


Original Research

A Plague of Their Own: Injury Incidence Remains Elevated in the 2021 Major League Baseball Season Compared to Pre-COVID-19 Seasons

Brooks N Platt¹, Breanna M Sullivan¹^a, Shawn Dripchak², Timothy L Uhl³, Aaron D Sciascia⁴, William Kibler⁵, Austin V Stone¹

¹ Orthopaedic Surgery and Sports Medicine, University of Kentucky, ² Department of Orthopaedic Surgery and Sports Medicine, University of Kentucky, ³ Physical Therapy, University of Kentucky, ⁴ Insitute for Clinical Outcomes and Research, Lexington Clinic, ⁵ Orthopaedic Surgery, Lexington Clinic

Keywords: baseball, coronavirus, injury, major league baseball, COVID-19

<https://doi.org/10.26603/001c.38479>

International Journal of Sports Physical Therapy

Vol. 17, Issue 6, 2022

Background

Significant increases in injuries were observed in the 2020 Major League Baseball (MLB) season; these were attributed to an increased acute to chronic workload due to the interrupted preseason and compressed season during the coronavirus disease of 2019 (COVID-19) pandemic. In 2021, the MLB resumed its regular schedule.

Hypothesis/Purpose

The purpose of this study was to determine the injury incidence and epidemiology of the 2021 MLB season compared to the injury incidence in the 2020 season and pre-COVID-19 seasons. The hypothesis was that, with the return to normal preseason training, injury incidence in 2021 would return to pre-COVID-19 rates. Additionally, it was hypothesized that injury list (IL) placements at midseason 2021 would be decreased relative to 2020 due to the uninterrupted preseason yet increased at full season 2021 due to increased overall workload from 2020.

Study Design

Descriptive epidemiology study

Methods

The MLB transactions database was searched for players placed on the IL between 2018 and 2021. Injuries were categorized by body part and player position. Incidence per 1000 athlete-exposures was calculated for the pre-COVID-19 (2018-2019), 2020, and 2021 seasons. The z test for proportions was used to determine significant differences between injury incidences.

Results

The injury incidence rate by midseason 2021 (9.32) compared to 2020 (8.66) was not significantly different ($p=0.234$). At full season 2021, injury incidence rate (8.69) was significantly higher than pre-COVID-19 seasons (5.13, $p<0.001$), but not 2020 ($p=0.952$). When comparing full season 2021 to 2020, increased foot/ankle (0.50 vs 0.14, respectively, $p<0.001$) and miscellaneous (1.92 vs 0.68, respectively, $p<0.001$) injuries were observed.

^a Corresponding author:

Breanna Sullivan, BA
Department of Orthopaedic Surgery and Sports Medicine,
University of Kentucky, Lexington, KY, USA
bsullyn2@uic.edu
Cell: 773-766-7728

Conclusion

The overall injury incidence in 2021 was significantly higher than pre-COVID-19 seasons, and no significant difference was observed between both mid- and full season 2021 and 2020, refuting the hypotheses. This signifies that injury incidence remained elevated in the 2021 season despite resumption of preseason training and a regular season.

Level of Evidence

3

INTRODUCTION

The 2020 Major League Baseball (MLB) season was restructured due to the coronavirus disease 2019 (COVID-19) pandemic. Spring training was interrupted, and when play resumed, the season was shortened from 162 to 60 games.^{1, 2} With an extended layoff between March and July and a shortened preseason, players had a substantially altered training schedule before beginning the regular season. The MLB resumed its normal schedule for the 2021 season, which ran from April 1st through October 3rd, and consisted of 162 games.³ Though MLB injuries are commonly front-loaded in the season, with high injury rates in April and May,⁴⁻⁶ there was an unprecedented number of injuries observed in the first half of the 2021 season with a rate/1000 exposures of 9.32. Platt et al. showed increased injury list (IL) placements during the 2020 season in both pitchers and position players.⁷ These injuries were likely attributable to a high acute to chronic workload ratio (ACWR) caused by a shortened preseason and a compressed game schedule.⁷ A high ACWR increases player injury risk.⁸ More double-headers in the 2020 season (45 seven-inning double-headers in an abbreviated season compared to 34 nine-inning double-headers in the full-season prior^{9,10}) further increased players' acute workloads and is proposed to have contributed to the increased injury incidence observed,⁷ despite measures aimed at decreasing load placed on individual players, such as expanded rosters, taxi-squad availability, and a runner starting on second in extra-innings.¹¹ Similar increases in injury incidence in 2020 following interruptions of play were observed in the National Football League (NFL)^{12,13} and an elite German soccer league,¹⁴ indicating that time away from formal training and competition due to COVID-19 has also affected injury rates in athletes of other professional sports. Baseball, in particular, does have other potential causes of the injury increase, namely a stylistic change to maximum effort,¹⁵ which is reflected in the increase in average fastball velocity¹⁶ and fewer average innings per start.¹⁵

With a substantial increase in games from the 2020 MLB season, it is possible that injury rates in 2021 would be higher than those in 2020 and may have continued to rise as volume accumulated. However, it is unknown whether the return to a traditional preseason timeline in 2021 successfully decreased injury incidence relative to 2020. The purpose of this study was to determine the injury incidence and epidemiology of the 2021 MLB season compared to the injury incidence in the 2020 season and pre-COVID-19 seasons. It was hypothesized that injury incidence in 2021 would return to pre-COVID-19 rates due to the return to

normal preseason training. Additionally, it was hypothesized that IL placements in 2021 at midseason would be decreased relative to 2020 due to the uninterrupted preseason schedule yet increased in the second half of the season due to increased overall workload from 2020.

METHODS

Data from the 2018-2021 MLB transaction reports were extracted from mlb.com/transactions.¹⁷ All injuries that resulted in a player being placed on the injured list (IL) were collected for analysis. Players are placed on the IL for 10 to 60 days after a physician's determination that they are unable to play.¹⁸ In the 2020 season, the longer term on the IL was decreased to 45 days, and the shorter term was decreased from 15 to 10 days for pitchers.¹⁸ Multiple injuries that occurred in the same season at the same time were accounted for individually. From the database, publicly accessible information was collected, such as player name, date of IL placement, position, and body part injured. Specific type of injury beyond anatomical location of injury was not analyzed as the public database was limited on further injury details. Each injury was then categorized into the anatomic areas of upper extremity, lower extremity, spine/core, and other injuries. The "other" category consisted primarily of head injuries, medical reasons (upper respiratory infection, viruses including COVID-19, GI illnesses) for being unable to play, and unreported reasons for IL placement. Positions were sorted into pitchers and position players. Position players included all positions other than pitchers.

Utilizing fangraphs.com,¹⁹ the number of games played by each injured player four weeks and one week prior to placement on the IL was collected. The ratio between the game count of one week and four weeks was calculated as a measure of ACWR. A one-week training load is generally considered acute, while the average of the training load over four to six weeks is representative of chronic loads.²⁰ Though pitch counts per game have been the primary variable collected to measure ACWR in baseball,^{20, 21} game count was used in this study in order to employ a measurement that applies to both pitchers and position players, thus allowing for estimates of workload to be calculated amongst all players. ACWR at the time of injury was compared to the average ACWR for pitchers and position players overall in 2021. The overall ACWR was calculated for both pitchers and position players as a moving average in each week of the season. From this, a grand mean was calculated, which was compared to ACWR at time of injury with a t-test.

Injury incidence per 1000 player exposures was calculated using the same method described by Posner et al.⁶ One player exposure was defined as one game per athlete. Therefore, for the pre-COVID-19 cohort (2018 and 2019 seasons), total exposures were calculated using a 162-game season, 25-man active roster (of the 40-man potential player pool),¹⁸ and 30 teams in the MLB equating to 121,500 player exposures per year. Incidence rate for the pre-COVID-19 cohort was calculated using the cumulative number of injuries and exposures in both years. For 2020, player exposures were calculated using the 60-game season, 30-man roster for the first two weeks, 28-man roster for the second two weeks, and a 26-man roster for the remainder of the season (expanded in 2020 to include a 60-man potential player pool),^{22,23} and 30 teams in the MLB resulting in 48,960 player exposures. In the 2021 season, roster sizes were consistently 26 players. By the all-star break, the number of total games played by each team multiplied by the active roster size of 26 equaled 70,044 exposures. At the end of the regular season, with 162 games played by each team, total exposures in 2021 equaled 126,360. Because the IL is not used during the post-season, injuries past the regular season were excluded.

Incidence of injury was evaluated overall and for each anatomical zone. Subgroup analysis was performed to determine incidence of injury for pitchers and position players separately. Anatomic zones were then further subdivided to calculate incidence of injury for each specific body part. Incidence rate ratio (IRR) was calculated by dividing incidence in the 2021 group by incidence in the 2020 group and pre-COVID-19 group. Finally, the proportion of injuries occurring in each anatomical zone was analyzed overall and in the subgroups of pitchers and position players.

Differences in incidence for the overall group, as well as each subgroup, were statistically analyzed using the z-test for proportions, which is an ideal test to measure the statistical significance of the rate of IL placement for this descriptive study. R software version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria)²⁴ was used for data analysis. Statistical significance was set at $p \leq 0.05$.

RESULTS

TOTAL INJURIES

In the pre-COVID-19 seasons, there were 1246 injuries recorded on the IL. In 2020, there were 424 injuries recorded on the IL. By the end of season in 2021, 1098 injuries resulted in IL placement, and of those injuries, 653 were recorded by the all-star break (mid-season). Pitchers accounted for 55.0% (685/1246) of the injuries pre-COVID-19 and 56.8% (241/424) in 2020, compared to 50.7% (331/653) in 2021 by midseason and 52.6% (578/1098) by the end of the 2021 regular season.

2021 SEASON VERSUS PRE-COVID-19 SEASONS

The overall incidence rate per 1000 athlete exposures continued to be elevated in 2021 compared to pre-COVID-19

rates (5.13), both at midseason (9.32) and full season (IRR= 1.69, 8.69, $p < 0.001$; [Table 1](#)). IL listing increases were present in all categories, including total, upper extremity, lower extremity, spine and core, and “other” categories ($p < 0.015$, [Table 1](#)). Significant increases in pitcher IL listings were seen in all categories except spine/core by midseason 2021 compared to pre-COVID-19 ($p \leq 0.020$) and all categories except lower extremity and spine/core for the full 2021 season ($p \leq 0.002$, [Table 1](#)). Increases were seen in all categories in the position player cohort at both midseason 2021 ($p \leq 0.002$) and full-season 2021 ($p \leq 0.015$, [Table 1](#)).

A breakdown of specific injury locations showed increases by full-season 2021 compared to pre-COVID-19 in each of the following: foot/ankle, hamstring, groin, spine/core, hand/wrist, elbow/forearm, shoulder/chest, and miscellaneous ($p \leq 0.016$, [Table 2](#)). The lone decrease in incidence in 2021 compared to pre-COVID-19 was observed in the “other upper extremity” category (IRR 0.23, $p < 0.001$, [Table 2](#)).

2021 MID-SEASON VERSUS 2020 SEASON

The overall incidence rate per 1000 athlete exposures by midseason 2021 (9.32) compared to 2020 (8.66) was not significantly different (IRR=1.08, $p=0.234$). Differences between 2020 and midseason 2021 included a significant increase in lower extremity injuries overall (IRR 1.38, $p < 0.001$). Pitchers experienced fewer IL placements due to spine/core injuries by midseason 2021 (IRR 0.62, $p=0.029$) and increased placements in the “other” category (IRR 1.66, $p=0.024$). Furthermore, position players experienced more IL listings overall by midseason 2021 compared to 2020 (IRR 1.23, $p=0.024$).

Increases were further found between midseason 2021 and 2020 in the foot/ankle, hamstring, and miscellaneous categories ($p \leq 0.013$). It is important to note that the miscellaneous category contained 243 injuries in 2021, of which 242 (99.6%) were listed as miscellaneous due to lack of reporting of the specific injury. Decreases, however, were seen in midseason 2021 compared to 2020 in the other upper extremity and infection categories ($p < 0.001$). Infection listing returned to their pre-pandemic levels.

2021 FULL SEASON VERSUS 2020 SEASON

The overall incidence rate per 1000 athlete exposures in full season 2021 (8.67) compared to 2020 (8.66) was not significantly different (IRR= 1.00, $p=0.952$, [Table 1](#)). The overall injury incidence in pitchers (9.15, $p=0.337$) and position players (8.20, $p=0.263$, [Table 1](#)) in full season 2021 was not significantly different from that of 2020. Pitchers in full season 2021 experienced fewer upper extremity (IRR=0.74, $p < 0.001$) and spine/core injuries (IRR=0.63, $p=0.016$) compared to 2020, but experienced an increase in “other” injuries (IRR=1.86, $p=0.002$, [Table 1](#)). Position players in full season 2021 also experienced an increase in “other” injuries (IRR=1.82, $p=0.002$, [Table 1](#)) compared to 2020.

Significant increases in foot/ankle (IRR= 3.56 $p < 0.001$, [Table 2](#)) and miscellaneous injuries (IRR=2.83, $p < 0.001$,

Table 1. Incidence comparison 2021 vs pre-COVID-19 and 2021 vs 2020 overall, pitchers, and position players

Cohort	Pre-COVID-19	2020	2021	IRR 2021 vs. pre-COVID-19 (95% CI)	p-value	IRR 2021 vs. 2020 (95% CI)	p-value
Overall							
Total	5.13	8.66	8.69	1.69(1.56-1.84)	<0.001	1.00 (0.90-1.12)	0.952
Upper extremity	1.53	3.80	3.02	1.37(1.20-1.56)	<0.001	0.79 (0.67-0.95)	0.010
Lower extremity	1.63	1.98	2.33	1.40(1.20-1.62)	<0.001	1.18 (0.94-1.48)	0.159
Spine/core	0.88	1.47	1.21	1.30(1.05-1.61)	0.015	0.78 (0.58-1.03)	0.077
Other	0.37	1.41	2.01	5.87(4.64-7.44)	<0.001	1.56 (1.20-2.03)	<0.001
Pitchers							
Total	5.87	9.84	9.15	1.56(1.39-1.74)	<0.001	0.93 (0.80-1.08)	0.337
Upper extremity	3.31	5.68	4.21	1.27(1.09-1.49)	0.002	0.74 (0.60-0.91)	<0.001
Lower extremity	1.42	1.27	1.61	1.27 (0.99-1.64)	0.060	1.61 (0.85-1.90)	0.234
Spine/core	1.10	1.76	1.11	1.12(0.83-1.51)	0.441	0.63 (0.43-0.92)	0.016
Other	0.30	1.19	2.22	7.39(5.10-10.70)	<0.001	1.86 (1.25-2.78)	0.002
Position players							
Total	4.44	7.48	8.20	1.85 (1.65-2.09)	<0.001	1.10 (0.93-1.30)	0.263
Upper extremity	1.19	1.92	1.82	1.37 (1.20-1.56)	<0.001	0.95 (0.68-1.33)	0.757
Lower extremity	2.04	2.73	3.05	1.40 (1.20-1.62)	<0.001	1.12 (0.85-1.48)	0.435
Spine/core	0.77	1.19	1.17	1.30 (1.05-1.61)	0.015	0.98 (0.64-1.51)	0.960
Other	0.44	1.63	2.18	5.87 (4.64-7.44)	<0.001	1.82 (1.23-2.74)	0.002

COVID-19=coronavirus disease 2019; IRR=Incidence rate ratio; CI= confidence interval. Bold font indicates statistically significant differences.

Table 2) were observed in full season 2021 versus 2020, while significant decreases were observed in other lower extremity (IRR=0.41, $p=0.003$), elbow/forearm (IRR=0.65, $p=0.003$), other upper extremity (IRR=0.12, $p<0.001$), and infection (IRR=0.07, $p<0.001$, Table 2).

ACWR COMPARISON

Position players at the time of injury had a significantly higher ACWR (1.17 +/- 0.76) than position players overall (0.98 +/- 0.41, $p<0.001$). Pitchers also had a significantly higher ACWR at the time of injury (1.34 +/- 0.76) compared to the ACWR of pitchers overall (0.99 +/- 0.31, $p<0.001$).

DISCUSSION

2021 SEASON VERSUS PRE-COVID-19 SEASONS

The primary finding of this analysis is that the rate of placement on the IL in the 2021 MLB season was significantly higher than that of pre-COVID-19 seasons. This disproves the hypothesis that the overall 2021 injury incidence would

not significantly differ from that of pre-COVID-19 seasons due to the return to regular preseason training. Furthermore, while injuries remained high in 2021, they did not increase as expected in the second half of the season suggesting the increase in injuries was not due to the return to a 162-game season from a 60-game season.

Many authors have examined the injury incidence in professional sports during the 2020 season following the disruptions to training and regular play,^{7,12-14,25} but to the best of the current authors' knowledge, there are no studies to date examining the long-term effects of the COVID-19 layoffs on the subsequent season. This finding of increased injury incidence in 2021 may be surprising to the sports community at large; an expert opinion in regards to the effects of COVID-19 on professional soccer hypothesized that there would be no long-term effects on injury incidence after return to normal play because players would have the offseason to recover and regular preseason to train.²⁶ This study's findings may indicate that there were other unforeseen factors, such as accumulated load, locomotion activity and intensity, mood and sleep quality, previous fatigue and other situational factors,²⁶ that may have influenced

Table 2. Detailed injury breakdown by body part 2021 vs pre-COVID-19 and 2021 vs. 2020

Body Part	Pre-COVID-19	2020	2021	IRR 2021 vs. pre-COVID-19 (95% CI)	p-value	IRR 2021 vs. 2020 (95% CI)	p-value
Foot/Ankle	0.32	0.14	0.50	1.56 (1.12-2.17)	0.009	3.56 (1.62-7.83)	<0.001
Knee	0.3	0.33	0.42	1.40 (0.98-1.99)	0.063	1.27 (0.73-2.22)	0.379
Hip	0.15	0.11	0.14	0.95 (0.54-1.67)	0.569	1.30 (0.49-3.39)	0.509
Hamstring	0.44	0.61	0.82	1.87 (1.43-2.45)	<0.001	1.35 (0.90-2.03)	0.153
Groin	0.19	0.36	0.29	1.54 (1.00-2.37)	<0.001	0.81 (0.46-1.43)	0.430
Other Lower Extremity	0.26	0.41	0.17	0.64 (0.39-1.05)	0.751	0.41 (0.22-0.75)	0.003
Spine/core	0.88	1.47	1.14	1.30 (1.05-1.60)	0.016	0.78 (0.58-1.03)	0.077
Head	0.21	0.18	0.23	1.09 (0.69-1.72)	0.704	1.28 (0.60-2.71)	0.562
Hand/wrist	0.51	0.78	0.86	1.69 (1.31-2.19)	<0.001	1.11 (0.76-1.60)	0.575
Elbow/forearm	0.74	1.55	1.01	1.37 (1.09-1.72)	0.007	0.65 (0.49-0.87)	0.003
Shoulder/chest	0.78	1.15	1.10	1.41 (1.13-1.76)	0.002	0.96 (0.70-1.30)	0.80
Other upper extremity	0.17	0.34	0.04	0.23 (0.09-0.59)	<0.001	0.12 (0.04-0.32)	<0.001
Infection	0.05	0.55	0.04	0.79 (0.28-2.24)	0.674	0.07 (0.03-0.19)	<0.001
Miscellaneous	0.11	0.68	1.92	17.48 (11.73-26.07)	<0.001	2.83 (1.97-4.06)	<0.001

COVID-19=coronavirus disease 2019; IRR=Incidence rate ratio for total cohort; CI= confidence interval. Bold font indicates statistically significant differences.

injury rates in 2021. The most notable of these factors is perhaps the massive increase in the accumulated load from 60 games in 2020 to 162 games in 2021. Since the COVID-19 pandemic presents an unprecedented situation, its long-term effects on injury risk in the MLB and professional sports at large should continue to be studied.

2021 MID AND FULL SEASON VERSUS 2020 SEASON

Comparing the first half of the 2021 season to the shortened 2020 season provides an interesting look at early season injury rates. There was no significant difference in overall injury incidence observed between the 2021 MLB midseason and 2020 season, indicating that injury incidence remained high in the first half of the 2021 season. This finding contrasts with the expected decrease in early season injury incidence as training and offseason routines were reestablished in 2021. One potential explanation for this finding is that the 2021 season once again began in early spring, making for colder weather on average compared to the July start in 2020. While primary literature supporting colder temperatures as a risk factor for soft tissue injury are scarce,²⁷ some physicians and physical therapists anecdotally suggest this is the case.^{28,29} Additionally, offseason routines may not have been reestablished as assumed. It is possible that players may not have returned to performing pre-COVID-19 offseason training; however, this factor is uncontrolled for in this study. Furthermore, no significant difference was observed in overall injury incidence between full season 2021 and 2020.

Increases in early season injury were also observed in the NFL 2020-2021 season following the suspended pre-season due to COVID-19.¹³ The injury rate during weeks one to four of the regular season of 2020-2021 was significantly elevated compared to the injury rate of weeks one to four of the preseasons and regular seasons of 2016-2017, 2018-2019 and 2019-2020.¹³ The authors hypothesized that this increase in injury was due to deconditioning, muscle weakness, and fatigue, further emphasizing the importance of the NFL training camp for preparing athletes for the demands of regular season play.¹³ These findings parallel the increase in injuries observed in the 2020 MLB season due to the disrupted preseason training,⁷ but also underscore that the sustained high injury incidence in 2021 is unexpected since preseason training returned to normal.

An important secondary finding is that the distribution of injuries changed while injury incidence remained high. Lower extremity IL placements overall were significantly increased in early 2021 over 2020. Foot/ankle and "other" lower extremity injuries were significantly increased in the full 2021 season compared to 2020. Position players also experienced a significant increase in overall IL stints compared to 2020 values in early 2021. Infections played a significantly lesser role in increasing IL placements compared to 2020.

These previous findings make the increase in lower extremity injuries particularly notable in 2021. In 2020, overall injury incidence increased in all broad injury categories other than those listed as "lower extremity."⁷ In early 2021, lower extremity injuries significantly increased over both

2020 and pre-COVID-19 due to, primarily, significant increases in foot/ankle injuries and hamstring injuries. In the full 2021 season, lower extremity injuries significantly increased compared to pre-COVID-19 but only in the lower extremity subcategories of foot/ankle and “other” compared to 2020. Ankle, lower leg, and hamstring injuries have been shown in previous seasons to be highest in MLB players at the beginning of the season,^{5,30} consistent with the reported rates of other baseball injuries.^{6,7} This pattern suggests a potential influence of ACWR in affecting lower extremity injuries.

ACWR has been identified as a significant risk factor for soft tissue injury in a variety of professional sports.⁸ The rapid increase in workload necessitated by the interrupted 2020 preseason was hypothesized to be the main cause for increases in IL listings during the 60-game season.⁷ In 2021, both pitchers and position players had a significantly higher ACWR at time of injury than the average ACWR for the 2021 population. While both starting pitchers and relief pitchers were analyzed together, the ACWR calculation remains valid as it is a proportion of current work to previous work, therefore suggesting that increases in frequency of appearance in both starters and relievers was associated with IL placement. This finding is consistent with previous literature on the topic. A recent study of collegiate baseball players found that players with an ACWR less than or greater than 33% were 8.3 times more likely to experience a throwing injury to the upper or lower extremity in the next week, indicating that an ideal ACWR is between 0.67-1.33.³¹ This study also identified a significant relationship between ACWR and upper extremity injuries.³¹ The mean ACWR for injured players in 2021 was shown to be significantly higher than the overall average ACWR for those in 2021, further supporting an elevated ACWR as a potential contributing factor to injury.

The continued increase in IL listing rates and the increases in lower extremity injuries despite the return to a normal preseason suggest the effects of deconditioning due to the 2020 layoff may be persisting longer than expected. One possible variable that may have contributed to the increased lower extremity injuries in 2021 is a delayed effect of alterations in both core strength and neuromuscular adaptation that began during the 2020 layoff. Core strength has been demonstrated to play a role in lower extremity injury prevention,³²⁻³⁵ and a lack of core strength and neuromuscular control leads to higher rates of lower extremity injury.^{33,35-38} In conjunction with this, posterior chain weakness may have also been a risk factor for the increase in lower extremity injuries observed. The posterior chain refers to the posterior musculoskeletal system, including the trunk, pelvis, hamstring and calf muscle complexes.³⁹ The hamstring complex is the most frequently affected muscle of injuries within the posterior chain.³⁹ Modifiable risk factors for posterior chain injury include: strength deficits, training overload, sprint performance and decreased range of motion.³⁹ These risk factors suggest that, if deconditioning that began during the 2020 COVID-19 layoff persisted in the 2021 season, strength deficits, particularly of the posterior chain, may have con-

tributed to the increase in lower extremity injuries observed in the 2021 season.

Taking all factors into account, it was surprising that lower extremity injuries did not significantly increase during the 2020 season. It is possible that lower extremity injuries were not as prevalent in 2020 because lower extremity conditioning may have been easier to accomplish during lockdown. The lower body can more easily be trained with body weight exercises and without extra equipment, as opposed to upper body, baseball-specific training, such as pitching and batting.⁷

Another difference between 2021 and 2020 was the significant decrease in infection as a reason for IL placement. COVID-19 infection was responsible for a substantial portion of IL placements in 2020.⁷ Notably, there were far fewer infectious causes for IL placement in 2021 compared to 2020. This finding supports the conclusion from the previous study⁷ that the increase in IL placements was largely not attributed to infection or exposure to COVID-19.

LIMITATIONS

As with all studies, this investigation has limitations. The IL is fundamentally a roster management tool. Therefore, using IL transactions is not a perfect secondary measure for injury. However, the continued increase in IL listings in 2021 compared to 2020 suggests many of the roster management factors that were particular to 2020 did not significantly influence the rate of IL placements. With the reinstatement of the minor leagues in 2021,⁴⁰ and a more standard workflow pertaining to MLB rosters, these results show that the spikes in 2020 and 2021 were not likely due to these roster idiosyncrasies of 2020.

Additionally, the population of MLB players renders the results not generalizable to most athletes. Utilizing publicly accessible data also limits details available for each injury. In 2020 and 2021, many IL placements were made without a specific reason and are sorted as “miscellaneous,” which is part of the broader “other” category. It is possible the COVID-19 protocol is responsible for many of these placements. Furthermore, only injuries that resulted in a placement on the IL were accounted for; therefore, this study did not capture injuries that did not result in an IL listing. Such a limitation suggests an underestimation of true injury incidence. In addition, in 2020 the 60-day injured list was reduced to 45 days.¹⁸ This time difference combined with the inadequate injury detail did not allow for an assessment of differences in injury severity between 2020 and 2021 and pre-COVID-19 seasons. Moreover, the epidemiologic nature of the study is not suited to propose a cause or explanation for the increase in IL placements. While hypotheses for potential causes are presented and supported, the current study is not designed to determine causation. Finally, utilizing games played to calculate ACWR is an imperfect measure since it does not account for differences in workload between different players per game. For example, a pitcher who throws multiple pitches per game may have a higher workload than a position player. Additionally, there are multiple intrinsic (e.g. rating of perceived exertion) and extrinsic (e.g. altitude and weather) factors that may con-

tribute to workload that were unable to be measured in this study.

CONCLUSION

Incidence of placement on the IL increased significantly during the 2020 MLB season compared to pre-COVID-19 and remained elevated in 2021. Rate of IL placements attributed to every anatomic zone, including upper extremity, lower extremity, spine/core, and other injuries were significantly increased over pre-COVID-19 rates in 2021. Both position players and pitchers who experienced IL placement had a significantly higher ACWR than the average ACWR for the 2021 population, suggesting that elevated ACWR may be a risk factor for injury. This analysis suggests the interruption in sport in 2020 may have significant injury risk effects that persist longer than anticipated.

DISCLOSURES

BNP: None

BMS: None

SD: None

TLU: 3C-Meloq, 8-Shoulder and Elbow (British Journal), Sports Health, 9-American Shoulder and Elbow Surgeons, International Board of Shoulder and Elbow Therapists

ADS: None

WBK: 3B-NSC Showmotion, 3C-Alignmed, 4-Alignmed, 7-Springer

AVS: 3C-Allosource, Smith and Nephew, 5- Allosource, Flexion Therapeutics, 9-American Orthopaedic Society for Sports Medicine, Arthroscopy Association of North America

Submitted: March 02, 2022 CDT, Accepted: July 24, 2022 CDT

© The Author(s)

.....



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-NC-4.0). View this license's legal deed at <https://creativecommons.org/licenses/by-nc/4.0> and legal code at <https://creativecommons.org/licenses/by-nc/4.0/legalcode> for more information.

REFERENCES

1. Zucker J. Timeline of coronavirus' impact on sports. Turner Broadcasting System. <https://bleacherreport.com/articles/2880569-timeline-of-coronavirus-impact-on-sports>. Accessed October 14, 2020.
2. Adler D, Kelly M, Langs S, Simon A. Breaking down every opening day matchup. MLB Advanced Media. 2020. Accessed October 14, 2020. <https://www.mlb.com/news/opening-day-2020-guide>
3. A guide to the 2021 MLB season. MLB Advanced Media. Accessed July 28, 2021. <http://mlb.com/news/what-you-need-to-know-about-mlb-in-2021>
4. Salhab HA, Fares MY, Khachfe HH, Fares J. Musculoskeletal lower limb injuries in Major League Baseball. *Phys Ther Sport*. 2019;39:38-43. doi:10.1016/j.ptsp.2019.06.007
5. Okoroha KR, Conte S, Makhni EC, et al. Hamstring injury trends in Major and Minor League Baseball: Epidemiological findings from the Major League Baseball health and injury tracking system. *Orthop J Sports Med*. 2019;7(7):1-7. doi:10.1177/2325967119861064
6. Posner M, Cameron KL, Wolf JM, Belmont PJ, Owens BD. Epidemiology of Major League Baseball injuries. *Am J Sports Med*. 2011;39(8):1675-1691. doi:10.1177/0363546511411700
7. Platt BN, Uhl TL, Sciascia AD, Zacharias AJ, Lemaster NG, Stone AV. Injury rates in Major League Baseball during the 2020 COVID-19 season. *Orthop J Sports Med*. 2021;9(3):1-7. doi:10.1177/2325967121999646
8. Andrade R, Wik EH, Rebelo-Marques A, et al. Is the acute: chronic workload ratio (ACWR) associated with risk of time-loss injury in professional team sports? A systematic review of methodology, variables and injury risk in practical situations. *Sports Med*. 2020;50(9):1613-1635. doi:10.1007/s40279-020-01308-6
9. MLB Doubleheaders- 2020. Accessed January 21, 2022. https://www.espn.com/mlb/stats/doubleheaders/_year/2020
10. MLB Doubleheaders- 2019. Accessed January 21, 2022. https://www.espn.com/mlb/stats/doubleheaders/_year/2019
11. New rules, features, protocols for 2020 MLB Season. MLB Advanced Media. June 29, 2020. Accessed June 3, 2022. <https://www.mlb.com/news/mlb-announces-new-features-for-2020-season#:~:text=By%20noon%20ET%20on%20the,and%20a%20minimum%20of%2025.&text=The%20maximum%20Active%20Roster%20limit,day%20of%20the%20regular%20season>
12. Bailey EP, Goodloe JB, McNeely RA, Traven SA, Woolf SK, Slone HS. COVID-19 modifications of offseason and preseason training for NFL athletes are associated with increased risk of regular season injuries. *Phys Sportsmed*. Published online September 8, 2021:1-5. doi:10.1080/00913847.2021.1976602
13. Baker HP, Pirkle S, Cahill M, Reddy M, Portney D, Athiviraham A. The injury rate in National Football League players increased following cancellation of preseason games because of COVID-19. *Arthrosc Sports Med Rehabil*. 2021;3(4):e1147-e1154. doi:10.1016/j.asmr.2021.05.002
14. Seshadri DR, Thom ML, Harlow ER, Drummond CK, Voos JE. Case report: Return to sport following the COVID-19 lockdown and its impact on injury rates in the German Soccer League. *Front Sports Act Living*. 2021;3(February):1-7. doi:10.3389/fspor.2021.604226
15. Lindbergh B. How can MLB fix its too-many-pitchers problem? The Ringer. May 2, 2022. Accessed June 3, 2022. <https://www.theringer.com/mlb/2022/5/2/23052714/pitcher-roster-rules-limit>
16. Fink D. Fastball velocities are already up. Fangraphs. April 9, 2021. Accessed June 3, 2022. <https://blogs.fangraphs.com/fastball-velocities-are-already-up/>
17. Major League Baseball transactions. MLB Advanced Media. Accessed August 10, 2020. <http://mlb.mlb.com/mlb/transactions/>
18. MLB miscellany: Rules, regulation and statistics. MLB Advanced Media. Accessed October 15, 2020. http://mlb.mlb.com/mlb/official_info/about_mlb/rules_regulations.jsp
19. Fangraphs. Accessed November 15, 2021. <https://www.fangraphs.com/>
20. Mehta S, Tang S, Rajapakse C, Juzwak S, Dowling B. Chronic workload, subjective arm health, and throwing injury in high school baseball players: 3-year retrospective pilot study. *Sports Health*. 2022;14(1):119-126. doi:10.1177/19417381211055142

21. Dowling B, McNally MP, Chaudhari AMW, Oñate JA. A review of workload-monitoring considerations for baseball pitchers. *J Athl Train*. 2020;55(9):911-917. doi:10.4085/1062-6050-0511-19
22. Baccellieri E. "Summer camp" is here-But MLB's calendar is shattered. *Sports Illustrated*. Published online 2020. Accessed November 1, 2020. <https://www.si.com/mlb/2020/07/01/baseball-return-summer-camp>
23. Feinsand M. FAQ: Roster and transaction rules for 2020. MLB Advanced Media. 2020. Accessed October 14, 2020. <https://www.mlb.com/news/mlb-roster-transaction-rules-for-2020-season>
24. R: A language and environment for statistical computing. Published online 2010.
25. Patetta M, Mayo B, Martini OZ, Sullivan B, Onsen L, Hutchinson M. Preseason elimination impact on anterior cruciate ligament injury in the national football league. *World J Orthop*. 2021;12(11):833-841. doi:10.5312/wjo.v12.i11.833
26. Guerrero-Calderón B. The effect of short-term and long-term coronavirus quarantine on physical performance and injury incidence in high-level soccer. *Soccer Soc*. 2021;22(1-2):85-95. doi:10.1080/14660970.2020.1772240
27. Chalmers PN, McElheny K, D'Angelo J, et al. Effect of weather and game factors on injury rates in professional baseball players. *Am J Sports Med*. 2022;50(4):1130-1136. doi:10.1177/03635465211070287
28. How cold weather affects sports injuries. Published online November 5, 2020. Accessed June 23, 2022. <https://www.gomberamd.com/blog/how-cold-weather-affects-sports-injuries-23105.html>
29. Hamstring injuries and cool weather: Part 1 of 2. *Published*. Published online March 15, 2010. Accessed June 2, 2022. <https://mackareyphysicaltherapy.com/hamstring-injuries-and-cold-temperature-part-1/>
30. Lucasti CJ, Dworkin M, Warrender WJ, et al. Ankle and lower leg injuries in professional baseball players. *Am J Sports Med*. 2020;48(4):908-915. doi:10.1177/0363546520902135
31. Slowik R, Morris C, Hoch M, Uhl T. Identifying risk factors of upper extremity injuries in collegiate baseball players: A pilot study. *Int J Sports Phys Ther*. 2021;16(3). doi:10.26603/001c.24146
32. Hewett TE, Myer GD, Ford KR, et al. Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes: A prospective study. *Am J Sports Med*. 2005;33(4):492-501. doi:10.1177/0363546504269591
33. Hewett TE, Ford KR, Hoogenboom BJ, Myer GD. Understanding and preventing ACL injuries: Current biomechanical and epidemiologic considerations - Update 2010. *N Am J Sports Phys Ther*. 2010;5(4).
34. Hewett TE, Zazulak BT, Krosshaug T, Bahr R. Clinical basis: Epidemiology, risk factors, mechanisms of injury, and prevention of ligament injuries of the knee. *The Knee Joint*. Published online 2012:53-70. doi:10.1007/978-2-287-99353-4_6
35. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J. Deficits in neuromuscular control of the trunk predict knee injury risk: A prospective biomechanical-epidemiologic study. *Am J Sports Med*. 2007;35(7):1123-1130. doi:10.1177/0363546507301585
36. Bahr R, Bahr IA. Incidence of acute volleyball injuries: A prospective cohort study of injury mechanisms and risk factors. *Scand J Med Sci Sports*. 1997;7(3):166-171. doi:10.1111/j.1600-0838.1997.tb00134.x
37. McGuine TA, Keene JS. The effect of a balance training program on the risk of ankle sprains in high school athletes. *Am J Sports Med*. 2006;34(7):1103-1111. doi:10.1177/0363546505284191
38. Verhagen EALM, Van Mechelen W, De Vente W. The effect of preventive measures on the incidence of ankle sprains. *Clin J Sport Med*. 2000;10(4):291-296. doi:10.1097/00042752-200010000-00012
39. Hughes R, Cross M, Stokes K, et al. Novel biomechanical injury risk score demonstrates correlation with lower limb posterior chain injury in 50 elite-level rugby union athletes. *BMJ Open Sport Exerc Med*. 2021;7(4). doi:10.1136/bmjsem-2021-001062
40. Dykstra S, Hill B. Fans' guide to Minor League opening day 2021. Minor League Baseball. Accessed July 28, 2021. <http://milb.com/news/fans-guide-to-minor-league-oper>