Home Run Derby Participation in Major League Baseball Players

Is There Associated Injury Risk and Impact on Second-Half Performance?

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Background: The Major League Baseball (MLB) All-Star Game (ASG) Home Run Derby (HRD) remains a highly anticipated event, during which contestants can take hundreds of maximum-effort swings en route to hitting a multitude of home runs. Critics have openly questioned the risk-benefit of HRD participation as it pertains to injury, alterations in swing mechanics, and timing.

Purpose: To determine whether participation in the MLB ASG HRD was associated with both increased injury risk and decline in second-half performance in MLB players.

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

Methods: MLB players who participated in the HRD between 2006 and 2019 were identified through publicly available internet databases. A control group of ASG participants who had the highest home run totals in the first half of the corresponding MLB season were selected as a control group. Multivariable linear regression was used to determine independent associations between HRD participation and batting metrics in the second half of the season. Multivariable logistic regression also assessed the impact of HRD participation on injured list placement during the second half of the concurrent MLB season.

Results: A total of 114 HRD participants and 114 ASG participant controls competed during the study period. No statistically significant differences were seen in batting metrics in the second half of the MLB season between HRD participants and ASG controls, although HRD participants had a significantly lower wins-above-replacement statistic for the season compared with controls (4.69 ± 2.06 vs 5.33 ± 2.08; $P = .021$). HRD participation was not significantly associated with injury during the second half. The number of HRD rounds in which a player participated did not result in a statistically significant increased odds of injury during the second half of the MLB season.

Conclusion: HRD participants did not have increased odds of being placed on the injured list during the second half of the MLB season compared with controls, nor did they experience second-half performance declines in offensive production versus controls when multivariable linear regression analysis was performed.

Keywords: Major League Baseball; injury; athletic performance; position players

The Major League Baseball (MLB) Home Run Derby (HRD) has been a midsummer staple during the All-Star break since 1985. Although the format has changed numerous times, 8 players (4 from the American League and 4 from the National League) compete in a home run challenge, with the winner of each head-to-head matchup advancing until a final winner is determined. In its current version, rounds are 4 minutes in length, with bonus time of 30 seconds granted if a participant hits 2 home runs that travel >440 feet. In the event of a tie during head-to-head rounds, a 1-minute tiebreaker round is implemented. If still tied, a "swing-off" of 3 swings per batter is used. Batters are allowed 1 time-out during each round and 2 time-outs in the finals.[15]

Players can take >100 maximum-effort swings during the HRD. In 2019, third baseman Vladimir Guerrero Jr hit 91 home runs during the competition, taking 197 swings (quarterfinal, semifinal, final rounds, three 30-second bonus rounds, 1 tiebreaker round, and 2 swing-off rounds). Although MLB position players routinely take hundreds of swings a day, not all of these are typically maximum effort swings. Despite these players having repeatedly downplayed the injury risk of HRD participation,[8] critics including sportswriters, bloggers, and team officials have openly

The Orthopaedic Journal of Sports Medicine, 9(2), 2325967120983350
DOI: 10.1177/2325967120983350

questioned the risk-benefit of partaking in the HRD as it pertains to injury and swing mechanics.[22] Outfielder Aaron Judge alluded that participation in the 2017 HRD contributed to a left shoulder injury that resulted in a decline in second-half performance and subsequent off-season surgery.[1,12,36]

Statisticians employed by MLB have postulated whether an HRD "curse" exists—that is, a decline in offensive performance during the second half of the season.[16,17,26,34] They argue that (1) players selected for the HRD overperform their "true" talent level during the first half of the season and (2) a regression to the mean occurs in the second half of the season rather than a performance decline caused by HRD participation.

However, most of these analyses used control groups of players whose statistics were historically similar to the HRD participants but who did not compete in the HRD, pair matching them with the HRD participants, a common statistical practice in cohort studies.[7,29] Baseball statistical sites such as www.baseball-reference.com provide "similarity scores" to identify pair-matched controls.[28] Using this approach introduces significant selection bias. Additionally, pair-matched controls identified by this means can include players who played in different eras or different seasons but had comparable performance statistics. A preferable control group—All-Star Game (ASG) participants from the same season with similar home run production in the first half of the season compared with HRD participants—has not been used by lay statisticians or published in a scientific study assessing the effect of HRD participation on performance or injury risk. Additionally, by using a group of players from the same season as a control, we can more accurately compare player statistics, specifically via the wins-above-replacement (WAR) metric. WAR is an advanced player statistic calculated with multiple fielding, hitting, and baserunning performance statistics that provides a player's overall performance value compared with a theoretical replacement level player.

The purpose of this study was to determine whether participation in the MLB ASG HRD was associated with both increased injury risk and second-half performance decline in MLB players. We hypothesized that HRD participants would have significantly higher rates of injured list (IL) placement in the second half of the MLB season compared with controls, significant second-half performance declines in offensive production compared with controls, and lower WAR compared with controls in a given season.

METHODS

Player Inclusion

HRD participants and control players from the 2006 to 2019 MLB seasons were identified, and data were collected through publicly available, internet-based databases, which included player profiles, biographies, performance data, injury reports and transactions, and press releases.[15,19,23,27] This method of data collection has been used successfully in multiple prior studies involving professional baseball players.[8,10,13,18,20] The 2006-2019 time period was chosen for several reasons: (1) professional baseball roster data have become robust and accurate since 2005,[5] (2) the HRD format underwent a change in 2006 from a format that had been in place from 1991 to 2005,[15] and (3) the 2006-2019 time period excluded the "steroid era" in MLB (1993-2002), a time durring which drug testing for performance-enhancing drugs was not routinely performed and home run totals could therefore have been artificially inflated.[9]

Control Group

We selected a control group of ASG participants who had the highest home run totals in the first half of the corresponding MLB season but did not participate in the HRD. Rather than using pair-matched controls selected by "similarity score," we chose this pool of players as controls for the following reasons: (1) ASG participants did not have the All-Star break off to rest and/or rehabilitate minor or overuse injuries, so their MLB season participation was most similar to HRD participants, with the exception of the intervention (HRD participation); (2) nearly half (54/114; 47.4%) of ASG participants selected as controls during 2006-2019 had participated in prior HRDs but declined the current year invitation, indicating these players had comparable qualifications for HRD participation; and (3) choosing ASG participants rather than "similarity score" matches eliminated confounders generated when including players from different seasons and eras. ASG participants who had home run totals in the top 8 for the first half of each season (excluding HRD participants) were selected as controls. In the case of a tie for home run (HR) output, the highest slugging percentage (SLG) was used as a tiebreaker.

A total of 114 HRD participants and 114 ASG participant controls were selected for study inclusion. This sample size

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Final revision submitted October 8, 2020; accepted January 9, 2021.
One or more of the authors has declared the following potential conflict of interest or source of funding: S.F.D. has received hospitality payments from Medical Devices Business Services and Zimmer Biomet. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.
Ethical approval for this study was not sought for the present study.

provides 80% statistical power for detecting a moderate standardized effect size of 0.4 comparing hitting metric outcomes between the 2 groups, based on the Student *t* test and assuming a 2-tailed 5% alpha level. Power calculations were performed using nQuery Advisor (Version 8.5; Statistical Solutions).

Demographic data (team, age, position, and batting handedness), offensive performance statistics (SLG, HR, batting average, on-base percentage [OBP], and on-base plus slugging [OPS]), WAR, and injury data (day-to-day injuries, IL placement) were obtained from websites reporting comprehensive information on players, including transactional histories. As previously defined, WAR is an advanced player statistic calculated with multiple fielding, hitting, and baserunning performance statistics that provides a player's overall performance value compared with a theoretical replacement level player. For example, a WAR of 3.0 means that over the course of the season, the player contributed 3 wins more than a replacement level player would have.

Statistical Analysis

Continuous data were presented as means and standard deviations, and categorical data were presented as frequencies and percentages within groups. Univariate comparisons between HRD participants and ASG controls on normally distributed continuous metrics (plate appearances, batting average, OBP, SLG, OPS, HR, base on balls [ie, walks], strikeouts, WAR) were performed using Student *t* tests to assess for significant differences between HRD participants and controls. For categorical variables (ie, IL in the second half of the season), the Fisher exact test was implemented to assess for significant differences between matched groups. Multivariable linear regression was implemented to determine the independent associations between a set of predictors (including HRD participation) and continuous hitting metric outcomes in the second half of the season. Results from multivariable linear regression models are presented as adjusted coefficients with corresponding 95% CIs and *P* values. Multivariable logistic regression was used to assess the impact of a set of predictors (including HRD participation) on IL placement during the second half of the concurrent MLB season, with results presented as adjusted odds ratios with 95% CIs and *P* values. Data analysis was performed using SPSS Version 25 (IBM) and Stata Version 16.0 (StataCorp). Statistical significance was defined by a 2-sided $P < .05$.

RESULTS

The demographic characteristics of the study sample are presented in Table 1. Participant age, number of plate appearances during the ASG, and batting handedness were similar between the HRD and ASG groups. For the HRD participants, 28 (24.6%) competed in 3 or more rounds, 30 (26.3%) competed in 2 rounds, and 56 (49.1%) competed in only 1 round (head-to-head rounds were included; tie-breaker and swing-off rounds were excluded). (Note that in 2014, there were 4 head-to-head rounds instead of 3 because there were 10 participants.) The mean number of total home runs hit by each participant during competition was 16.6 ± 15.6 (range, 0-91; median, 13; interquartile range, 21.75).

TABLE 1
Demographic Characteristics of ASG Controls and HRD Participants[a]

	ASG Controls (n = 114)	HRD Participants (n = 114)
Age, y	28.9 ± 3.9	27.4 ± 3.4
ASG plate appearances	2 ± 0.9	2 ± 1
Position		
Catcher	3	2
Designated hitter	11	4
Infielder	51	64
Outfielder	49	44
Batting handedness		
Right	67	68
Left	36	40
Switch	11	6

[a]Data are presented as mean ± SD or frequency. Position is the primary position the participant played during the majority of games in the regular season. There were 8 participants and corresponding controls from 2006 to 2019, except 2014 where there were 10. ASG, All-Star Game; HRD, Home Run Derby.

Univariate comparisons of hitting metrics between the HRD and ASG groups at the end of the first and second halves of the MLB season are presented in Table 2. Of note, the control group consisted of only 113 players for the second half of the season, because 1 player sustained a season-ending concussion.

Both HRD participants and ASG controls had a decrease in performance in the second half of the season compared with the first; however, during the second half, HRD participants had significantly worse SLG, worse OPS, and more strikeouts than ASG controls (Figure 1). Additionally, HRD participants had a statistically significant lower WAR for the season compared with ASG controls (4.69 ± 2.06 vs 5.33 ± 2.08; $P = .021$).

Multivariable linear regression models were generated for each hitting metric outcome in the second half of the season. Each model was adjusted for player age, ASG year, and the corresponding hitting metric in the first half of the season, as shown in Table 3.

Multivariate analysis indicated there were no statistically significant differences in hitting metrics in the second half of the MLB season between HRD participants and ASG controls. Changes in hitting metrics in the second half of the season for the HRD participants versus ASG controls are demonstrated in Figure 2.

Multivariable logistic regression analysis for the odds of injury in the second half of the MLB season was additionally performed (Table 4). HRD participation was not significantly associated with injury during the second half (Figure 3).

TABLE 2
Performance Data of ASG Controls Compared With HRD Participants (2006-2019)[a]

	ASG Controls (n = 114)			HRD Participants (n = 114)			*P* Value		
Hitting Metric	1st Half of Season (n = 114)	2nd Half of Season (n = 113[b])	Mean Change (n = 113[b])	1st Half of Season (n = 114)	2nd Half of Season (n = 114)	Mean Change (n = 114)	1st Half	2nd Half	Change
HR	21.9 ± 3.8	12.5 ± 5.2	–9.5 ± 6.0	20.0 ± 5.0	12.5 ± 5.8	–7.5 ± 6.2	**.001**	.986	**.015**
PA	369.0 ± 33.4	256.1 ± 71.8	–113 ± 79.7	362.5 ± 44.9	270.9 ± 59.8	–91.6 ± 71.5	.218	.094	**.034**
BA	0.298 ± 0.028	0.285 ± 0.042	–0.013 ± 0.049	0.288 ± 0.044	0.275 ± 0.047	–0.013 ± 0.057	**.029**	.107	.927
OBP	0.385 ± 0.038	0.375 ± 0.048	–0.201 ± 0.055	0.382 ± 0.078	0.364 ± 0.046	–0.186 ± 0.068	.734	.072	.063
SLG	0.576 ± 0.051	0.521 ± 0.081	–0.056 ± 0.088	0.549 ± 0.061	0.495 ± 0.094	–0.055 ± 0.105	**<.001**	**.029**	.945
OPS	0.956 ± 0.093	0.895 ± 0.118	–0.060 ± 0.131	0.917 ± 0.101	0.859 ± 0.131	–0.059 ± 0.148	**.003**	**.031**	.942
BB	42.9 ± 14.3	30.0 ± 12.4	–12.9 ± 14.3	39.6 ± 13.6	30.2 ± 13.6	–9.4 ± 13.2	.071	.927	.059
SO	65.4 ± 21.4	47.9 ± 18.9	–17.5 ± 22.2	69.5 ± 20.6	53.9 ± 19.2	–15.5 ± 18.7	.147	**.018**	.460

[a]Data are presented as mean ± SD. Bolded *P* values indicate statistically significant differences between groups ($P < .05$). ASG, All-Star Game; BA, batting average; BB, base on balls (walks); HR, home run; HRD, Home Run Derby; OBP, on-base percentage; OPS, on-base percentage plus slugging percentage; PA, plate appearance; SLG, slugging percentage; SO, strikeout.
[b]Because 1 player sustained a season-ending concussion in July 2010, data were available for 113 ASG controls in the 2nd half of the season.

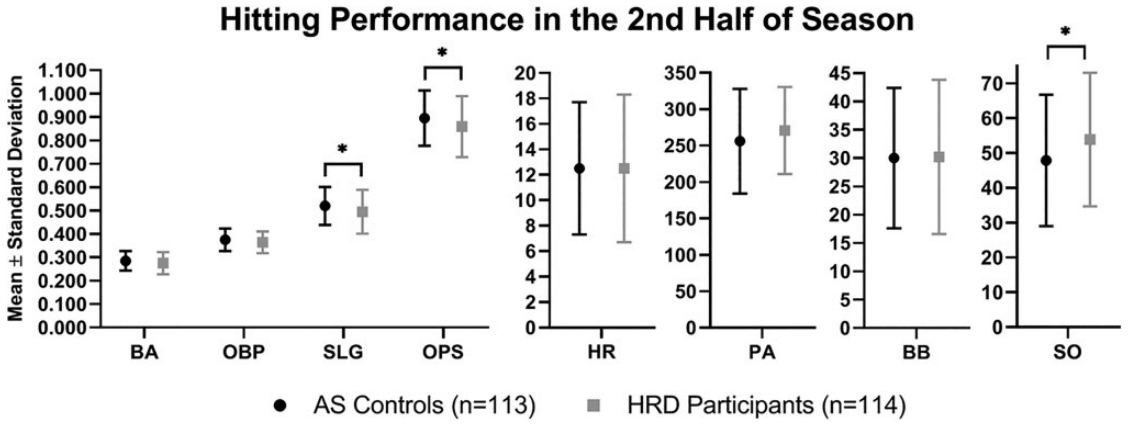

Figure 1. Hitting performance in the 2nd half of the season. AS, All-Star; BA, batting average; BB, base on balls (walks); HR, home run; HRD, Home Run Derby; OBP, on-base percentage; OPS, on-base plus slugging percentage; PA, plate appearance; SLG, slugging percentage; SO, strikeout. *Statistically significant difference between groups.

The number of rounds in which an HRD contestant participated did not result in a statistically significant increased odds of injury during the second half of the MLB season (Table 5).

DISCUSSION

The most important findings of our study were that HRD participants did not have increased odds of IL placement in the second half of the MLB season compared with controls, nor did the HRD participants experience second-half performance declines in offensive production versus controls when multivariable linear regression analysis was performed. HRD participants had a statistically significant lower WAR for the season compared with ASG controls, partially confirming our hypothesis, but the clinical significance of this result is questionable. To our knowledge, this study is the first to investigate the relationship between HRD participation, injury, and hitting performance in the second half of the regular MLB season.

Hitting-related injuries are prevalent in MLB but remain challenging to define, and it is difficult to prove causation related to specific exposures, including exhibitions such as the HRD. Success in the HRD often requires alterations to swing mechanics aimed at pulling the ball toward the corners rather than hitting straight-away to center field, which requires more power to generate longer distances. Additionally, to pull balls, players need to hit pitches out front of home plate more than on other pitch locations, which may cause timing problems in a player's swing when he returns to regular season games.[35] Because of these potential risks of injury and alterations to swing mechanics and timing, MLB players have been known to decline the invitation to participate.[12,36] However, to date, no study has assessed whether an increased injury risk is associated with participation in the MLB Home Run Derby.

TABLE 3
Change in Hitting Statistics in 2nd Half of the Season[a]

Hitting Metric in 2nd Half of Season	Adjusted Effect (95% CI) for HRD Participation[b]	*P* Value
HR	0.53 (–0.92 to 1.98)	.471
PA	13.2 (–4.27 to 30.72)	.138
BA	–0.007 (–0.018 to 0.004)	.23
OBP	–0.011 (–0.023 to 0.001)	.074
SLG	–0.022 (–0.046 to 0.002)	.069
OPS	–0.029 (–0.062 to 0.004)	.082
BB	1.18 (–1.83 to 4.19)	.442
SO	3.69 (–0.79 to 8.17)	.106

[a]A multivariable linear regression model was fit for each hitting metric outcome in the 2nd half of the season. Each multivariable model was adjusted for player age, year of the All-Star Game, and the corresponding hitting metric in the 1st half of the season. BA, batting average; BB, base on balls (walks); HR, home run; HRD, Home Run Derby; OBP, on-base percentage; OPS, on-base percentage plus slugging percentage; PA, plate appearance; SLG, slugging percentage; SO, strikeout.
[b]Reference = All-Star control players.

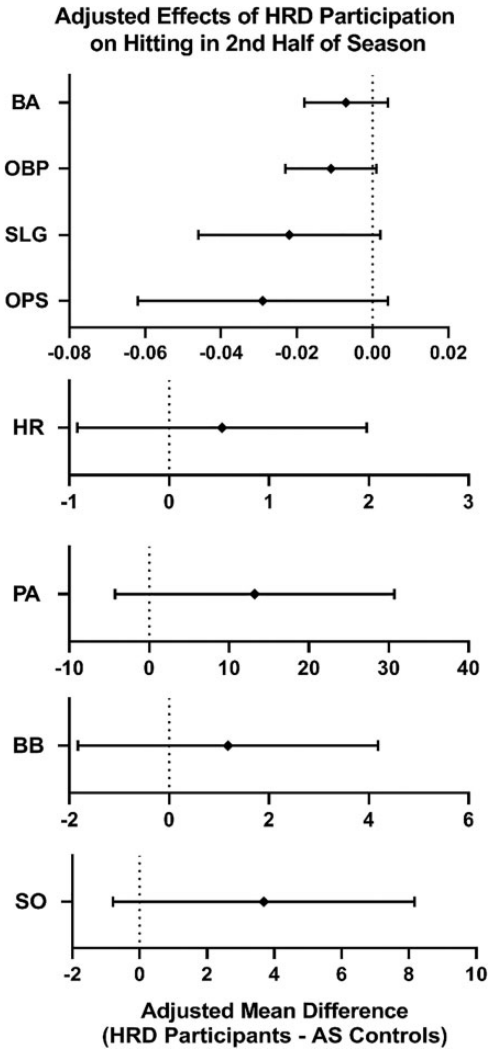

Figure 2. Adjusted effect of hitting on the 2nd half of season for HRD participants versus AS participants. AS, All-Star; BA, batting average; BB, base on balls (walks); HR, home run; HRD, Home Run Derby; OBP, on-base percentage; OPS, on-base plus slugging percentage; PA, plate appearance; SLG, slugging percentage; SO, strikeout.

Posner et al[24] noted an increase in MLB injuries after the 2005 season, possibly as a result of increased reporting due to a stricter drug surveillance policy before the 2006 season. Noncontact wrist injuries, abdominal and chest wall injuries (eg, oblique and intercostal muscle strains), low back injuries, and lead shoulder injuries are a narrow subset of injuries that previous authors have attributed to hitting.[4,6,11,25,32] Mechanics of batting may be a causative factor in noncontact-related wrist injuries. The wrist undergoes rapid ulnar deviation with progressive, simultaneous supination/pronation in the lead and dominant hands during hitting and follow-through phases of batting.[25] Loading of the ulnar side of wrist with forearm rotation can result in acute or chronic injuries to the triangular fibrocartilage complex, ulnotriquetral ligament, or extensor carpi ulnaris tendon, sheath, and subsheath.[2,14,31] Subtle injuries like these can lead to a delay in diagnosis, which oftentimes prolongs recovery or time to surgery. Camp et al[4] used the MLB Health and Injury Tracking System (HITS) to identify all oblique injuries that resulted in time loss in MLB and Minor League Baseball during the 2011-2015 seasons. Those investigators found that 46% of oblique strains were batting related, with the lead side injured more commonly than the trailing side (72% vs 28%). Injured batters missed a mean of 21 days of play.[4]

Low back pain is also common among positional MLB players. Muscular injuries (such as strains and spasms) typically present acutely with obvious inciting incidents during swinging or throwing and are usually localizable. Other lumbar spine injuries (eg, spondylolysis, intervertebral disk disease, facet joint disease, and spinal stenosis) tend to be either chronic or acute-on-chronic processes, aggravated by an inciting incident.[6] Batter's shoulder, or posterior glenohumeral instability, is a condition involving the hitter's lead shoulder that is believed to be the result of repetitive microtrauma rather than an acute or single event. Likely due to rotational velocities and bat mass, as in the case of a missed pitch, a lack of counterforce to the dynamic posterior pulling force on the lead shoulder during batting occurs. Increased shoulder abduction angle and subsequent shear forces across the glenohumeral joint are magnified with missed outside pitches. A 1-handed follow-through also has been presumed to increase microtrauma across the posterior labrum and capsule.[32]

In the present retrospective study involving 228 MLB position players over 14 seasons, only 1 hitting-related injury necessitating injury list designation (known as the disabled list before the 2019 season) was identified that was temporally related to the MLB ASG and HRD. In 2012,

TABLE 4
Risk of Injury in 2nd Half of Season[a]

	Adjusted Odds Ratio (95% CI)	*P* Value
Group		
HRD participants	0.52 (0.25-1.12)	.097
ASG controls	Reference	
ASG year	1.11 (1.01-1.22)	**.044**
Player age	0.97 (0.89-1.10)	.947
Injury 60 days before ASG	0.93 (0.19-4.46)	.932

[a]Bolded *P* value indicates statistical significance ($P < .05$). ASG, All-Star Game; HRD, Home Run Derby.

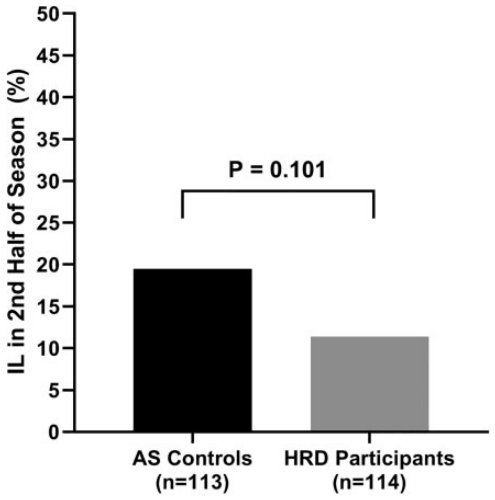

Figure 3. Percentage of players placed on injured list (IL) in second half of season. AS, All-Star; HRD, Home Run Derby.

right fielder Jose Bautista hit a total of 20 home runs during 3 rounds of the HRD on July 9. He was placed on the IL on July 17 of the same year with left wrist inflammation, ultimately missing 34 games and requiring season-ending wrist surgery. In 2013, outfielder Yoenis Cespedes missed 4 games between July 19 and 22 due to left wrist soreness after participating in the HRD on July 15, during which he hit a total of 32 home runs during 3 rounds but was not placed on the IL. However, he had sustained a left-hand sliding injury that required a 15-day IL stint in April, within 60 days of the HRD. Although our results show that the odds of sustaining a second half of season injury resulting in IL placement were 11.1 times higher for HRD participants competing in 3 rounds compared with 1 round of the HRD, these results were not statistically significant (Table 5). This does warrant consideration, however, given that such a small number of players participate in the HRD each year (8-10 players).

WAR has been described as baseball's most important statistic.[33] Unlike favored metrics from past eras such as BA or runs batted in (RBI) or newer statistics such as OBP, WAR encompasses all aspects of a player's

TABLE 5
Risk Factors for 2nd Half of Season in HRD Participants[a]

	Adjusted Odds Ratio (95% CI)	*P* Value
ASG year	1.19 (0.95-1.49)	.133
Player age	0.98 (0.82-1.18)	.854
Injury 60 days before ASG	1.13 (0.11-11.26)	.915
Total home runs in HRD	0.93 (0.84-1.03)	.143
Number of rounds in HRD		
1	Reference	
2	2.01 (0.35-11.57)	.434
3	11.1 (0.61-202)	.104
4	—[b]	

[a]ASG, All-Star Game; HRD, Home Run Derby.
[b]Data were omitted because there were no 2nd-half injuries in this group.

performance, whereas BA, RBI, and OBP are offense-only metrics. WAR incorporates offense, defense, and baserunning into ratings for position players. It is particularly useful to compare an everyday player who (theoretically) becomes injured with his replacement (eg, minor leaguer or bench player) to determine how much value, expressed in wins, a team would lose or gain. An advantage to WAR is that players between leagues, teams, and even seasons can be compared because WAR is context-, league-, and park-neutral.[3,21] In this study, HRD participants had statistically significant lower WARs for the season compared with ASG participant controls (4.69 ± 2.06 vs 5.33 ± 2.08; $P = .021$). It is unclear whether this mean WAR difference of 0.64 represents clinical significance. WAR scales have been proposed by statisticians and sportswriters, with the following scale receiving general acceptance: Over a full season, WAR 0-2 constitutes a bench role player, whereas WAR 2-4 is typically a regular starter. A WAR of 4-6 indicates an All-Star caliber player, whereas a WAR >6 is typically reserved for Most Valuable Player candidates.[30] According to the results of this study, this difference is roughly the equivalent of a bench type player. WAR has to be taken in the context of a full season and cannot be split into a first and second half statistic; however, it is worthwhile to note that in this study, HRD participants had a lower season-long WAR than ASG controls. Whether this finding is due to true injury or overuse or can simply be explained by first half overperformance by the HRD group is difficult to determine.

There are several limitations to this study that warrant discussion. First, the use of publicly available data to identify MLB players with injuries necessitating IL placement is prone to selection, reporting, and observer bias. Regrettably, none of the physicians involved in this study have direct access to the MLB HITS; however, this method of data acquisition has been used in multiple previous studies involving professional baseball players.[8,10,13,18,20] Specifically, players only appear on the IL if they miss >15 games, which may have resulted in some lesser injuries' being missed by this data collection strategy. Future analyses using the HITS could potentially capture injuries not requiring time loss or IL placement more accurately.

Second, as with any (nonrandomized) observational study, association does not imply causation. Although HRD participants were found to have a statistically significant lower WAR for the season compared with ASG participant controls, this could be explained by other unmeasurable exposures or factors that may cause these results, rather than participating in the HRD. Third, due to the limited amount of scientific study on this topic, a number of references for the study are from well-respected baseball websites due to the paucity of scientific literature. Despite these limitations, our study had several strengths: inclusion of 14 seasons of data, use of a control group, statistical analysis using multivariate linear and logistic regression models, and assessment of both injury and performance-based outcomes.

CONCLUSION

HRD participants did not have increased odds of IL placement in the second half of the MLB season compared with controls nor did they experience second-half performance declines in offensive production versus controls when multivariable linear regression analysis was performed.

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