AJSM PreView, published on June 27, 2011 as doi:10.1177/0363546511411700

Epidemiology of Major League Baseball Injuries

Matthew Posner,* MD, Kenneth L. Cameron,† PhD, ATC, Jennifer Moriatis Wolf,‡ MD, Philip J. Belmont Jr,* MD, and Brett D. Owens,†‖ MD
Investigation performed at Keller Army Hospital, West Point, New York

Background: Little is known about the injury rates in Major League Baseball (MLB) players, as a formal injury surveillance system does not exist. The goal of this study was to characterize the epidemiology of MLB injuries over a 7-year period.

Hypothesis: Injuries in MLB would be common.

Study Design: Descriptive epidemiologic study.

Methods: The authors analyzed the MLB disabled list data from 2002 through 2008. Injuries were analyzed for differences between seasons, as well as during seasons on a monthly basis. The injuries were categorized by major anatomic zones and then further stratified based on injury type. Position-specific subanalyses for pitcher and position players were performed.

Results: From the 2002 season through the 2008 season, an average of 438.9 players per year were placed on the disabled list, for a rate of 3.61 per 1000 athlete-exposures. There was a significant 37% increase in injuries between 2005 and 2008. The highest injury rate during the season was during the month of April (5.73/1000 exposures) and the lowest in September (0.54/1000 exposures). No differences were noted in the injury rates between the National League and the American League (incidence rate ratio [IRR] = 1.06; 95% confidence interval [CI] = 0.98, 1.15). Pitchers experienced 34% higher incidence rates for injury compared with fielders during the study period (IRR = 1.34; 95% CI = 1.25, 1.44). Among all player injuries, upper extremity injuries accounted for 51.4% while lower extremity injuries accounted for 30.6%. Injuries to the spine and core musculature accounted for 11.7% while other injuries and illnesses were 6.3% of the total disabled list entries. There was a significant association between position played and anatomic region injured ($P < .001$), with pitchers experiencing a significantly greater proportion of injuries to the upper extremity (67.0%; 95% CI = 63.1%, 70.9%) compared with fielders (32.1%; 95% CI = 29.1%, 35.1%). Conversely, fielders experienced a significantly greater proportion of injuries to the lower extremity (47.5%; 95% CI = 43.8%, 51.1%) compared with pitchers (16.9%; 95% CI = 14.9%, 18.8%). The mean number of days on the disabled list was 56.6. Overall, a greater proportion of disability days were experienced by pitchers (62.4%; 95% CI = 62.0%, 62.8%; $P < .001$) compared with fielders (37.6%; 95% CI = 37.3%, 37.9%).

Conclusion: Injuries in MLB resulting in disabled list designation are common. Upper extremity injuries were predominant in pitchers, while lower extremity injuries are more common in position players. These data may be used in the development of a formal MLB injury database, as well as in the development and implementation of specific preseason training and in-season conditioning for injury prevention.

Keywords: baseball; injury; sports; epidemiology; pitcher

Little is known about the injury rates in Major League Baseball (MLB) players, as a formal injury surveillance system does not yet exist. Although baseball is referred to as the "national pastime," scant literature is available with regard to the epidemiology of injuries at baseball's most elite level.

Only 1 study to date exists that describes the epidemiology for MLB injuries. Conte et al[3] studied the disability list data over an 11-year period and showed that the number of injuries has gradually and consistently increased despite advances in training, conditioning, diagnostic tools, and surgical treatment. They found that team membership, injury location, and position do not appear to be related to injuries.

At the collegiate level, as well as at the scholastic level, there are reliable data on baseball injuries. Dick et al[4] studied the epidemiology of collegiate men's baseball injuries over a 16-year time span and found a relatively low rate of injury compared with other National Collegiate Athletic Association (NCAA) sports. This study also showed that 25% of injuries in college baseball are severe and result in

‖Address correspondence to Brett D. Owens, MD, Associate Professor, John A. Feagin, Jr. Sports Medicine Fellowship, Keller Army Hospital, 900 Washington Rd, West Point, NY 10996 (e-mail: b.owens@us.army.mil).
*William Beaumont Army Medical Center, El Paso, Texas.
†Keller Army Hospital, West Point, New York.
‡University of Colorado, Denver, Colorado.

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the Department of Defense or United States government.

Presented at the 36th annual meeting of the AOSSM, Providence, Rhode Island, July 2010.

The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

The American Journal of Sports Medicine, Vol. XX, No. X
DOI: 10.1177/0363546511411700

greater than 10 days of time loss from participation. Collins and Comstock[2] studied high school baseball over 3 seasons and showed that 50.3% of injuries resulted in a time loss of less than 7 days. Extrapolation of these data from these lower echelons of play to MLB players is fraught with potential pitfalls because of the higher caliber athletes, nearly half-year–long seasons, and increased availability of the most contemporary sports medicine and rehabilitation care.

While there are many reports from individual surgeons who care for MLB players, these are subject to selection bias and cannot be used to evaluate injury trends. Given the paucity of epidemiologic data on MLB injuries, we used publicly available team-reported disabled list data to evaluate injuries at this level over a 7-year period. The purpose of this study was to evaluate injury incidence, type, and impact of position on injury in MLB players.

MATERIALS AND METHODS

We analyzed the MLB disabled list data from 2002 through 2008. The data were compiled using publicly accessible information extracted from a single Internet Web site.[7] We utilized data only for those injuries that resulted in a player being placed on the disabled list. According to MLB rules, to be placed on the disabled list, the player must be certified as unable to play, with a specific diagnosis made by the team physician.[6] Once on the disabled list, the player cannot return to the active roster for a minimum of 15 days. The player can remain on the disabled list for as many days as necessary for him to return to play. The same player may appear on the disabled list more than once in a season. For players with multiple injuries occurring at the same time, we accounted for each injury separately although the player was listed only once on the disabled list.

Our database consisted of the player's name, team, position, injury information, and dates on the disabled list. We then categorized each injury into major anatomic zones, and then further stratified the data based on injury type. A random sample of 25 players per year was individually researched to assess the overall accuracy of our database. We used actual team records, available on each individual team's Web site to view team notes and transaction listings. We found 100% confirmation of our dataset with team records and press reports of the 175 randomly sampled injuries. The database was then stratified to evaluate pitchers and fielders separately. The grouping of fielders consisted of all non-pitchers, to include the designated hitters in the American League. Finally, we analyzed the injury incidence based on the month in which the player was placed on the disabled list, excluding injuries from the off-season that resulted in players being placed on the disabled list before or on the first day of the season.

To estimate person-time at risk for injury, we used a 25-man roster for each team for the entire 162-game season and defined each game as 1 athlete-exposure. Teams can place unlimited numbers of players on the disabled list without any effect on the total number of players on their roster. We further assumed that each team played all 162 games for each of the 7 seasons studied.

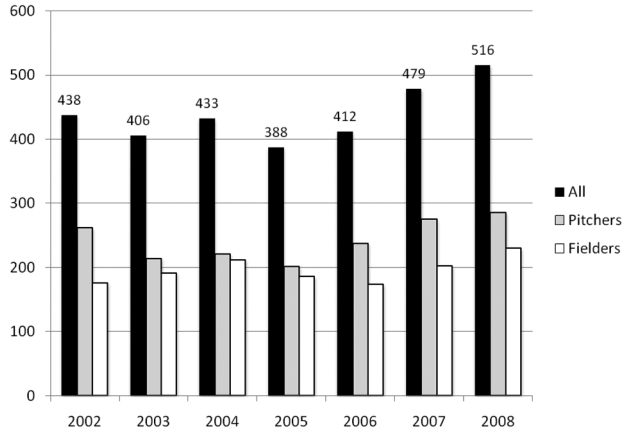

Figure 1. Total number of injuries to all players, pitchers, and fielders by year.

Initially we calculated the frequency and proportional distribution of injuries by anatomic region, league, month of injury, and position. For continuous variables, we calculated means and standard deviations. Associations between injury and league, anatomic region, and position were assessed using χ^2 tests. Incidence rates, incidence rate ratios, and 95% confidence intervals (CIs) were calculated in aggregate and annually during the study period by position, anatomic region, league, and time of season using a Poisson distribution. Linear regression was used to examine changes in the incidence rate by month across the 7 years studied. Between-group differences for the number of days spent on the disability list by anatomic region for pitchers and fielders were evaluated using analysis of variance and between-group differences were evaluated using the Scheffe post hoc test. All statistical analyses were performed using Stata software version 10.0 (StataCorp, College Station, Texas), with significance set at $P < .05$.

RESULTS

From the 2002 season through the 2008 season inclusive, 3072 MLB players were placed on the disabled list. The average number of players placed on the disabled list per year was 438.9 players, with a high of 516 in 2008 and a low of 388 in 2005 (Figure 1). The overall incidence rate for injuries that resulted in players being placed on the MLB disabled list was 3.61 (95% CI = 3.49, 3.74) per 1000 athlete-exposures during the study period.

Analysis of the dataset by season showed a small decrease during the first 3 years of study, followed by a subsequent increase in the final 3 years. Among all players, a significant 37% increase in the injury rate was noted between 2005 and 2008 (incidence rate ratio [IRR] = 1.37; 95% CI = 1.18, 1.59). When examining incidence rates for pitchers, between 2002 and 2005 there was a significant 29% decrease in the incidence rate for injuries (IRR = 0.71; 95% CI = 0.58, 0.88) followed by a subsequent 58% increase (IRR = 1.58; 95% CI = 1.29, 1.94) between 2005 and 2008 (Figure 2).

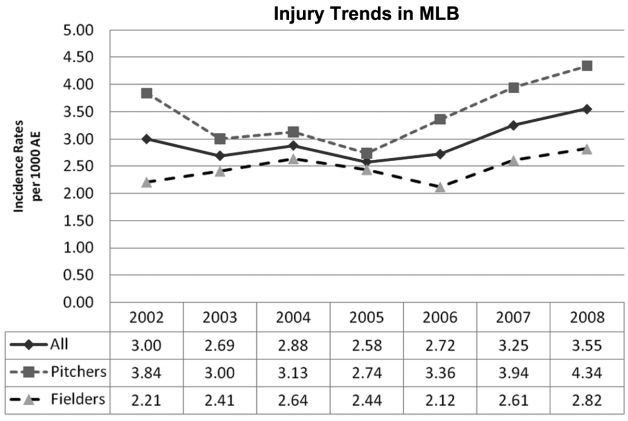

Figure 2. Injury incidence rates for all players, pitchers, and fielders by year.

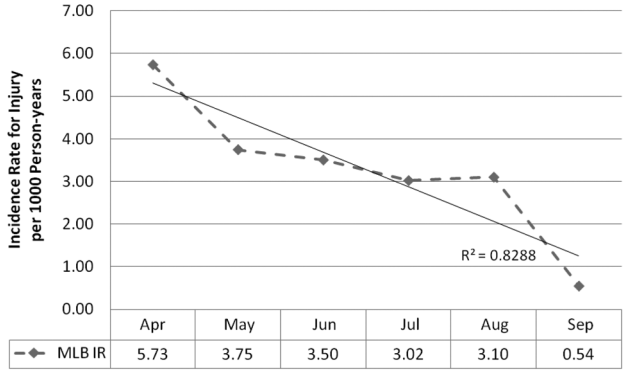

Figure 3. Injury incidence rates for all players by month of season.

Analysis of incidence rates by month of the season across all years of the study showed that the majority of injuries occurred in the first half of the season. The highest rate of injury was observed in the first month of the regular season and the lowest rate was in the last month (Figure 3), and there was a significant decrease in the incidence of injury as the season progressed ($t = -4.4$, $P = .012$). On average, the incidence rate declined by 0.81 injuries per 1000 athlete-exposures per month during the regular season. Overall, 83% of the variability in the incidence rate during the season could be explained by month of the season.

No differences were noted in the injury rates between the National League and the American League (IRR = 1.06; 95% CI = 0.98, 1.15). There were no differences between leagues in the incidence rate for injuries for pitchers (IRR = 1.09; 95% CI = 0.98, 1.21) or for fielders (IRR = 1.03; 95% CI = 0.91, 1.16). The proportional distribution of injuries by anatomic region was nearly identical between leagues for pitchers and fielders (Table 1).

Pitchers experienced significantly higher incidence rates for injury when compared with fielders during the study period. The incidence rate for injuries among pitchers was 4.16, compared with 3.10 for fielders. Overall, the incidence rate for injury among pitchers was 34% higher (IRR = 1.34; 95% CI = 1.25, 1.44) when compared with fielders. When only extremity injuries were examined, excluding spine/core injury, the results were similar (IRR = 1.41; 95% CI = 1.30, 1.53).

TABLE 1
Body Region Percentage of Injuries Broken Down by Pitchers and Fielders, as well as National League (NL) and American League (AL)

	AL, %	NL, %	Total, %
All Players			
Upper extremity	51.1	51.7	51.4
Lower extremity	30.5	30.7	30.6
Spine and Core	12.3	11.2	11.7
Other	6.0	6.5	6.3
Pitchers only			
Upper extremity	66.9	67.0	67.0
Lower extremity	17.0	17.0	16.9
Spine and Core	10.3	10.9	10.6
Other	5.8	5.1	5.5
Fielders only			
Upper extremity	32.3	32.0	32.1
Lower extremity	46.7	48.2	47.5
Spine and Core	14.7	11.6	13.0
Other	6.3	8.2	7.4

Among all player injuries, upper extremity injuries accounted for 51.4%, while lower extremity injuries accounted for 30.6%. Injuries to the spine and core musculature accounted for 11.7%, while other injuries and illnesses were 6.3% of the total disabled list entries (Table 1 and Table 2). There was a significant association between position played and anatomic region injured ($P < .001$). Pitchers experienced a significantly greater proportion of injuries to the upper extremity (67.0%; 95% CI = 63.1%, 70.9%) when compared with fielders (32.1%; 95% CI = 29.1%, 35.1%). Conversely, fielders experienced a significantly greater proportion of injuries to the lower extremity (47.5%; 95% CI = 43.8%, 51.1%) when compared with pitchers (16.9%; 95% CI = 14.9%, 18.8%). The incidence rate among pitchers was 2.79 times higher (IRR = 2.79; 95% CI = 2.50, 3.12) for upper extremity injuries and was 52% lower (IRR = 0.48; 95% CI = 0.41, 0.55) for lower extremity injuries, when compared with fielders.

The mean number of days on the disabled list was 56.6. Overall, pitchers had a greater proportion of disability days (62.4%; 95% CI = 62.0%, 62.8%; $P < .001$) compared with fielders (37.6%; 95% CI = 37.3%, 37.9%). Pitchers spent significantly more days on the disabled list for upper extremity injuries (mean = 74.25; 95% CI = 70.90, 77.60) than for lower extremity injuries (mean = 41.26; 95% CI = 37.12, 45.40; $P < .001$). Fielders also spent significantly more days on the disabled list for upper extremity injuries (mean = 54.16; 95% CI = 49.85, 58.47) than for lower extremity injuries (mean = 44.59; 95% CI = 41.53, 47.65; $P < .001$).

TABLE 2
Mean Injuries per Season Among Fielders, Pitchers, and Overall, Broken Down by Body Region

Body Region	Fielders	%	Pitchers	%	Overall	%
Foot/ankle	17.1	8.8	7.0	2.9	24.1	5.5
Knee	24.4	12.5	8.7	3.7	33.1	7.7
Hip	3.1	1.6	3.1	1.3	6.3	1.4
Other lower extremity	16.0	8.1	3.9	1.7	19.9	4.5
Hamstring	27.0	13.7	8.1	3.3	35.1	8.0
Groin	5.7	3.0	10.4	4.4	16.1	3.8
Core	10.4	5.3	8.4	3.5	18.9	4.3
Hernia, abdomen	2.9	1.5	2.0	0.8	4.9	1.1
Chest	4.9	2.5	5.4	2.3	10.3	2.4
Back/spine	15.3	7.8	17.9	7.4	33.1	7.6
Head	4.1	2.1	1.4	0.6	5.6	1.3
Hand/wrist	33.4	17.0	10.3	4.2	43.7	10.0
Elbow	8.1	4.1	63.9	26.3	72.0	16.4
Shoulder	18.4	9.5	75.0	30.7	93.4	21.2
Other upper extremity	2.9	1.5	13.4	5.4	16.3	3.6
Illness	2.3	1.1	2.6	1.1	4.9	1.1
Miscellaneous	0.3	0.1	1.1	0.5	1.4	0.3
Total	196.4	100.0	242.7	100.0	439.1	100.0

DISCUSSION

Surprisingly, few published articles are available that pertain to the epidemiology of MLB injuries. Conte et al[3] previously examined the injury experience in MLB based on data presented by American Specialty Companies from 1989 through 1999. Their work showed that the number of players and player days on the disabled list increased, despite improvements in training, conditioning, diagnostic methods, and surgical treatments. They showed that team membership, injury location, and position did not appear to be related to the increase. Further, the increase in injuries was not believed to be a result of more sensitive diagnostic testing. While our data were not compiled by disability days, the absolute number of players placed on the disability list in each year of our study was larger than any year in the Conte study. This corroborates the conclusion that MLB injuries are increasing over time. We also noted an increase in injuries after the 2005 season. The cause for this in unclear, but may be influenced by the change to a stricter drug surveillance policy before the 2006 season.

McFarland and Wasik[5] studied the epidemiology of collegiate baseball injuries over the course of 3 seasons. They found that 58% of the injuries were to the upper extremity, 15% to the trunk/back, and 27% to the lower extremity. Our data are quite similar, with 51% upper extremity, 12% trunk/back, and 31% lower extremity. They further reported that upper extremity injuries accounted for 75% of the total time lost from the sport and concluded that more study of upper extremity injuries is warranted. In the present study, upper extremity injuries accounted for significantly more days on the disabled list for both pitchers and fielders than lower extremity injuries or injuries to the trunk/back. The NCAA Injury Surveillance System was analyzed by Dick et al[4] over 16 seasons from 1988 through 2004. Again, their percentage of injuries by body part incurred in games/practice were quite similar to our data, with 44.6%/46.4% for upper extremity, 35.2%/31.7% for lower extremity, and 8.3%/11.5% for core and spine. They also found that 25% of all injuries caused greater than 10 days of lost sport time. In our cohort, the mean number of days on the disabled list was 56.5, with only 6 injuries resulting in fewer than 10 days on the disabled list.

We observed the highest incidence rate for injuries in the first month of the season and rates declined significantly as the season progressed. Among NCAA baseball players, Dick et al[4] noted that injuries incurred during practice were greatest during the preseason, which they attributed to deconditioning and overload. Similar mechanisms of overuse and deconditioning may be associated with professional baseball injuries, although preseason training time is not accounted for in the disability data. Chambless et al[1] studied injury rates by level of play in the minor leagues. They studied the incidence and severity of orthopaedic injuries from 1985 through 1997 for 6 minor league teams. Significantly greater injury rates were found at the rookie levels than at the higher minor league levels. After injury, higher level athletes lost no more than 3 days of sport time, while rookies were more likely to lose up to 20 days of sport time. The authors attributed these results to inexperienced athletes attempting to participate in a higher level of competition without adequate conditioning and time for adaptive changes. This study again confirms the importance of proper conditioning and training in order to prevent early season injuries.

Our study has several limitations. First, the source of data did not come from an official MLB source. We extracted disabled list injury data from a publicly available Web site for professional baseball and cross-referenced a random sampling of injuries to assess the accuracy of the data with MLB sources. Another weakness of this study stems from our use of the disabled list as our source of injury data. An untold number of injuries occur in MLB

that were not captured in our database simply because the severity of injury was not sufficient to require the baseball player to be placed on the disabled list. Players with minor injuries can miss up to 2 weeks of the season without being placed on the disabled list. As a result, we still know little about the effect and burden of less severe injuries among MLB players. In addition, the multiple roster moves throughout the season and the infusion of minor league players onto active MLB rosters were variables that we were not able to control for in our analysis. We also could not control for the accurate timing of "return to play," as disabled list rules mandate 15-day designations even for minor injuries. Therefore, the true epidemiology of injuries in professional baseball is likely underestimated in our study. Further, we utilized a crude estimate of athlete-exposure to calculate incidence rates, assuming that all players on the roster were exposed to injury each game during the season. As a result, the incidence rates for injury are likely underestimated, particularly for pitchers. We elected not to include preseason exhibition games in our injury and exposure calculations, while clearly these injuries may result in regular season disabled list designation. In order to best control for this, we excluded players placed on the disabled list before and including the first day of the season; however, it is possible that some prevalent cases were included in our data that may have contributed in part to the higher observed incidence rate in April. Finally, players who are injured during the month of September may not be placed on the disabled list because of MLB rules permitting teams to expand their rosters to include 40 players. This may in part explain the much lower injury rate observed during the last month of the regular season in the present study. Future studies should attempt to prospectively document injuries and person-time at risk (athlete-exposures) among MLB players as precisely as possible (eg, games or innings played) so that more precise estimates of injury incidence can be established in this population. Despite the limitations noted above, the present study is one of the first to examine incidence rates and injury patterns among MLB players and these data may provide baseline estimates of the burden of injury in this population as the league works to implement a systematic injury surveillance system.

In conclusion, in the evaluation of MLB injuries resulting in time on the disabled list, there were a number of noteworthy findings. First, upper extremity injuries are predominant in pitchers while lower extremity injuries are more common in position players. Second, there has been a significant 37% increase in the incidence rate for injuries between 2005 and 2008 for all MLB players. Third, the highest injury rates were seen in the early months of the season and rates declined as the season progressed. The effectiveness of offseason and preseason training and in-season conditioning programs should be examined more closely based on these findings so that evidence-based injury prevention initiatives can be implemented in this population.

REFERENCES

1. Chambless KM, Knudtson J, Eck JC, Covington LA. Rate of injury in minor league baseball by level of play. *Am J Orthop*. 2000;29(11):869-872.
2. Collins CL, Comstock RD. Epidemiologic features of high school baseball injuries in the United States, 2005-2007. *Pediatrics*. 2008;121:1181-1187.
3. Conte S, Requa RK, Garrick JG. Disability days in Major League Baseball. *Am J Sports Med*. 2001;29:431-436.
4. Dick R, Sauers EL, Agel J, et al. Descriptive epidemiology of collegiate men's baseball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train*. 2007;42(2):183-193.
5. McFarland EG, Wasik M. Epidemiology of collegiate baseball injuries. *Clin J Sport Med*. 1998;8(1):10-13.
6. MLB Miscellany: Rules, regulations and statistics. http://mlb.mlb.com/mlb/official_info/about_mlb/rules_regulations.jsp. Accessed March 18, 2011.
7. Owner's Edge MLB – MLB Disabled List Injuries. http://ownersedge.fanball.com/mlb/dl_injuries.php. Accessed May 2009.