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The PITCH study: pitcher injuries during the first 30 days of the coronavirus disease 2019 halted Major League Baseball season

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Background: Major League Baseball (MLB) was among the first professional team sports leagues to resume play in the United States after public health measures related to the appearance of coronavirus disease 2019 caused interruptions to preseason training and major alterations to regular season play. There was a high level of concern that these athletes were ill-prepared for competition and would experience an increased risk of injury under the restricted play rules.

Methods: The data in our study were compiled using publicly accessible records of players placed on injured lists from 2015 to 2020. These records came from 4 open access websites: rotoworld.com, fangraphs.com, foxsports.com, and spotrac.com. All injuries were confirmed using the transaction database found on the official MLB website (mlb.com).

Results: A greater proportion of pitchers were injured during the first 30 days of the 2020 season compared to the first 30 days of any of the 5 prior seasons (29.74% vs. 11.72%, n=2190, $P<.001$). There was a demonstrated increase in injury risk in 2020 for the following anatomic locations: back and trunk, shoulder, upper arm and elbow, forearm and wrist, and hand and finger ($P=.02$; confidence interval [0.497-5.783]). When dividing the first month of play in 2020 into equal halves (15 days each), the number of relief pitcher injuries increased with time (60% vs. 78%, $P=.04$). Lastly, there was no proportional difference in placement on the short-term vs. long-term injured list.

Conclusion: A significantly large increase in soft tissue injuries in 2020 compared to the prior 5 seasons predominantly affected the trunk and the upper extremity of pitchers in the first 30 days of play. Alterations to preseason training and regular season play in the 2020 MLB season due to coronavirus disease 2019 may have been particularly disadvantageous to professional pitchers who are positioned at baseline, the most injury prone position.

In 2020, Major League Baseball (MLB) was among the first professional team sports leagues to resume play in the United States after public health measures related to the appearance of coronavirus disease 2019 (COVID-19) caused major alterations to the off-season, preseason, and regular season schedule. Due to COVID-19, MLB pitchers had mandatory restrictions on training from March to July 2020, followed by a condensed preseason training period, and a regular season met with starts and stops between competitive play that were drastically different from the traditional routine for the season. Preliminary data from baseball analysts and researchers showed that lack of preparedness was a concern for pitchers across the league[10] and that in the COVID-19 era, challenges arose in athletes after 12 weeks of restrictions in a variety of domains including decreased strength, decreased tolerance to high-speed activities, and deterioration of performance due to lack of competition among others.[9,22] In a traditional preseason, flexibility, range of motion, and proximal control in the kinetic chain are slowly developed in the pitchers training regimen as these factors, when poor, are associated with upper extremity injuries.[5,12,21] In addition, a gradual ramp up to repetitive high velocity pitching, customary for these athletes, is required to protect against undue biomechanical stress seen in overhead sports.[5,8]

A previous study of a halt in play for 4 months due to a prolonged collective bargaining agreement in the National Football League showed a resulting relative increase in the number of Achilles tendon injuries when play resumed that season.[16] In baseball, as it stands, upper limb injuries in pitchers account for nearly 50% of all injury reports in the league and pitchers suffer greater time out of play compared to all other position players.[6] As the COVID-19 pandemic was an unprecedented time in organized

Rutgers eIRB approved this study (study number: Pro2020002038).

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sports, all levels of play are aware of the need to adapt. By analyzing the modified 2020 MLB season in its first month of play compared to the 5 prior seasons, we aim to identify any injury prone scenarios. This preliminary model gives athletes and training staff valuable information on training and load management when resuming competitive play.

We hypothesized that there would be an increase in injuries to MLB pitchers in the first 30 days of the 2020 season compared to the first 30 days of the prior 5 seasons. Secondarily, we hypothesized that there would be a greater risk of injury specifically to the upper limb during this time period. Lastly, we sought to find a correlation between the altered season's play and other relevant variables, such as age, pitching position, and injured list (IL) designation for MLB pitchers.

Materials and methods

Traditionally, the MLB preseason preparation, known as spring training, begins in early-to-mid February (ie, approximately 6 weeks), followed by regular season play of 162 games that are carried out over a 6-month period from early April to late September. The 2020 MLB preseason began on February 10, 2020 and proceeded, uninterrupted, until March 13, 2020 (ie, approximately 4 weeks) when the league announced that all spring training camps had been suspended to reduce the risk of COVID-19 contraction and spread. Players were given the option to stay in their team training camps or to return home. On March 16, 2020 a follow-up announcement from the league postponed the start of the regular season to the mid-May 2020 time frame, and it was on May 20, 2020 that select teams began to open their facilities and offer individual limited workouts for the players. On July 23, 2020, after restrained preparation, competitive play resumed under a shortened 60-game schedule with teams limited to their geographic region to reduce travel risk during the COVID-19 pandemic.

Injured MLB players can be placed on the IL temporarily for a predetermined length of time. Prior to the 2020 season, options included a 10-day IL for position players, 15-day IL for pitchers, 60-day IL for all players, and a 7-day IL for all players specifically diagnosed with a concussion. Once evaluated by a physician and deemed unfit to play, the player must remain inactive at a minimum for that IL's predetermined length of time. The player can, however, remain on any IL indefinitely until the player is fit to play and/or until the season ends.[20] For the shortened 2020 season, all players could be placed on a 10-day IL or 45-day IL for all injuries, a 7-day IL specifically for a concussion, or a special COVID-19 list with no minimum or maximum number of days ineligible. Prior to the 2020 MLB season, teams included 25 active players eligible to play in games with approximately 12 pitchers on the active roster.[3] Changes implemented prior to the restart of the 2020 season included expanding these rosters to 30 active players for the first 2 weeks, 28 for the next 2 weeks, and 26 for the remainder of the season. In 2020, teams were expanded to a maximum of 13 pitchers on the active roster.[23]

Study design

This retrospective cohort study, targeting injuries in MLB pitchers, was exempted from the institutional review board approval of the researcher's institution under the stipulation that individual players and teams be unidentifiable in the reported data. The data in our study were compiled using publicly accessible records of players placed on ILs from 2015 to 2020. These records came from 4 open access websites: rotoworld.com,[15] fangraphs.com,[19] foxsports.com,[14] and spotrac.com.[13] All injuries were confirmed using the transaction database found on the official MLB website (mlb.com).[11] No special permissions were required to access these sites on the Internet.

Patient selection

All MLB pitchers placed on any IL during the first 30 days of the 2015-2020 seasons were included in our study. Players were excluded from our data analysis if their placement on the IL was a continuation of an injury from the off-season, preseason, or the prior season. In total, 327 pitchers were included in our analysis within the selected dates during these 6 seasons of play.

Variables assessed

The primary variables assessed were player's age, designation as a starting pitcher (SP) or relief pitcher (RP), location of injury, type of injury, and IL designation as short term or long term. The IL was divided into 2 categories, short term (10- and 15-day ILs) and long term (45- and 60-day ILs). If a pitcher played both roles as SP and RP during the season, they were designated as an SP if at least 50% of their appearances in games in that season were in a starting role. Anatomic location of injury was divided into the following categories: (1) head and neck, (2) back and trunk, (3) shoulder, (4) upper arm and elbow, (5) forearm and wrist, (6) hand and finger, (7) hip and core, (8) upper leg and knee, (9) lower leg and ankle, (10) foot and toe, and (11) other. Category 11 included any non-musculoskeletal illness (eg, COVID-19 infection, gastrointestinal disorders, etc). Pitcher ailments that fell under category 11 were deemed to be outside of the scope of the study and were excluded from data analysis. When analyzing soft tissue injuries alone, non-soft tissue injuries (eg, acute traumatic fracture or dislocation) were excluded from the analysis as these are not traditionally considered overuse or training-deficit injuries. Lastly, the 7-day IL was also omitted as there were no diagnosed concussions documented in the first 30 days of the 2020 season of play. If a player was placed initially on a short-term IL but transferred to the long-term IL within the first 30 days of each season, they were considered as having a long-term injury for our data purposes.

Data analysis

Data were entered into an Excel spreadsheet (Microsoft Corporation) and data analysis was performed using SPSS software (version 27; IBM Corp, Armonk, NY, USA).

Analysis of categorical variables was based on frequencies and percentages, whereas analysis of continuous variables was based on mean differences and standard deviations. One-way analysis of variance and unpaired t-testing were used on continuous variables (age, risk analysis). Associations between the independent variables and categorical variables (injury status, player position, and IL designation) were assessed using chi-square tests for independence. P values $<.05$ were considered statistically significant (confidence interval [CI] = 95%). The main independent variable in all statistical tests was the first 30 days of each season. Where appropriate, the first 5 years of data were combined, so that 2015-2019 data were compared to 2020 data. In addition, for the 2020 season, variation in the first 15 days of the season vs. the second 15 days of the season was also studied.

Due to variation in the roster size and the number of pitchers carried on a team in 2020 compared to prior years, the total number of injuries of each season was not directly comparable. In the years 2015 through 2019, there were 360 active pitchers on each opening day. In 2020, there were 390 active pitchers on the opening day. Using the chi-square test for independence, we assessed the

proportion of injured to non-injured players for the combined 2015-2019 seasons vs. the 2020 season (Tables I and II). Second, the injury risks for each season were calculated after dividing the total number of injuries in the first 30 days of the season, as well as the risk of injury for each anatomic location, by the total number of active pitchers on the opening day of the respective season (Table III).[18] An unpaired t-test analysis was carried out to compare 2015-2019 with 2020 (Table IV).

Results

Total injuries

A chi-square test of independence was performed to examine the relation between total injuries and baseball seasons. The relation between these variables was significant, showing that a greater proportion of pitchers were injured during the first 30 days of the 2020 season compared to the first 30 days of the 5 prior baseball seasons [X^2 (1, N = 2190) = 82.0, P<.001] (Table I).

The average risk of all injuries to pitchers during the years 2015-2019 was 11.72% (range 8.89%-14.44%, n=1800), and in 2020 the risk was 29.7% (n=390). While the increase in risk in 2020 was nearly triple that of any prior year, it did not meet statistical significance for the overall body (P = .054; CI [−0.038 to 3.654]). However, when sub-analyzing injury risk for the specific body regions listed previously, a statistically significant increase in injury risk in 2020 was found for the following anatomic locations: back and trunk, shoulder, upper arm and elbow, forearm and wrist, and hand and finger (P = .02; CI [0.497-5.783]). See Table III for the anatomic distribution of injury risk during the first 30 days of each analyzed season.

Soft tissue injuries

A chi-square test of independence was performed to examine the relation between soft tissue injuries in pitchers and baseball seasons. The relation between these variables was significant, showing that a much greater proportion of soft tissue injuries occurred during the first 30 days of the 2020 season compared to the first 30 days of the 5 prior baseball seasons [X^2 (1, N = 2190) = 72.2, P < .001] (Table II).

When sub-analyzing the body regions where pitchers are most prone to injury, there was again a large statistically significant increase in soft tissue injury risk to the back and trunk, shoulder, upper arm and elbow, and forearm and wrist for pitchers in 2020 compared to 2015-2019 (P=.009; CI [1.281-5.934]). See Table IV for the anatomic distribution of soft tissue injury risk during the first 30 days of each analyzed season.

Injury distribution by relevant variables

The distribution of injuries among SP and RP during the first 30 days of the 2020 season was analyzed. It was found that, of pitchers injured during the first 15 days of the season, 40% were SP and the remaining were RP. During the second 15-day period, however, the number of RP injuries increased to 78%. RPs were injured more frequently in the second half of the first 30 days of the 2020 season than in the first half (60% vs. 78%, P = .04) (Table V). There was no difference in the percentage of SP vs. RP placed on the IL in any of the 5 MLB seasons (Table VI).

When analyzing length of injury, there was also no significant difference in the proportion of pitchers placed on the short-term vs. long-term IL in 2020 compared to the prior 5 seasons (Table VII).

The average age of injured pitchers during the 2015-2019 seasons was 29.6 years (range 28.6-30.4) and 28.8 years for injured pitchers in 2020. While one-way analysis of variance showed a significant difference in the distribution of age (P=.048), no single year was statistically significant from the others upon post hoc analysis (Table VIII).

Table I
Proportion of total injuries to pitchers in the 2015-2019 seasons vs. the 2020 MLB season.

Total injury	2015-2019	2020	Test	*P* value
Injured	211	116	Chi-square	<.001
Non-injured	1589	274		
Total pitchers	1800	390		

MLB, Major League Baseball.

Table II
Proportion of soft tissue injuries to pitchers in the 2015-2019 seasons vs. the 2020 MLB season.

Soft tissue injury	2015-2019	2020	Test	*P* value
Injured	201	108	Chi-square	<.001
Non-injured	1599	282		
Total pitchers	1800	390		

MLB, Major League Baseball.

Discussion

MLB was one of the first team sports leagues to resume organized training and competitive play in the setting of the COVID-19 health pandemic. Significant modifications to preseason training and regular season play may have been particularly disadvantageous to professional pitchers who are positioned at baseline, the most injury prone position. By comparison to the 5 prior seasons, there was a significantly larger increase in pitching injuries in 2020. Further, when specifically looking at body regions most commonly injured in baseball players, the trunk and upper limb kinetic chain showed a significantly increased risk for injury in the first 30 days of the 2020 season when compared to 2015-2019. Age was not a factor in injury risk.

As previously discussed, there were several changes to the 2020 MLB season as a result of the COVID-19 pandemic. These changes included a shortened spring training (specifically from 6 weeks to 4 weeks), followed by a delayed (approximately 10 weeks for select teams) restart of spring training activities of variable duration (depending upon specific circumstances related to a given team or player), a condensed regular season schedule, and frequent delays in play due to COVID-19 outbreaks in select teams. Therefore, pitchers were likely not afforded a conventional preseason routine: full aerobic conditioning, a gradual increase to high volume and high velocity pitching, or opportunities to correct errors in faulty mechanics. It has been previously established that participation in preseason training correlates with a decreased injury incidence rate in athletes,[7] and elite players who participate in a greater number of full preseason conditioning sessions have a reduced likelihood to miss regular season games due to injury.[24]

In 2020, teams played a regular season schedule of 60 games in 67 days, equating to 0.90 games played per day. In comparison, during the 2019 season, teams played a total of 162 games in 193 days, equating to a rate of 0.84 games played/day. This condensed and irregular schedule in 2020 introduced greater physical demand on the pitchers and increased the potential for overuse injury. Starters quickly became injured in the first 2 weeks of the 2020 season, and more coaching staff decisions were made to decrease the workload for star players to less than 5 innings per start on average.[2] Specifically, as of August 18, 2020, SPs were pitching 4.7

Table III
Total injury risk of each anatomic location by year and averaged risks of 2015-2019 MLB seasons.

	2020 Inj risk	2015-19 Avg inj risk	2019 Inj risk	2018 Inj risk	2017 Inj risk	2016 Inj risk	2015 Inj risk
Head and neck (%)	0.77	0.33	0	0.28	0.28	0	0.11
Hand and finger (%)	1.54	0.56	0.56	0.56	0.83	0.56	0.28
Forearm and wrist (%)	4.10	0.72	0.83	1.11	0.83	0	0.83
Upper arm and elbow (%)	6.67	3.06	3.33	2.22	2.78	3.61	3.33
Shoulder (%)	7.44	2.44	1.67	3.06	2.22	2.50	2.78
Back and trunk (%)	4.62	1.89	1.67	2.78	3.33	0.56	1.11
Hip and core (%)	2.05	0.78	0.56	1.67	0.83	0.28	0.56
Upper leg and quad and hamstring and knee (%)	2.05	1.17	1.67	1.94	0.83	0.83	0.56
Lower leg and ankle (%)	0.26	0.56	0.28	0.56	0.83	0.56	0.56
Foot and toe (%)	0.26	0.17	0.28	0.28	0.28	0	0
Total injuries	116	211	39	52	48	32	40
Total pitchers	390	1800	360	360	360	360	360
Total injury risk (%)	29.74	11.72	10.83	14.44	13.33	8.89	11.11

MLB, Major League Baseball; *Inj*, injury; *Avg inj*, average injury.

Table IV
ST injury risk of each anatomic location by year and averaged risks of 2015-2019 MLB seasons.

	2020 ST inj risk	2015-19 Avg ST inj risk	2019 ST inj risk	2018 ST inj risk	2017 ST inj risk	2016 ST inj risk	2015 ST inj risk
Head and neck (%)	0.27	0.28	0	0.28	0.28	0	0.83
Hand and finger (%)	0.51	0.56	0.56	0.56	0.83	0.56	0
Forearm and wrist (%)	4.10	0.61	0.83	0.83	0.83	0	0.56
Upper arm and elbow (%)	6.41	2.94	3.33	1.94	2.77	3.33	3.33
Shoulder (%)	7.44	2.44	1.67	3.10	2.22	2.50	2.78
Back and trunk (%)	4.36	1.89	1.67	2.78	3.33	0.56	1.11
Hip and core (%)	2.10	0.78	0.56	1.67	0.83	0.28	0.56
Upper leg and quad and hamstring and knee (%)	2.10	1.17	1.67	1.94	0.83	0.83	0.56
Lower leg and ankle (%)	0.26	0.50	0.28	0.56	0.56	0.56	0.56
Foot and toe (%)	0.26	0	0	0	0	0	0
Total ST injuries	108	201	38	50	45	31	37
Total pitchers	390	1800	360	360	360	360	360
Total ST injury risk (%)	27.70	11.17	10.56	13.89	12.50	8.61	10.27

ST, soft tissue; *MLB*, Major League Baseball; *Inj*, injury; *Avg*, average.

Table V
Number of pitchers designated to the IL by position during the first 15 days and second 15 days of the 2020 season.

Position	July 23-August 7, 2020	August 8-23, 2020	Test	*P* value
SP	26	13	Chi-square	.04
RP	39	45		

IL, injured list; *SP*, starting pitcher; *RP*, relief pitcher.

innings per start on average, down from 5.2 innings per start in 2019. This is the largest year-to-year drop since 1974, when MLB first introduced the "save" statistic and RP utilization subsequently increased.[2] As a result, there was a rapid increase in the number of injuries suffered by RP, which our data support. Teams were not prepared and despite allowances to increase the bullpen in size, more injuries occurred to all pitchers regardless of whether the pitcher was exclusively or primarily an SP or RP.

In addition to the increased frequency of games played, game schedules were met with interruptions as several teams were forced to suspend play due to COVID-19 outbreaks within the organizations and reschedule missed games in harried fashion. A total of 36 games were postponed in the first 30 days of the 2020 season,[1] an increase compared to all prior seasons. The previous record for game postponements in a single month was 28 games in April 2018.[4] Weather-related postponements are common in spring for teams playing in outdoor stadiums, but these delays in play typically only result in 1 day off, whereas teams affected by COVID-19 were barred from playing games (and restricted from practicing) for up to 17 days in the case of the St. Louis Cardinals in July-August 2020.[17] These interruptions in play can contribute to the inability to settle into a rhythm among pitchers and has been previously associated with an increased injury incidence.[8]

Despite the increase in injuries to pitchers during the first 30 days of the 2020 season, there was no significant change in the time spent on the IL as a result of injury. With the knowledge that the regular season was a mere 67 days, pitchers may have rushed through injury recovery hoping to contribute to a team's chance of securing a playoff opportunity. We speculate that longer-term harmful effects on the physical health of pitchers may present themselves in the off-season and more extensive collection of data should be further monitored for a trend.

Limitations

Our studied data were limited to injured pitchers that appeared on the IL during our specified time intervals. This does not account for players with injuries that did not require placement on an IL

Table VI
Percentage of pitchers placed on the IL each year, based on position.

Position	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	Test	*P* value
SP	37.5	42.4	52.1	30.8	43.2	31.7	Chi-square	.15
RP	62.5	57.6	47.9	69.2	56.8	68.3		

IL, injured list; *SP*, starting pitcher; *RP*, relief pitcher.

Table VII
Percentage of IL designations during the first 30 days of each season.

IL designation	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	Test	*P* value
Short-term	57.5	54.5	72.9	75.0	59.1	75.6	Chi-square	.04*
Long-term	42.5	45.5	27.1	25.0	40.9	24.4		*Not significant based on post hoc analysis

IL, injured list.

Table VIII
Average age of MLB pitchers during the first 30 days of each season.

Age (yr)	2015	2016	2017	2018	2019	2020	Test	*P* value
Average	29.88	29.18	28.56	30.44	30.07	28.8	One-way ANOVA	.048*
SD	4.21	4.30	3.45	3.88	3.83	3.62		*Not significant based on post hoc analysis

MLB, Major League Baseball; *ANOVA*, analysis of variance; *SD*, standard deviation.

since players can miss up to 2 consecutive weeks of the season without receiving this IL designation, although this is typically done when players have minor injuries and are expected to return earlier than the 10-day minimum of the shortest IL. We also were not able to account for specific outcomes of injuries, such as surgeries required or return to play performance as all collected data were de-identified. Additionally, we assumed that each team utilized the maximum number of pitchers available at the start of each season; thus, our calculated population of pitchers used to determine injury risk may have been larger than in reality. Players placed on the IL prior to the first day of each season were excluded from our study, yet it is possible for pitchers to have an injury during the preseason but first appear on the IL during the first day of the season. Actual injury risks for MLB pitchers may differ for these reasons. One last way that this study could be improved would be to utilize MLB's Health and Injury Tracking System, if granted access for research purposes. Our study used data extracted from publicly available websites, which were subsequently confirmed for accuracy using the transaction database found on the official MLB website.

Conclusions

To our knowledge this is the first study to analyze the risk of injury to MLB pitchers during the first 30 days of the COVID-19 halted 2020 season. Our research found that a greater proportion of overuse injuries occurred in 2020 as well as an increased risk of trunk and upper limb injury to pitchers compared to the 5 prior seasons. The overall impact of unanticipated interruptions to training and competition in player performance is an area that requires further study. These findings should be compared with injury trends and return-to-sport strategies used in non-U.S. and non-Canadian baseball leagues that have resumed play in the COVID-19 era. In addition, further research is needed to explore the role that innings pitched, days off between game appearances, and total workload during the preseason and regular season may have on injuries. These areas could be examined prospectively during the upcoming 2021 season, which may continue to face pandemic-related alterations.

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