

Epidemiology and Impact of Prior Musculoskeletal Injury and Orthopaedic Surgery on Draft Rank, Availability, and Short-term Performance in Major League Baseball

A Summary Analysis and Matched Cohort of 1890 Predraft Players

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Background: Despite the many reports of injury rates in Major League Baseball (MLB), little is known about the epidemiology or impact of prior musculoskeletal injuries and surgical procedures among players entering the MLB draft.

Purpose: To determine the (1) epidemiology of all musculoskeletal injuries and surgical procedures among players entering the MLB draft, (2) impact of injury or surgery on draft rank, (3) impact of injury or surgery on availability within the first 2 years of play in the MLB, and (4) impact of injury or surgery on performance.

Study Design: Cohort study; Level of evidence, 3.

Methods: We retrospectively reviewed 1890 medical records that were completed by MLB team physicians as preparticipation physical assessment prior to the draft from 2014 to 2018. Players were divided into 3 groups: noninjured, nonoperative, and operative. Draft status, overall draft rank, missed games, batting average, and earned run average for the first 2 seasons of MLB play were obtained for all available players. Players across all 3 groups were compared with linear, logistic, and beta regression models, controlling for age, position, injury status, and draft rank. Unadjusted differences among groups were assessed with 1-way analysis of variance.

Results: Overall, 750 position players and 1140 pitchers were included, of whom 22.8% had no reported injury history; 48.8% reported injury treated nonoperatively; and 28.5% were treated operatively. The most common predraft injuries were elbow tendinitis ($n = 312$), ulnar collateral ligament injury ($n = 212$), and shoulder labral tear ($n = 76$). The most common predraft treatments were physical therapy ($n = 922$), ulnar collateral ligament reconstruction ($n = 115$), and fracture fixation ($n = 69$). Of the 1890 players, 719 were drafted and played for at least 2 years. No difference was found among noninjured, nonoperative, and operative groups in terms of draft rank, games missed, or performance. Players with a nonoperative injury had a decreased odds ratio of being drafted (0.738; $P = .017$).

Conclusion: More than half of the players entering the MLB reported a history of musculoskeletal injury requiring treatment, and the most commonly affected joints were the shoulder and elbow. Musculoskeletal history did not affect draft rank, short-term availability, or performance for MLB prospects.

Keywords: baseball; Major League Baseball; injury rate; epidemiology

musculoskeletal injuries is unknown, particularly with respect to the long-term impact of these preprofessional injuries on the athlete's career, from availability to performance.^{15,18,20} In the National Football League (NFL), the impact of predraft injuries and surgical procedures, including anterior cruciate ligament reconstruction, rotator cuff tears, and shoulder labral tears, has been reported extensively from the medical records of the treating physicians; the findings portend unfavorable career prognoses for those with a musculoskeletal injury history, including a lower likelihood of a successful draft and a greater likelihood of decreased performance.^{1,2,9,13,17}

In baseball, where increased research into pitching biomechanics, quantitative performance analytics, and pitch counts highlights the growing concern for injury awareness and proclivity, there exists little evidence on the epidemiology and effects of predraft injuries in MLB.^{8,20} In a recent comprehensive review of major and minor league baseball injury epidemiology, Camp et al³ described the limitations of unofficial, publicly available data as follows: low fidelity with absent medical specialist oversight, low granularity of diagnoses and pathoanatomy, and misinterpretation commonly attributed to the reliance on roster management tools such as the disabled list (DL).

Numerous epidemiology reports have been published regarding injuries in MLB, from the medial ulnar collateral ligament (UCL) to concussions.^{4-7,10,14} Although several studies have described the epidemiology and impact of injuries among MLB players from the moment they are drafted,^{4,10,12} no study has taken into account the musculoskeletal history of these athletes prior to the draft. The combination of increased standardization in athlete evaluation and data centralization with electronic medical records offers the ability to build a prospective database of preprofessional injuries to evaluate the significance of prior musculoskeletal injury on future MLB careers.

To date, only the impact of UCL reconstruction and shoulder surgery prior to the MLB draft has been investigated, but a macroscopic understanding of the epidemiology and effect on draft rank, availability, and short-term performance remains elusive for all injuries.^{3,5,19} The purpose of this study was to determine the (1) epidemiology of all musculoskeletal injuries and surgical procedures among players entering the MLB draft, (2) impact of injury or surgery on draft rank,

(3) impact of injury or surgery on availability within the first 2 years of play in the MLB, and (4) impact of injury or surgery on performance. We hypothesized that shoulder and elbow injuries will make up the majority of musculoskeletal injuries in this population and that those who have had prior orthopaedic surgery are likely to be less available or have decreased performance in the MLB.

METHODS

We reviewed the prospectively collected medical records from 2014 to 2018 of all MLB players evaluated for the MLB draft during that period. Team physicians of the Cleveland Indians franchise conducted all histories and physical examinations of players eligible to declare for the MLB draft under league mandate. All player data from all draft-eligible players were stored on a single password-protected computer at the Cleveland Indians franchise facility and are not publicly available. Each player was assigned to 1 of the following 3 cohorts: noninjured (no history of musculoskeletal injury), nonoperative (previous musculoskeletal injury successfully treated nonoperatively), and operative (previous musculoskeletal injury necessitating operative treatment). Player-specific statistics, including draft rank, availability, and performance, were obtained from the official MLB database (<http://mlb.mlb.com/stats/>).

Draft Ranking

For this analysis, 1890 athletes were available to assess the importance of age, position (pitcher vs position player), and injury status (noninjured vs nonoperative vs operative) on the odds of being drafted per a multivariable logistic regression model. In a subsequent analysis, all 1258 drafted players were assessed for overall draft rank via a multivariable linear regression model, with age, position, and injury status as covariates. Unadjusted differences in overall draft rank position were calculated with a 1-way analysis of variance (ANOVA).

Availability

Availability for position players was defined with an "availability index" by calculating the mean of each player's rank of total games played plus total at bats, normalized to

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the 50th percentile across all players. This metric was used to determine the durability of the players, or how physically “available” the player would be to his franchise. For pitchers, “availability” was defined as the mean of each player’s rank of appearances and innings pitched, normalized to the 50th percentile across all players. The availability metric was used as a surrogate to quantify how often players were available for play to the franchise; it was preferred over number of games played to account for the possibility that a manager may decide not to use a player despite the player being healthy. Availability accounted for all time away from the field, including DL, surgery, and career discontinuation. For the availability analysis, we included all players from the study period for whom availability and draft rank statistics were calculated ($n = 719$). A beta regression model was constructed with availability as the dependent variable and with age, position, injury status, and overall draft rank as covariates. Two additional linear regression analyses were performed for availability, where at bats for position players and innings pitched for pitchers were compared among players, with age, overall draft rank, and injury status as covariates.

Performance

Performance metrics included batting average for position players and earned run average (ERA) for pitchers, averaged over the first 2 seasons of MLB play. The performance analysis was completed in a similar fashion to the availability analysis, where all 719 players were included for whom performance and draft rank statistics were calculated. A beta regression model with dependent variable adjustment was built, with performance as the dependent variable and with age, position, injury status, and overall draft rank as covariates. Two additional regression analyses were performed for performance: a linear regression for pitcher ERAs and a logistic regression for batting averages of position players.

Statistical Analysis

Statistical analysis was performed with R (v 3.7.0; The R Foundation). Differences among the noninjured, nonoperative, and operative groups were analyzed for age, position, and draft round with 1-way ANOVA to assess for confounding variables. Significance was defined as a P value of $\leq .05$.

RESULTS

Epidemiology

The cohort of 1890 players included 750 position players and 1140 pitchers. Of these athletes, 430 (22.8%) had no documented injury history, 922 (48.8%) had nonoperative treatment of a musculoskeletal injury, and 538 (28.5%) had received operative treatment (Table 1). A total of 719 players (289 position players and 430 pitchers) had 2 years of follow-up data for the performance analysis, with 177

TABLE 1
Player Positions by Noninjured, Nonoperative,
and Operative Groups^a

Position	Total	Noninjured	Nonoperative	Operative
Pitcher	1140	253	562	325
Outfielder	313	74	145	94
Catcher	137	29	70	38
Shortstop	82	23	40	19
1st baseman	58	12	31	15
2nd baseman	84	18	41	25
3rd baseman	58	15	25	18
Utility ^b	1	1	0	0
Infielder	17	5	8	4
Total	1890	430	922	538

^aData are reported as counts.

^bA designated utility player may play any given position in the game.

(24.6%) having no injuries, 333 (46.3%) with nonoperative treatment, and 209 (29.1%) with operative treatment. The mean ages among cohorts with follow-up data were significantly different at 20.2 years, 20.1 years, and 20.9 years for noninjured, nonoperative, and operative, respectively; the operative group was 8 months older ($P < .0001$). ANOVA for remaining confounders revealed no difference for the noninjured and nonoperative groups with respect to the operative group in terms of overall draft rank, ERA (for pitchers only), and batting average (for position players) (Table 2).

The most common predraft injuries included elbow tendinitis ($n = 312$), UCL sprain ($n = 134$), UCL tear ($n = 78$), shoulder labral tear ($n = 76$), and subacromial bursitis ($n = 74$) (Table 3). The most frequent nonoperative treatments included physical therapy ($n = 922$) and cellular therapy injections ($n = 50$). The most common surgical procedures included UCL reconstruction ($n = 115$), closed reduction and percutaneous pinning or open reduction and internal fixation ($n = 69$), knee arthroscopy ($n = 25$), and shoulder arthroscopy with labral repair ($n = 16$) (Figure 1). Patients who underwent postoperative physical therapy are not represented.

Draft Rank

The only significant predictor increasing the odds ratio (OR) of being drafted was age (OR = 1.175, $P < .0001$), whereas nonoperative injury status was associated with a decreased log OR of being drafted (OR = 0.738, $P = .017$). For drafted players between 2014 and 2018 inclusive, age was associated with an earlier draft rank ($\beta = -23.152$, $P = .0002$), and pitcher position was associated with a later draft rank ($\beta = 38.213$, $P = .044$) (Table 4).

Availability

Significant predictors of increased availability included age ($\beta = 0.072$, $P = .025$) and pitcher position ($\beta = 1.146$, $P < .0001$). Overall draft rank was associated with a

TABLE 2
Unadjusted Player and Injury Epidemiology, Draft Rank, and Performance^a

	Total (N = 719)	Noninjured (n = 177, 24.6%)	Injured		P Value ^b
			Nonoperative (n = 333, 46.3%)	Operative (n = 209, 29.1%)	
Age, y	20.4 ± 1.5	20.2 ± 1.52	20.1 ± 1.5	20.9 ± 1.2	<.0001
Overall draft rank	340 ± 285	354 ± 302	329 ± 283	345 ± 274	.612
ERA (pitchers)	4.20 ± 2.64	4.40 ± 1.5	4.02 ± 1.9	4.35 ± 3.83	.734
Batting average (position players)	0.259 ± 0.043	0.256 ± 0.030	0.256 ± 0.034	0.270 ± 0.061	.133

^aFor players drafted between 2014 and 2016 and for whom ERA (for pitchers) and batting average (for position players) were available. Data are reported as mean ± SD. ERA, earned run average.

^bOne-way analysis of variance.

TABLE 3
Predraft Musculoskeletal Diagnoses Requiring Treatment^a

Injury	n (%)
Elbow tendinitis	312 (20.4)
UCL tear/sprain	212 (13.9)
Shoulder labral tear	76 (5.0)
Subacromial bursitis	74 (4.8)
Elbow fracture	63 (4.1)
Metacarpal fracture	51 (3.3)
Ankle sprain	92 (6.0)
ACL tear	43 (2.8)
Spondylolysis	61 (4.0)
Wrist fracture	42 (2.7)
Metatarsal fracture	40 (2.6)
Phalanx fracture	39 (2.6)
Meniscal tear	38 (2.5)
Foot fracture	31 (2.0)
Hamate fracture	31 (2.0)
Knee contusion	28 (1.8)
Ulnar neuritis	28 (1.8)
Ankle fracture	26 (1.7)
Hamstring strain	26 (1.7)
Lower back strain	24 (1.6)
Shoulder instability	23 (1.5)
Rotator cuff tendinitis	22 (1.4)
GIRD	18 (1.2)
Thumb sprain	17 (1.1)
Clavicle fracture	16 (1.0)
Spondylolisthesis	16 (1.0)
Facial fracture	13 (0.9)
Scaphoid fracture	11 (0.7)
AC joint sprain	10 (0.7)
Other injuries	46 (3.0)
Total	1529 (100)

^aAC, acromioclavicular; ACL, anterior cruciate ligament; GIRD, glenohumeral internal rotation deficit; UCL, ulnar collateral ligament.

decrease in availability ($\beta = -0.0004, P = .014$). There was no significant difference between athletes with no injury and those with nonoperative or operative injury treatment (Table 5). When separate linear regression models were built just for pitchers based on age, overall draft rank, and injury status, age ($\beta = 4.14, P < .0001$) and overall draft

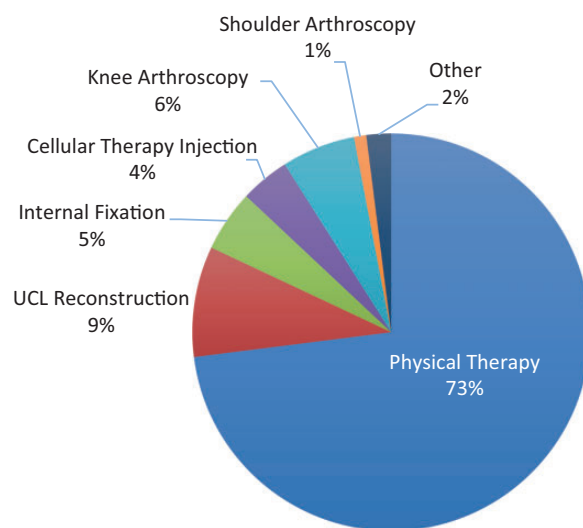


Figure 1. The most common musculoskeletal interventions and surgical procedures among pre-draft Major League Baseball players. UCL, ulnar collateral ligament.

rank ($\beta = -0.028, P < .0001$) were significant predictors of decreased availability. The separate linear regression modeling at bats for position players reported that age ($\beta = 23.1, P < .0001$) and overall draft rank ($\beta = -0.112, P < .0001$) were significant predictors of decreased availability.

Performance

The only significant predictor of increased performance was pitcher position ($\beta = 1.049, P < .0001$). There was no significant difference in performance index among the 3 injury groups (Table 5). The pitcher-only linear regression had overall draft rank as a significant predictor of increased ERA ($\beta = 0.002, P = .016$). There were no significant predictors in the batting average logistic regression for position players. There was no significant between-group difference in ERA or batting average for pitchers and position players, respectively (Table 2).

TABLE 4
Results of Drafted Logistic Regression
and Overall Draft Rank Linear Regression^a

	Dependent Variable	
	Drafted (Yes/No): Logistic	Overall Draft Rank: Linear
Age	0.161 (0.032)	-23.152 (6.116)
P value	<.0001	.0002
Pitcher (vs position player)	-0.024 (0.101)	38.213 (18.881)
P value	.813	.044
Nonoperative (vs noninjury)	-0.304 (0.127)	23.895 (23.042)
P value	.017	.300
Operative (vs noninjury)	-0.250 (0.143)	30.430 (25.666)
P value	.081	.236
Intercept	-2.307 (0.637)	818.869 (123.696)
P value	.0003	<.0001
Observations, n	1890	1258

^aValues are reported as estimate (standard error).

TABLE 5
Beta Regression Results for Availability
and Performance Ranks^a

	Dependent Variable	
	Availability	Performance
Age	0.072 (0.032)	-0.022 (0.032)
P value	.025	.494
Overall draft rank	-0.0004 (0.0002)	-0.0002 (0.0002)
P value	.014	.330
Pitcher (vs position player)	1.146 (0.098)	1.049 (0.098)
P value	<.0001	<.0001
Nonoperative (vs noninjury)	-0.207 (0.113)	-0.124 (0.114)
P value	.068	.279
Operative (vs noninjury)	-0.152 (0.126)	-0.001 (0.127)
P value	.231	.997
Intercept	-1.802 (0.654)	-0.051 (0.658)
P value	.006	.939
Observations, n	719	719

^aValues are reported as estimate (standard error).

DISCUSSION

Although the injury patterns of MLB athletes have been described previously, there is little understanding of the impact of injuries sustained by athletes before entering the MLB draft.^{1,4,16,19,21} Knowledge of these data may help improve decision making by medical, coaching, and franchise personnel prior to drafting these athletes. This study assessed all predraft MLB prospects and compared those who were noninjured (22.8%), had nonoperatively treated musculoskeletal injuries (48.8%), and had operatively treated musculoskeletal injuries (28.5%) over a 5-year period. The most common predraft injuries were elbow tendinitis (n = 312), UCL injury (n = 212), and shoulder labral tear (n = 76), while the most common predraft treatments were

physical therapy (922, 48.8%), UCL reconstruction (115, 6.1%), and fracture fixation (69, 3.7%). From a macroscopic perspective, no difference was found among noninjured, nonoperative, and operative groups in terms of overall draft rank, availability, and performance. However, players with nonoperative injuries did have a lower OR (0.738) of being drafted. A similar but nonsignificant effect was also seen for the operative group, suggesting that managers may be hesitant to select players with injuries. If athletes are drafted, their previous injury does not appear to be significant in determining overall draft rank.

This study demonstrated that the most common predraft injuries among MLB athletes included shoulder and elbow injuries; physical therapy was the most common nonoperative intervention; and UCL reconstruction was the most common surgical procedure. The lack of difference in draft rank, availability, or performance among the noninjured, nonoperative, and operative groups demonstrates that for any eligible player participating in the MLB draft, there is no increased proclivity for injury causing differences in draft round, availability, or performance. Although the ERA was 4.35 for the injured operative group as compared with 4.02 for the injured nonoperative group, this was statistically nonsignificant given the wide standard deviation range of the operative group. Similarly, the 8-month age difference for the operative group versus the other 2 groups was statistically significant, although unlikely to be clinically significant.

These results reinforce the notion that professional organizations remain willing to draft athletes with a history of shoulder and elbow injuries, among other previous injuries. This is consistent with a recent report by MLB team physicians who perform medical screening of potential draftees, who indicated that they are less concerned with a previous UCL reconstruction, among other previous surgical procedures.¹⁰ In a study of 38 pitchers with a history of UCL repair, Wymore et al²² reported no difference in professional achievement or performance, although there was an increased rate of placement on the DL, which provides limited insight as this is primarily a roster management tool. Camp et al³ demonstrated an increased rate of progression to higher levels of play among 252 players with a history of UCL reconstruction as compared with healthy controls. Similarly, Chauhan et al⁵ demonstrated that MLB athletes with a history of shoulder surgery were more likely to be placed on the DL but had no difference in career advancement or performance, although pitchers with a history of shoulder surgery threw for fewer innings per game. Overall, these studies did not demonstrate any impact of prior surgical intervention on MLB draft rank or performance, supporting our findings that eligible players carrying a musculoskeletal injury history, regardless of treatment group, are not treated any differently at the time of the draft and have no readily perceivable differences in the first 2 years. This is in sharp contrast to athletes in the NFL, where a study of 2203 athletes at the NFL Scouting Combine demonstrated a significant reduction in performance following injury, particularly for defensive players.¹⁸

This study is not without limitations. Our analysis found no difference in draft rank or performance after adjusting for injury status. Yet, additional factors, such as injury

timing, severity, and baseline performance status, may represent intervening variables in the relationship between prior injury and career trajectory. Additionally, the metric of draft rank may rely on a variety of injury-independent factors, including team needs, athlete's preinjury performance, and fit. Despite these limitations, draft rank incorporates many player-specific factors and provides data that are comparable over time. It is important to note that not all injuries are created equal, and while the results on the macroscopic perspective demonstrated no difference among predraft players, evaluating players on a case-by-case basis is critical to establish if a player may experience differences in terms of draft rank or future performance. Similarly, our sample size of 719 players for the performance analysis may have been too small to detect a difference. Athletes may have sustained prior injuries that were not reported in their predraft medical records, although these unreported injuries may have occurred at an equal rate in each cohort. Analyses of these players lacked longer-term perspective on performance with advanced analytics, including wins above replacement, beyond 2 seasons. While the risk of selection bias is low because players who are severely injured are not eligible for the MLB draft that year without a team physical examination, it is possible that these players may have scheduled private physical examinations on a different date and not made the database.

A majority of athletes entering the MLB draft have a history of musculoskeletal injury requiring intervention, frequently involving the shoulder and elbow. When selecting a specialist surgeon to care for a franchise, the MLB may seek expertise in a specialist with a niche in shoulder and elbow. This study found no significant difference in draft rank, availability, or performance among noninjured, nonoperative, and operative cohorts, which suggests that franchises and coaching personnel may benefit from selecting and investing in these players' careers without heavily weighing prior musculoskeletal injury as a metric for future injury proclivity. Further study with longer-term availability and performance follow-up is warranted, however. Analysis of specific injuries with the HITS database in conjunction with this reported predraft MLB injury database has the opportunity to provide complete context of the athletes' careers and injury trajectories, including recurrence rate.

CONCLUSION

More than half of the players entering the MLB reported a musculoskeletal injury requiring treatment, and the most common affected joints were the shoulder and elbow. After position matching and analyzing for confounding factors such as age and draft round, musculoskeletal history did not affect draft rank, short-term availability, or performance for MLB prospects.

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