported by pathology, while knee injuries carried the most long-term impact on games missed due to injury. **Level of Evidence:** IV, Epidemiological study

Since its inception in 1997, the Women's National Basketball Association (WNBA) has gained national interest in the United States. Despite the WNBA's growing popularity, less is known about the risk of injury in WNBA athletes. Multiple studies have described female basketball athletes, at the high school and collegiate level of play, having a greater risk of knee and ankle injury when compared with male athletes.[1-5] These findings are consistent with the well-described difference in injury rate, incidence, and risk between male and female athletes participating in sports other than basketball.[1-5] However, limited data exist regarding injuries in WNBA athletes.[6]

Previous studies report that female athletes suffer greater rates of injury in college when compared with male athletes.[1-3,5,7] Thus, one can speculate that this observed trend would continue for female basketball players throughout their professional careers. However, published data that specifically examine the injury profiles of WNBA athletes are limited. The purpose of this study was to provide an overview of the injuries suffered by WNBA athletes and to analyze the demographic data, injury rates, and games missed as a result of individual injuries. We hypothesized that WNBA athletes commonly would suffer lower-extremity injuries, specifically anterior cruciate ligament (ACL) tears, at similar rates to those reported in previous studies examining female athlete injury rates.[7,8]

Methods

This study was a retrospective review of all injuries suffered by WNBA athletes during the 2015 through 2019 regular seasons. The data were compiled using publicly available injury reports published on multiple websites[9,10]; each injury was corroborated with 2 additional publicly available online sources and care was taken to identify and exclude duplicate injuries reported on multiple sources. Our data set was compiled in accordance with previously published protocols that has been verified as a valid method of

Table 1. Demographic Characteristics

	Height, cm	Weight, kg	Age, y	BMI
Mean	183.03	76.93	28.72	22.88
Median	183	78	28	22.99
Standard deviation	9.50	10.75	3.85	1.99
Minimum	134	38	22	17
Maximum	206	113	38	30.34

BMI, body mass index.

analyzing publicly available data and published in multiple high impact journals.[11-17] Reportable injuries were based on the criteria that the injury necessitated a team physician referral or emergent care and resulted in game time being missed.

Our database included player's name, position, injury, date of injury, number of games missed, and demographic information including age, height, and weight at the time of injury. We used team records, available on each individual team website, to collect demographic information. Finally, we excluded injuries from the off-season that resulted in players being place on the disable list prior to the start of the season, as well as the post-season.

An analysis was performed of the WNBA database from 2015 through the 2019 basketball season for regular season games (approximately May 24 to September 8 of each year). The mean, standard deviation, frequency, and incidence rate of injury were calculated using SPSS 25 (IBM Corp., Armonk, NY).

For data analysis, an athletic exposure (AE) was defined as 1 athlete appearing in 1 game. No distinction was made between athletes with regards to playing time. Game injury rates were calculated per 1000 AE. The maximum AEs during a single game was 24, in which all 12 players from each team participated in the contest. We did not calculate the incidence rate of injury for practices, preseasons, and postseason games due to a lack of standardized protocol and unreliable reporting methods.[18] Injury incidence rate per 1000 AEs was calculated using the following formula:

(Total number of injuries × 1000)/Total number of AEs

Table 2. Injury Rate by Body Area

	Total		Games Missed		Rate (per 1000 Athletic Exposures)
	N	%	N	%	
Body area					
Lower extremity	143	0.73	1189	0.88	4.38
Upper extremity	11	0.06	31	0.02	0.34
Torso	2	0.01	17	0.01	0.06
Head	27	0.14	82	0.06	0.83
Spine/back	11	0.06	33	0.02	0.34
Totals	195	100	1352	100	

Table 3. Injury Rate by Structure

	Total		Games Missed		Rate (per 1000 Athletic Exposures)
	N	%	N	%	
Ankle	43	0.22	176	0.13	1.32
Spine/back	12	0.06	60	0.04	0.37
Patella	1	0.01	0	0.00	0.03
Knee	56	0.29	683	0.51	1.72
Foot	18	0.09	202	0.15	0.55
Tibia/leg	8	0.04	42	0.03	0.25
Femur/thigh	15	0.08	46	0.03	0.46
Hip	3	0.02	17	0.01	0.09
Hand/wrist	2	0.01	12	0.01	0.06
Face	5	0.03	7	0.01	0.15
Shoulder	4	0.02	21	0.02	0.12
Eye	1	0.01	1	0.00	0.03
Fingers	2	0.01	3	0.00	0.06
Thumb	2	0.01	8	0.01	0.06
Elbow	1	0.01	7	0.01	0.03
Concussion	20	0.10	58	0.04	0.61
Rib/chest	2	0.01	9	0.01	0.06
Total	195	100	1352	100.00	

Results

There were 12 teams competing in the WNBA from the 2015 through the 2019 regular seasons. Each WNBA team plays 34 games during the regular season per year. WNBA rosters are limited to 12 individual players. A total of 720 players appeared on at least 1 regular season roster. We identified 195 injuries during the period of study. The incidence of injury was 5.97 per 1000 AEs. These injuries accounted for 1352 games missed. The average height, weight, and age of players included in the study was 183 cm, 77 kg, and 28.7 years old, respectively (Table 1).

The lower extremity was the most frequently injured body area, accounting for 73% of all injuries (Table 2). Lower-extremity injuries were responsible for 76% of the games missed due to injury. The lower-extremity injury incidence of 4.38 per 1000 AEs was significantly greater than any other body area. The next-most-common body area injured was the head, which accounted for 14% of all injuries and 13% of games missed due to injury (Table 2).

The knee was the most commonly injured joint, accounting for 56 (29%) injuries and 354 (26%) games missed (Table 3). Knee injury incidence rate per 1000 AEs was 1.32. Ankle injuries (n, 43; 22%) were second most common, and were responsible for more games missed due to injury 441 (33%). Together, knee and ankle injuries accounted for more than one half of the reported injuries included in the study. Concussion (n, 20; 10%) and foot injuries (n, 18; 9%) also were responsible for a significant portion of the injuries.

Analysis of pathology demonstrated similar results; lateral ankle sprains were noted to be the most common injury (n, 39; 20%), accounting for 117 (9%) of all games missed (Table 4). The incidence rate of lateral ankle sprains (1.19 per 1000 AE) was twice the

Table 4. Injury Rate by Specific Pathology

	Total		Games Missed		Rate (per 1000 Athletic Exposures)
	N	%	N	%	
Lateral ankle sprain	39	0.2	117	0.09	1.195
Achilles tendinopathy	4	0.02	20	0.01	0.123
ACL tear	18	0.09	376	0.28	0.55
Lumbar sprain/strain	9	0.05	32	0.02	0.28
Hand/wrist fracture	3	0.02	27	0.02	0.092
Nose fracture	5	0.03	8	0.01	0.15
Calf sprain/strain	5	0.03	32	0.024	0.15
Cervical sprain/strain	2	0.01	2	0.0015	0.06
Osteochondral injury (knee)	4	0.02	81	0.06	0.12
Plantar fasciitis	2	0.01	9	0.007	0.061
Concussion	19	0.10	55	0.041	0.58
Foot inflammation	2	0.01	6	0.004	0.061
Foot sprain	2	0.01	8	0.006	0.061
Hamstring strain	10	0.05	37	0.027	0.31
Hip contusion	3	0.02	17	0.013	0.092
Lumbar disc degeneration	1	0.01	26	0.019	0.031
Periorbital contusion	2	0.01	3	0.002	0.061
Foot fracture	2	0.01	27	0.02	0.061
Knee/patella contusion	8	0.04	72	0.053	0.25
Patellofemoral inflammation	16	0.08	41	0.03	0.49
Ankle fracture	1	0.005	17	0.013	0.03
Peroneal strain	2	0.01	40	0.030	0.06
High ankle sprain	1	0.005	4	0.0030	0.03
Knee sprain	1	0.005	9	0.0067	0.03
AC sprain	3	0.02	21	0.016	0.092
Meniscal tear	9	0.05	113	0.084	0.28
MCL sprain	1	0.005	4	0.0030	0.031
Finger sprain	2	0.01	3	0.002	0.061
Patella tendonitis	1	0.005	0	0	0.031
Shoulder labrum tear	1	0.005	0	0	0.031
Quadriceps contusion	2	0.01	2	0.0015	0.06
Elbow contusion	1	0.005	7	0.0052	0.031
Adductor strain	1	0.005	2	0.0015	0.031
Leg contusion	3	0.015	10	0.0074	0.092
Thumb sprain	1	0.005	2	0.0015	0.031
Rib contusion	2	0.01	9	0.0067	0.061
Achilles tendon tear	3	0.015	101	0.075	0.092
Hip flexor strain	2	0.01	5	0.0037	0.061
Thumb UCL tear	1	0.005	6	0.004	0.031
Wrist sprain	1	0.005	1	0.001	0.031
Total	195	100	1352	100	

AC, acromioclavicular; ACL, anterior cruciate ligament; MCL, medial collateral ligament; UCL, ulnar collateral ligament.

incidence rate of the second most common pathology (concussion: 0.58 per 1000 AE). ACL tears were the most common reason for games missed at 376 (28%); of note ACL tears only accounted for 18 (9%) of the reported injuries. Patellofemoral inflammation was also a common reported pathology (n, 16; 8%); however, it was only responsible for 41 (3%) of games missed.

Analysis of injury type demonstrated that sprains were the most common (27%), followed by strains or spasms (16%), and inflammatory conditions (13%) (Table 5).

Discussion

The most important finding of this study was that lateral ankle sprains were the most common injury type by incidence in WNBA athletes (20%). These findings are similar to the publication by Drakos et al.[18] classifying injury prevalence and type in the NBA over a 17-year period; Drakos et al.[18] reported lateral ankle sprains were the most common injury in NBA athletes over the study period (13.2% of all injuries). Akin to their analysis, this is not necessarily a surprising finding, given the frequency of jumping and landing among crowded spaces of players. Furthermore, our finding highlights or necessitates the need for further research dedicated to ankle-inversion injury, which has been historically lacking in the high-level female athlete population.

In addition, ACL tears were the injury resulting in the greatest number of games missed (n = 376, 28%), with lateral ankle sprains (n = 117, 9%) and meniscal tears

Table 5. Injury Rate by Type

	Total		Games Missed		Rate (per 1000
	N	%	N	%	Athletic Exposures)
Inflammatory	25	0.13	76	0.06	0.77
Strain/spasm	31	0.16	148	0.11	0.95
Contusion	21	0.11	120	0.09	0.64
Fractures	11	0.06	79	0.06	0.34
Sprain	54	0.3	203	0.15	1.65
Meniscal tear	9	0.05	113	0.08	0.28
ACL tear	18	0.09	376	0.28	0.55
Osteochondral injury	4	0.02	81	0.06	0.12
Achilles tendon tear	3	0.02	101	0.07	0.092
Neurologic	19	0.10	55	0.041	0.58
Total	195	100	1352	100	

ACL, anterior cruciate ligament.

(n = 113, 8.36%) following behind. This finding corroborates the data mentioned in the aforementioned study, demonstrating that although ankle sprains seem to be the most frequent injury by rate, knee injuries tend to be more devastating from a games and time lost perspective.

Several studies have described the risk of injury in National Basketball Association (NBA) athletes.[19-22] Not surprisingly NBA players have twice the risk of game-related injury when compared with collegiate basketball players; this observation has been attributed to longer games and more games per season occurring in the NBA.[21] However, Zelisko et al.[23] found, when comparing male and female professional basketball players that women sustained 60% more injuries. Of note, the study by Zelisko et al.[23] was published in 1982, which predates the WNBA by 15 years. In a similar study comparing the injury rates between WNBA and NBA athletes Deitch et al.[24] found that the lower-extremity was the most commonly injured body part in both groups, with ankle sprain being the most common diagnoses.

Our study reports an injury incidence rate of 5.97 per 1000 AEs in WNBA athletes; 5.97 per 1000 AEs is a significantly lower incidence rate of injury when compared with the injury rate of 19.1 per 1000 AEs reported in a similar study on NBA athletes.[18] This observation may be due to a number of different confounding factors. Most importantly, the WNBA season is 34 games in length, which is significantly shorter than the 82-game NBA regular season. Furthermore, WNBA games are 40 minutes in length, whereas NBA games are 48 minutes. Of note, NBA playoffs can potentially add another 28 games to a team's schedule (if each of the 4-game series were decided by a game 7). Thus, one can speculate that NBA athletes are more susceptible to suffering injuries secondary to fatigue, when compared with

their WNBA counterparts, due to the length of their season and games. Previous studies have demonstrated the correlation between fatigue and muscular injury.[25,26] A greater incidence of injury in NBA players due to fatigue secondary to an increased number of games played per season is supported by the fact that the second, third, and fourth most common injuries reported in NBA players over 17 seasons were injuries of overuse (patellofemoral inflammation, lumbar strains, and hamstring strains respectively).[18] In contrast, our study reported the 3 most common injuries in WNBA athletes were due to trauma as the primary etiology of injury, which would be expected to be independent of fatigue (lateral ankle sprains, concussion, and ACL tear, respectively). These findings likely do not account for all of the difference noted in the injury incidence rates between NBA and WNBA athletes, as this difference is likely confounded by the limitations of the study, listed to follow.

Only 2 previous studies[8,25] have investigated the injury profile in the WNBA athlete. One was written as a comparative trial between the NBA and WNBA and the other was primarily focused only on injury history before entry into the WNBA based on documented collegiate injury history. We believe that this is the first documented report of injury type by incidence, body area, and specific pathology over a longitudinal period of time involving current WNBA athletes.

Limitations

Our study has several limitations. Details regarding injury diagnosis and management, including injury severity, exact pathology, imaging reports, operative reports, exact medical clearance, and date of return to play were not available for all players. Because injured players were identified using public records, the possibility of selection bias, reporting errors, and omissions exist. Without operative reports the details of each surgery are unclear, which makes it difficult to comment on severity of injury in WNBA athletes. Finally, there remains the possibility of selection bias in our injured group in which only "newsworthy" players injured were reported on. We attempted to minimize this bias by corroborating reported injuries with two additional resources, but our data are limited by what is publicly available.

Conclusions

Our findings corroborate previous notions that lower-extremity injuries are the greatest source of injury in this population. Ankle injuries were the most frequent injury reported by pathology, while knee injuries carried the most long-term impact on games missed due to injury.

References

1. Agel J, Arendt EA, Bershadsky B. Anterior cruciate ligament injury in national collegiate athletic association basketball and soccer: A 13-year review. *Am J Sports Med* 2005;33:524-530.

2. Arendt E, Dick R. Knee injury patterns among men and women in collegiate basketball and soccer. NCAA data and review of literature. *Am J Sports Med* 1995;23:694-701.

3. Arendt EA, Agel J, Dick R. Anterior cruciate ligament injury patterns among collegiate men and women. *J Athl Train* 1999;34:86-92.

4. Gomez E, DeLee JC, Farney WC. Incidence of injury in Texas girls' high school basketball. *Am J Sports Med* 1996;24:684-687.

5. Hosea TM, Carey CC, Harrer MF. The gender issue: Epidemiology of ankle injuries in athletes who participate in basketball. *Clin Orthop Relat Res* 2000;(372):45-49.

6. McCarthy MM, Voos JE, Nguyen JT, Callahan L, Hannafin JA. Injury profile in elite female basketball athletes at the Women's National Basketball Association combine. *Am J Sports Med* 2013;41:645-651.

7. Agel J, Olson DE, Dick R, Arendt EA, Marshall SW, Sikka RS. Descriptive epidemiology of collegiate women's basketball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train* 2007;42:202-210.

8. Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes: Part 1, mechanisms and risk factors. *Am J Sports Med* 2006;34:299-311.

9. Henley D. WNBA Players/InjuriesMcleod G, ed. *WNBA Players/Injuries* Vol 2019. newsday.com: The Wall Street Journal, 2019.

10. Hult JS. Injury Report. In: Wurst M, ed. WNBA Injury report *Vol 2019*. WNBA.com: Turner Sports Interactive Inc., 2019.

11. Conte SA, Thompson MM, Marks MA, Dines JS. Abdominal muscle strains in professional baseball: 1991-2010. *Am J Sports Med* 2012;40:650-656.

12. Erickson BJ, Gupta AK, Harris JD, et al. Rate of return to pitching and performance after Tommy John surgery in Major League Baseball pitchers. *Am J Sports Med* 2014;42:536-543.

13. Gibson BW, Webner D, Huffman GR, Sennett BJ. Ulnar collateral ligament reconstruction in major league baseball pitchers. *Am J Sports Med* 2007;35:575-581.

14. Makhni EC, Lee RW, Morrow ZS, Gualtieri AP, Gorroochurn P, Ahmad CS. Performance, return to competition, and reinjury after Tommy John surgery in Major League baseball pitchers: a review of 147 cases. *Am J Sports Med* 2014;42:1323-1332.

15. Marshall NE, Jildeh TR, Okoroha KR, Patel A, Moutzouros V, Makhni EC. Implications of core and hip injuries on Major League Baseball pitchers on the disabled list. *Arthroscopy* 2018;34:473-478.

16. Marshall NE, Keller RA, Lynch JR, Bey MJ, Moutzouros V. Pitching performance and longevity after revision ulnar collateral ligament reconstruction in Major League Baseball pitchers. *Am J Sports Med* 2015;43:1051-1056.

17. Posner M, Cameron KL, Wolf JM, Belmont PJ Jr, Owens BD. Epidemiology of Major League Baseball injuries. *Am J Sports Med* 2011;39:1676-1680.

18. Drakos MC, Domb B, Starkey C, Callahan L, Allen AA. Injury in the national basketball association: A 17-year overview. *Sports Health* 2010;2:284-290.

19. Herskowitz A, Selesnick H. Back injuries in basketball players. *Clin Sports Med* 1993;12:293-306.

20. Krinsky MB, Abdenour TE, Starkey C, Albo RA, Chu DA. Incidence of lateral meniscus injury in professional basketball players. *Am J Sports Med* 1992;20:17-19.

21. Starkey C. Injuries and illnesses in the national basketball association: A 10-year perspective. *J Athl Train* 2000;35:161-167.

22. Zagelbaum BM, Starkey C, Hersh PS, Donnenfeld ED, Perry HD, Jeffers JB. The National Basketball Association eye injury study. *Arch Ophthalmol* 1995;113:749-752.

23. Zelisko JA, Noble HB, Porter M. A comparison of men's and women's professional basketball injuries. *Am J Sports Med* 1982;10:297-299.

24. Deitch JR, Starkey C, Walters SL, Moseley JB. Injury risk in professional basketball players: a comparison of Women's National Basketball Association and National Basketball Association athletes. *Am J Sports Med* 2006;34:1077-1083.

25. Opar DA, Williams MD, Shield AJ. Hamstring strain injuries: Factors that lead to injury and re-injury. *Sports Med* 2012;42:209-226.

26. Witvrouw E, Danneels L, Asselman P, D'Have T, Cambier D. Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players. A prospective study. *Am J Sports Med* 2003;31:41-46.