

# Professional and Amateur Pitchers' Perspective on the Ulnar Collateral Ligament Injury Risk

Danica D. Vance,<sup>\*†</sup> MD, Frank J. Alexander,<sup>†</sup> MS, ATC, Brian W. Kunkle,<sup>‡</sup> PhD, Mark Littlefield,<sup>§</sup> ATC, and Christopher S. Ahmad,<sup>†</sup> MD

*Investigation performed at Columbia University Medical Center, New York, New York, USA*

**Background:** Medial ulnar collateral ligament (UCL) injury is increasingly prevalent in professional baseball pitchers, and significant research has been devoted to understanding the risk factors and prevention strategies associated with it. To date, no study has investigated what the players themselves believe causes and prevents the injury.

**Purpose:** To evaluate the opinions of UCL injuries among pitchers, including professional athletes.

**Study Design:** Cross-sectional study.

**Methods:** A total of 214 baseball pitchers (45 high school/college, 169 Major League Baseball [MLB]/Minor League Baseball) completed a 52-item questionnaire designed to evaluate their opinions on the cause of UCL injuries, injury prevention, and Tommy John surgery. Overall, 51 of the 214 pitchers had previously experienced a UCL injury. The frequency of the selection of each answer option was measured. Additionally, chi-square tests were used to compare (1) responses between professional and nonprofessional pitchers and (2) responses between pitchers with and without a previous UCL injury.

**Results:** Only 45% of pitchers thought that UCL injuries are avoidable in MLB. Additionally, 55% of pitchers with a UCL injury had a history of elbow injuries as an adolescent/child, compared with 18% in the uninjured group ( $P < .0001$ ). Also, 72% of all surveyed pitchers agreed that fatigue over the course of a season increases the risk of UCL injuries, and the majority of pitchers agreed that inadequate rest from throwing both during the off-season (61%) and the season (59%) increases the risk of UCL injuries. Moreover, 59% of pitchers believed that a 6-man starting rotation would decrease the incidence of UCL injuries. Professional and nonprofessional pitchers significantly differed ( $P = .005$ ) in the type of pitch most prone to causing UCL injuries.

**Conclusion:** Pitchers with a previous childhood elbow injury had a significantly higher incidence of UCL injuries during their adult career, suggesting possible predisposition to UCL injury and warranting further research. Fatigue and inadequate rest were of greatest concern among all pitchers for an increased risk of UCL injuries. Understanding and acknowledging the opinions that players have regarding UCL injuries are important to improve UCL education, prevention, and treatment.

**Keywords:** elbow; ulnar collateral ligament; pitching; baseball; Tommy John

Medial ulnar collateral ligament (UCL) injuries have become increasingly prevalent in professional baseball pitchers over the past decade.<sup>10,26</sup> As the elbow's primary stabilizer to valgus force during overhead throwing,<sup>3</sup> the UCL undergoes significant stress during pitching, predisposing it to injuries.<sup>10</sup> Developed in 1974 by Dr Frank W. Jobe, UCL reconstruction, or "Tommy John surgery," has become the gold standard of treatment for UCL injuries in professional pitchers.<sup>1,10</sup> It is now estimated that approximately 25% of Major League Baseball (MLB) pitchers undergo Tommy John surgery for a UCL injury.<sup>10,20</sup> This high prevalence has made UCL injury prevention a mainstream discussion topic across all levels of baseball and

their respective media. Significant research in both biomechanics and epidemiology has been devoted to understanding the risk factors associated with a UCL injury. Although the cause is likely multifactorial, previous studies have suggested possible risk factors to include pitching mechanics, pitching fatigue, pitch type, and pitch velocity.<sup>18</sup> The UCL injury epidemic has even led several national baseball associations to publish guidelines to limit the pitch count for young athletes in the hopes of preventing future such injuries.<sup>14</sup>

Earlier questionnaire studies surveyed the public and media's opinions on UCL injuries.<sup>1,9</sup> The emphasis of these studies was to elude common misconceptions that have formed regarding Tommy John surgery, including indications and postoperative performance. They gathered questionnaire data on players, coaches, parents, and media personnel<sup>1,9</sup> and concluded that better

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education regarding UCL injuries and their respective surgery was warranted. However, no study to date has evaluated the players' opinions on what causes a UCL injury and how to prevent it. Do players believe that a large increase in pitched innings from one season to the next raises the risk of UCL injuries? Do players think that having a 6-man starting rotation will decrease their risk of UCL injuries? These questions are just few of the many that we sought out to answer. Additionally, no study to date has investigated what factors influence a player's opinion about UCL injuries, such as his achieved level of play or whether he personally had a UCL injury. It has been the senior author's (C.S.A.) experience that many pitchers can explain the cause of a UCL injury. Therefore, the objective of this study was to evaluate the opinions of UCL injuries regarding risk factors and prevention among pitchers of various levels, including professional athletes.

## METHODS

This study was approved through the research compliance administration system at the respective institution. An online survey (Qualtrics; <https://www.qualtrics.com>) was created to evaluate players' knowledge of UCL injuries as well as their opinions of associated risks and prevention. The survey questions were developed based on the current literature of UCL injuries and Tommy John surgery. Two orthopaedic physicians, including the head team doctor for an MLB team (C.S.A.), and a sports medicine athletic trainer (F.J.A.) developed the survey. The survey consisted of 52 questions in several different formats including multiple choice, selection from a list of options, and open-ended questions. Questions were divided into 6 main categories: (1) demographics/medical history, (2) UCL injuries, (3) individual variables as risks for UCL injuries, (4) pitching variables as risks for UCL injuries, (5) throwing fatigue, and (6) surgical variables and outcomes. The majority of the multiple-choice questions were presented as statements, and the players were asked to choose the degree to which they agreed or disagreed with the statement in question (strongly agree, agree, neutral, disagree, or strongly disagree). The survey was available in both Spanish and English versions.

### Demographics/Medical History

To assess the players' background and medical history, questions were asked regarding highest level of play,

position, and handedness. Additionally, players were asked whether they had a history of elbow injuries as a child or a history of a diagnosis of a UCL injury and/or Tommy John surgery for a complete UCL tear. Players were also asked how often they had pitched through elbow pain and stiffness and had trouble loosening up during warm-ups.

### UCL injuries

Respondents were asked to agree or disagree with statements regarding a pitcher's elbow anatomy and causes of UCL injuries. These included questions related to whether UCL injuries are a result of a single throw or multiple smaller injuries over time. Also asked was whether UCL injuries can be avoided in professional pitchers. All answers were in a multiple choice format.

### Individual Variables

Players were asked what individual variables put a pitcher at risk for injuring his UCL. This included height, weight, age, or a prior shoulder injury. These questions were presented as statements with the multiple-choice option to agree or disagree. Additionally, players were presented with a sliding scale from 80 to 105 mph and asked to choose the average pitching velocity that causes a UCL tear.

### Pitching Variables

Respondents were asked specifics on pitch type and whether it increases the risk of UCL injuries. This included if a specific pitch type (fastball, slider) was more prone to UCL injuries and if developing a new pitch increased a player's risk for these injuries. Additionally, we asked whether players agreed or disagreed that pitching mechanics influence the risk of UCL injuries.

### Throwing Fatigue

In this section, players were asked details regarding whether pitch fatigue increases the risk of UCL injuries. Questions included whether increasing the number of innings pitched within a season or from one season to the next put a player at a higher risk for injuries and whether inadequate rest between games or in the off-season increased the risk of injuries. Additionally, players were asked their opinions about potential preventative measures against UCL injuries such as expanding the number of pitchers on a roster, moving to a 6-man starting rotation, and adding

\*Address correspondence to Danica D. Vance, MD, Department of Orthopedic Surgery, New York-Presbyterian/Columbia University Medical Center, 622 West 168th Street, PH11, New York, NY 10032, USA (email: [ddv305@gmail.com](mailto:ddv305@gmail.com)) (Twitter: [@ddv305](https://twitter.com/ddv305)).

<sup>†</sup>Department of Orthopedic Surgery, New York-Presbyterian/Columbia University Medical Center, New York, New York, USA.

<sup>‡</sup>John P. Hussman Institute for Human Genomics, Miller School of Medicine, University of Miami, Miami, Florida, USA.

<sup>§</sup>New York Yankees, New York, New York, USA.

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a "rest" disabled list for pitchers. Questions were presented as statements, and respondents chose to agree or disagree.

### Surgical Variables and Outcomes

Players were asked whether they thought pitching velocity increased after Tommy John surgery and whether undergoing Tommy John surgery has a negative or positive impact on the signing of future contracts or scholarships. Also asked was whether pitchers returned to their preinjury level of performance after Tommy John surgery. These questions were presented as statements, and players were asked if they agreed or disagreed. Two open-ended questions were included in this section. The first asked the players who had suffered a previous UCL injury to list what factors led to that injury. The second question asked uninjured players what factors had helped them avoid UCL injuries.

### Data Collection

Players completed the online 52-question survey (Appendix) in person on an electronic device either during training camp for an MLB team or, for nonprofessional pitchers, during doctor office visits at the respective institution. Participants were not limited in the time that they had to complete the questionnaire. All participants self-identified as pitchers. Inclusion criteria were baseball pitchers who had reached the high school, college, Minor League Baseball (MiLB), or MLB level. Each participant completed the survey anonymously without influence or assistance from any of the coauthors. A total of 214 baseball pitchers participated in the questionnaire. However, the numbers for each individual response varied slightly depending on whether the questionnaire was fully answered by the respective player.

### Statistical Analysis

Data were analyzed using SAS software (SAS Institute). All data analyses were performed by a research scientist (B.W.K.) with a PhD in epidemiology and postdoctoral training in statistical genetics and biostatistics. The frequency of the selection of each answer option was measured. For agreement questions, answer choices were grouped together into 3 categories: (1) strongly agree/agree, (2) neutral, and (3) strongly disagree/disagree. Additionally, chi-square tests (SAS software) were used to compare (1) responses between professional and nonprofessional pitchers and (2) responses between pitchers with and without a previous UCL injury.

## RESULTS

Of the 214 participants, 45 pitched at the high school/college level (nonprofessional), and 169 pitched for MLB/MiLB (professional). Overall, 51 pitchers (24%) had experienced a previous UCL injury (Table 1). Specifically, 23% (3/13) of surveyed MLB pitchers, 23% (35/154) of surveyed

TABLE 1  
Demographics of Pitchers<sup>a</sup>

	n (%)
Highest level of play	
College	25 (11.7)
High school	20 (9.4)
Minor League Baseball	155 (6.5)
Major League Baseball	14 (72.4)
Total	214 (100.0)
Current position	
Reliever	76 (38.6)
Starter	113 (57.4)
Starter/reliever	8 (4.0)
Total	197 (100.0)
Throwing arm	
Right-handed	177 (84.3)
Left-handed	33 (15.7)
Total	210 (100.0)
Previous UCL injury	
Yes	51 (24.4)
No	158 (75.6)
Total	209 (100.0)

<sup>a</sup>UCL, ulnar collateral ligament.

MiLB pitchers, and 31% (13/42) of nonprofessional pitchers reported a previous UCL injury.

Of the 51 players who had injured their UCL, 36 (71%) underwent UCL reconstruction, and 5 (10%) underwent UCL repair. The remaining 10 (20%) underwent nonoperative treatment with physical therapy, rest, and/or platelet-rich plasma injections. Also, 83% of players with a UCL injury who underwent either UCL reconstruction or UCL repair missed a minimum of 12 months before returning to play. In contrast, 70% of pitchers with a UCL injury who underwent nonoperative management returned to play within 6 months (Table 2).

For players without a previous UCL injury, the majority responded that they had never pitched through elbow pain (60%) or stiffness (58%) or had trouble loosening up their elbow during warm-ups (72%). For players with a previous UCL injury, 50% of pitchers who underwent operative management and 40% who underwent nonoperative management reported that they had never pitched through elbow pain since returning to play.

Overall, 45% of pitchers believed that UCL injuries can be avoided in professional pitchers. Of the surveyed pitchers, 50% believed that UCL injuries are caused by an accumulation of smaller injuries over time; 50% did not think that UCL injuries are caused by a single throw, while 29% were neutral to this question. Fifty-one percent of pitchers believed that pitching after a rain delay increases their risk of UCL injuries, while 27% were neutral to this question (Table 2).

Regarding individual characteristics and UCL injuries, the majority of players did not think that height (62% disagree, 26% neutral, 12% agree) or weight (52% disagree, 28% neutral, 20% agree) plays a role in UCL injuries. Fifty percent of surveyed pitchers believed that higher pitching velocity plays a role in UCL injuries, while 34% were

TABLE 2  
Pitchers' Responses to Questions  
Related to Previous UCL Injuries<sup>a</sup>

	n (%)
Treatment for UCL injury <sup>b</sup>	
UCL reconstruction	36 (70.6)
UCL repair	5 (9.8)
Nonoperative management (physical therapy, PRP, rest)	10 (19.6)
Total	51 (100.0)
Time to return to play <sup>b</sup>	
Operative treatment (Tommy John surgery or UCL repair)	
6 mo	3 (7.2)
9 mo	4 (9.8)
12 mo	13 (31.7)
14 mo	12 (29.3)
>16 mo	9 (22.0)
Total	41 (100.0)
Nonoperative treatment	
6 mo	7 (70.0)
9 mo	1 (10.0)
12 mo	2 (20.0)
14 mo	0 (0.0)
>16 mo	0 (0.0)
Total	10 (100.0)
UCL injuries can be avoided in professional pitchers	
Agree/strongly agree	94 (45.0)
Neutral	55 (26.3)
Disagree/strongly disagree	60 (28.7)
Total	209 (100.0)
Rain delay increases the risk of UCL injuries	
Agree/strongly agree	105 (50.5)
Neutral	56 (26.9)
Disagree/strongly disagree	47 (22.6)
Total	208 (100.0)

<sup>a</sup>PRP, platelet-rich plasma; UCL, ulnar collateral ligament.

<sup>b</sup>Answered only by pitchers with a previous UCL injury.

neutral to this question. Additionally, 67% of players believed that 90 to 95 mph is the average pitching velocity of players sustaining UCL injuries.

In evaluating pitching variables and their effects on UCL injuries, the type of pitch that was chosen to most likely cause a UCL injury was a curveball (42%). Forty-six percent of surveyed pitchers thought that developing a new pitch increases their risk of UCL injuries, while 31% were neutral to this question. Overall, 83% of the surveyed pitchers believed that pitching mechanics influence UCL injuries (Table 3).

Furthermore, 59% of surveyed pitchers believed that the overuse of pitchers by managers/coaches put them at an increased risk of UCL injuries (Table 3). Regarding the effect of pitching fatigue on UCL injuries, 72% of surveyed pitchers thought that fatigue over the course of a season increases the risk of UCL injuries, while 21% were neutral to this question. Additionally, 46% of pitchers believed that pitching fatigue during a single outing increases the risk of UCL injuries, while 31% were neutral to this question. The majority of surveyed pitchers thought that inadequate rest

TABLE 3  
Pitchers' Responses to Questions on Pitching Variables<sup>a</sup>

	n (%)
Which pitch has the highest risk of causing a UCL injury?	
Curveball	86 (41.8)
Slider	30 (14.5)
Cutter	12 (5.8)
4-seam fastball	24 (11.7)
2-seam fastball	9 (4.4)
Splitter	45 (21.8)
Total	206 (100.0)
Developing a new pitch can increase the risk of UCL injuries	
Agree/strongly agree	95 (45.9)
Neutral	65 (31.4)
Disagree/strongly disagree	47 (22.7)
Total	207 (100.0)
Overuse of pitchers by managers/coaches increases the risk of UCL injuries	
Agree/strongly agree	120 (58.5)
Neutral	56 (27.3)
Disagree/strongly disagree	29 (14.2)
Total	205 (100.0)

<sup>a</sup>UCL, ulnar collateral ligament.

from throwing both during the off-season (61%) and the season (between outings) (59%) increases the risk of UCL injuries. In evaluating ways to prevent UCL injuries, 59% of all surveyed pitchers, including 58% (97/166) of the professional pitchers (MLB/MiLB), answered "yes" to believing that expanding to a 6-man starting rotation would decrease a player's risk of UCL injuries. Additionally, 50% of all surveyed pitchers, specifically, 45% (74/164) of professional pitchers (MLB/MiLB) and 68% (28/41) of nonprofessional pitchers (college/high school), thought that establishing a "rest" disabled list for pitchers would decrease the risk of UCL injuries, while 31% were neutral to this question (Table 4).

In evaluating pitchers' opinions on Tommy John surgery outcomes, 43% of surveyed pitchers believed that players return to preinjury performance after Tommy John surgery, while 46% were neutral to this question, and 33% of surveyed pitchers thought that velocity increases after Tommy John surgery, while 51% were neutral to this question (Table 5).

A comparison of players with a previous UCL injury to those without an injury identified significant differences ( $P \leq .05$ ). Overall, 55% of pitchers with a UCL injury had a history of elbow injuries as an adolescent/child, compared with 18% in the noninjured group ( $P < .0001$ ). Pitchers with a previous UCL injury did not believe that such injuries can be avoided in professional pitchers (51% in the noninjured group thought that UCL injuries are avoidable vs 26% in the UCL group;  $P = .03$ ) or that pitchers have stronger ligaments than other players (41% of the noninjured group thought that ligaments are stronger vs 22% of the UCL group;  $P = .0004$ ) (Table 6).

TABLE 4  
Pitchers' Responses to Questions on Throwing Fatigue<sup>a</sup>

	n (%)
Fatigue over a course of a season increases the risk of UCL injuries	
Agree/strongly agree	149 (71.6)
Neutral	43 (20.7)
Disagree/strongly disagree	16 (7.7)
Total	208 (100.0)
Fatigue during a single outing increases the risk of UCL injuries	
Agree/strongly agree	96 (46.4)
Neutral	64 (30.9)
Disagree/strongly disagree	47 (22.7)
Total	207 (100.0)
Inadequate rest during the off-season increases the risk of UCL injuries	
Agree/strongly agree	126 (60.9)
Neutral	43 (20.8)
Disagree/strongly disagree	38 (18.3)
Total	207 (100.0)
Inadequate rest during the in-season increases the risk of UCL injuries	
Agree/strongly agree	122 (59.2)
Neutral	52 (25.3)
Disagree/strongly disagree	32 (15.5)
Total	206 (100.0)
Expanding to a 6-man starting rotation will decrease UCL injuries	
Yes	121 (58.6)
No	86 (41.4)
Total	207 (100.0)
Adding a "rest" disabled list will decrease UCL injuries	
Agree/strongly agree	39 (19.1)
Neutral	64 (31.2)
Disagree/strongly disagree	102 (49.7)
Total	205 (100.0)

<sup>a</sup>UCL, ulnar collateral ligament.

In comparing answers between professional and nonprofessional pitchers, several opinions were significantly different. Significantly more nonprofessional pitchers believed that throwing sliders increases their risk of UCL injuries compared with professional pitchers (78% vs 45%, respectively;  $P = .005$ ). Additionally, more nonprofessional versus professional pitchers believed that managers/coaches' overuse of pitchers leads to an increased risk of UCL injuries (87% vs 51%, respectively;  $P < .001$ ).

## DISCUSSION

This is the first study to evaluate professional athletes' opinions on UCL injuries, including risk factors, injury prevention, and impact of Tommy John surgery, on their career. Previous UCL questionnaire studies have focused instead on the media's perception of UCL injuries<sup>1</sup> or pitching factors in adolescent nonprofessional pitchers.<sup>19</sup> Furthermore, it is also the first study that indicates that

TABLE 5  
Pitchers' Responses to Questions on Surgical Variables and Outcomes

	n (%)
Pitchers return to preinjury performance after Tommy John surgery	
Agree/strongly agree	89 (43.2)
Neutral	95 (46.1)
Disagree/strongly disagree	22 (10.7)
Total	206 (100.0)
Throwing velocity increases after Tommy John surgery	
Agree/strongly agree	68 (33.0)
Neutral	104 (50.5)
Disagree/strongly disagree	34 (16.5)
Total	206 (100.0)

childhood/adolescent elbow injuries may be a possible precursor to a future UCL injury at the professional level.

The patient's perspective can be valuable in helping guide injury prevention and treatment protocols. As health care providers, we are privileged to medical knowledge that can improve players' health care status; however, it is the athlete who knows best how these improvements affect his or her well-being.<sup>6</sup> Simply put, there are few better sources of information than those patients who are most affected by the injury. This study sought to add to the current knowledge of UCL injuries by understanding the pitcher's perspective.

Among the 214 pitchers evaluated, we found 51 pitchers (24%) with a previous UCL injury. This included 23% (3/13) of surveyed MLB pitchers and 23% (35/154) of surveyed MiLB pitchers. Current data suggest that around 25% of MLB pitchers have undergone Tommy John surgery,<sup>18</sup> suggesting that our data are reasonably comparable with the general population.

The increasing prevalence of UCL injuries in MLB over the past several years has led to growing concern within the baseball community.<sup>8,10,12,13,22</sup> Only 45% of the surveyed pitchers in this study believed that UCL injuries are avoidable. There is some validation to this in the current literature, with data showing that elbow injuries occur more often in pitchers than any other player position.<sup>7</sup> Furthermore, pitchers have been shown to require the highest numbers of days to return to play after an elbow injury compared with other player positions.<sup>7</sup> This mind-set among pitchers regarding the "inevitable" could lead to consequences down the road. Players who believe that the injury is unavoidable may decline proper arm care for injury prevention and may not react to early signs and symptoms of a UCL injury, thus affecting treatment and outcomes.

Of the surveyed pitchers, 42% thought that throwing curveballs creates a higher risk of UCL injury compared with other types of pitches. Previous research on pitch type and risks for UCL injuries has been inconclusive. A questionnaire by Lyman et al<sup>19</sup> among youth pitchers found that breaking balls such as sliders and curveballs increased the

TABLE 6  
Comparison of Responses for Pitchers With a Previous UCL Injury Versus Pitchers Without a UCL Injury<sup>a</sup>

Did you suffer an elbow injury as a child/adolescent?	Yes	No	P Value	
UCL injury	28	23	<.0001	
No injury	28	130		
Can UCL injuries be avoided in professional pitchers?	Agree	Neutral	Disagree	P Value
UCL injury	13	17	20	.03

<sup>a</sup>Data are reported as No. UCL, ulnar collateral ligament.

risk of elbow and shoulder pain. This is in contrast to Keller et al,<sup>18</sup> who found that MLB pitchers with UCL tears pitched a significantly higher percentage of fastballs when compared with controls ( $P = .035$ ). Both fastballs and curveballs place high loads across the elbow, but it might be the mastering of a new set of pitching mechanics required for curveballs that puts the elbow more at risk.<sup>19</sup>

Throwing fatigue and inadequate rest as major risk factors for a UCL injury were common themes among surveyed pitchers. The majority of pitchers (72%) believed that pitching fatigue over the course of a season increases the risk of UCL injuries. Additionally, the majority of pitchers believed that inadequate rest from throwing, both in the off-season (61%) and during the season itself (59%), increases the risk of UCL injuries. The surveyed pitchers' opinions are consistent with prior research. Olsen et al<sup>21</sup> reviewed 95 adolescent pitchers with previous elbow or shoulder surgery and found that 52% of the injured group regularly pitched through elbow fatigue compared with 11% of controls. Through a multivariable analysis, they found that a pitcher who pitches through fatigue is 36 times more likely to experience an injury.<sup>14,21</sup> Other studies have also demonstrated overuse as a major risk factor for a UCL injury, with players who pitched more than 100 innings per year having triple the risk of serious elbow injuries.<sup>14,15</sup> Most recently, Erickson et al<sup>11</sup> demonstrated that 74% players who threw a complete game during the season spent time on the disabled list compared with only 20% of controls. Successful pitching is a coordinated effort of muscle groups throughout the entire body, including the core and lower extremities. Fatigue or improper rest in any part of the kinetic chain can result in higher loads across the elbow and can cause injuries.<sup>24</sup> These findings necessitate the importance of true rest time from pitching.

With increases in the rate of Tommy John surgery in MLB pitchers, the baseball community is desperately looking for a preventative measure. Among those suggested is the possibility of changing to a 6-man starting rotation. Fifty-nine percent of the professional pitchers in this study agreed that expanding to a 6-man starting rotation would decrease the risk of UCL injuries. Those in favor of the 6-man starting rotation often bring up Japan, another baseball hotbed, as an example.<sup>23</sup> In contrast to the United States, Tommy John surgery is not as prevalent within Japanese professional baseball, despite consistently high pitch loads.<sup>23</sup> Although several factors could be in play, one obvious difference is that Japanese teams use a 6-man

starting rotation. This means that pitchers typically get at least 5 days of rest between games, potentially reducing their throwing fatigue and protecting their arm.<sup>23</sup>

Across the surveyed pitchers, we examined the differences in survey answers between pitchers with a previous UCL injury and those without. The most striking contrast between the 2 groups was that those pitchers with a previous UCL injury had a considerably higher rate of elbow injuries as an adolescent or child ( $P < .0001$ ). Previous studies have focused on pitch velocity, pitch type, pitching while fatigued, and pitch count as risk factors for a UCL injury.<sup>4,5,17,18,21</sup> Not yet extensively evaluated is whether having an elbow injury as a child increases a player's risk of UCL injuries in the future. Childhood/adolescent medial elbow injuries are often grouped under the term "Little League elbow" and are thought to be caused by repetitive microtrauma at the injury site.<sup>16,25</sup> The majority of these injuries are treated nonoperatively with rest and physical therapy. Perhaps sustaining a throwing elbow injury as a child weakens the UCL, causing unknown fibrosis and scarring. Studies have demonstrated changes within the UCL such as ligament thickening and calcification even in asymptomatic young pitchers.<sup>2</sup> It is unclear how these changes, whether adaptive or pathological, affect the healing properties of the UCL when injured.<sup>2</sup> If the ligament never heals to full strength after an injury, it is predisposed to a further, more serious throwing injury down the line. Another possibility could be that these early childhood elbow injuries are related to poor pitching mechanics, volume of throwing, or fatigue, and if these variables are never corrected as the player matures, then future UCL injuries are sustained. Further research is warranted to fully evaluate whether childhood elbow injury is a predisposing factor for UCL injury and whether this affects surgical outcomes.

This study has several limitations. The questionnaire used in this study has not been validated, although it was designed to avoid bias by being self-administered via a tablet in a standardized format. There were several participants who did not answer every question, leading to slight differences in overall numbers, which could have affected reported results. There was a minimum 96% response rate ( $\geq 205/214$ ) on every question except "current position," to which 92% (197/214) of pitchers responded. Additionally, questionnaire studies are prone to several response biases that could have affected the results of this study. Recall/response bias is attributed to differences in

the accuracy and completeness of the participants' recollections, and in our study, this could have affected pitchers' responses regarding their history of elbow injuries and the factors that they attributed to them. We must acknowledge that the term "elbow injury" is vague and could represent a spectrum of injuries not specifically addressed in the questionnaire, possibly influencing players' responses to certain questions. Additionally, as with most questionnaire studies, there is a limitation in the ultimate number of questions that one is able to ask in a respective period of time. The survey used in this study was reviewed to include the 52 questions thought to be the most important for the purpose of this study. However, it is inevitable that there are questions excluded that could have affected players' responses, such as the participants' childhood pitching count.

## CONCLUSION

In evaluating risk factors, both fatigue and inadequate rest were of greatest concern among all pitchers for increasing their risk of UCL injuries. Additionally, both the level of play that a pitcher has achieved and whether they have had a prior UCL injury can significantly change their opinions on UCL injuries and their prevention. Interestingly, pitchers with a previous UCL injury had a significantly higher incidence of childhood elbow injuries, suggesting possible correlations and warranting further investigation on the topic. Given the growing phenomenon of UCL injuries in professional pitchers, it is increasingly important to understand and acknowledge the opinions that players have regarding UCL injuries to improve education, prevention, and treatment.

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## APPENDIX

## Players' Perceptions of Tommy John Surgery

**Introduction/Agreement**

Q1 This short survey will help provide us with the players' perspective regarding UCL injuries. The information collected will be completely anonymous and used for research purposes only.

By clicking below, I agree to participate in the following anonymous survey. I have been made aware that none of my personal information will be used.

- I agree (1)

**Level of Play**

Q2 What is the highest level of play you have reached?

- MLB (1)  
 MiLB (2)  
 College (3)  
 High School (4)

**Position/Handedness**

Q3 Please select your current position.

- Starter (1)  
 Reliever (2)

Q4 Please select your throwing arm.

- Righty (1)  
 Lefty (2)

**Medical History**

Q5 Have you ever had an elbow injury from throwing as a child/adolescent?

- Yes (1)  
 No (2)

Q6 Have you ever injured your ulnar collateral ligament (UCL)?

- Yes (1)  
 No (2)

*Skip to: Q7 if "Have you ever injured your ulnar collateral ligament (UCL)?" = Yes*  
*Skip to: Q13 if "Have you ever injured your ulnar collateral ligament (UCL)?" = No*

Q7 What treatment did you have for your UCL injury? (Check all that apply)

- Physical Therapy (1)  
 PRP (platelet-rich plasma) Injections (2)  
 UCL Reconstruction (Tommy John surgery) (3)  
 UCL Repair (4)

Q8 Estimate how much time you missed from competitive play due to UCL injury?

- 6 Months (1)  
 9 Months (2)  
 12 Months (3)  
 14 Months (4)  
 >16 Months (5)

Q9 Since returning to play from UCL injury, have you ever pitched through elbow pain?

- Never (1)  
 Occasionally (2)  
 Often (3)  
 Always (4)

Q10 Since returning to play from UCL injury, have you ever pitched with elbow stiffness?

- Never (1)  
 Occasionally (2)  
 Often (3)  
 Always (4)

(continued)



Q11 Since returning to play from UCL injury, have you ever had difficulty getting loose during warm-ups because of your elbow?

- Never (1)
- Occasionally (2)
- Often (3)
- Always (4)

Q12 Have you needed a revision (second) Tommy John surgery?

- Yes (1)
- No (2)

*Skip to: End of block if "Have you needed a revision (second) Tommy John surgery?" = Yes*

*Skip to: End of block if "Have you needed a revision (second) Tommy John surgery?" = No*

Q13 Have you ever pitched through elbow pain?

- Never (1)
- Occasionally (2)
- Often (3)
- Always (4)

Q14 Have you ever pitched with elbow stiffness?

- Never (1)
- Occasionally (2)
- Often (3)
- Always (4)

Q15 Have you ever had difficulty getting loose during warm-ups because of your elbow?

- Never (1)
- Occasionally (2)
- Often (3)
- Always (4)

### **UCL Injuries**

**Please select your level of agreement with the following statements.**

Q16 UCL injuries can be avoided in professional pitchers.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q17 UCL injuries are caused by throwing a high number of pitches in a single outing.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q18 UCL injuries are caused by the number of innings thrown in an outing.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q19 UCL injuries are caused on a number of years a pitcher has played competitive baseball.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q20 UCL injuries are an accumulation of smaller injuries that add up over time.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

(continued)

Q21 UCL injuries are caused by a single throw.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q22 Pitching after a significant delay within a game such as a rain delay increases the risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

### **Anatomy**

**Please select your level of agreement with the following statements.**

Q23 Pitchers have stronger ligaments than other players.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

### **Individual Variables**

**Please select your level of agreement with the following statements.**

Q24 A player's height plays a role in UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q25 A player's weight plays a role in UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q26 A player's age plays a role in UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q27 At what age do you think most professional players tear their UCL?

- 18-20 (1)
- 21-25 (2)
- 26-29 (3)
- 30+ (4)

Q28 Having prior shoulder injury will lead to a UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

(continued)

Q29 Higher pitching velocity plays a role in a pitcher tearing his UCL.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q30 What do you believe is the average velocity most pitchers who tear their UCL throw?



**Pitching Variables**

Q31 What type of pitch do you believe puts a pitcher at most risk for tearing his UCL?

- Curve (1)
- Slider (2)
- Cutter (3)
- 4-Seam Fastball (4)
- 2-Seam Fastball (5)
- Splitter (6)

Q32 Fatigue over the course of a season increases a player's risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q33 Throwing a higher percentage of fastballs increases the risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q34 Throwing a higher percentage of sliders increases the risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q35 Developing a new pitch can increase the risk of UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q36 Pitching mechanics influence the risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

**Throwing Fatigue**

Q37 Fatigue during a single outing increases a player's risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q38 Do you believe that a 6-man starting rotation will decrease the risk of UCL injuries?

- Yes (1)
- No (2)

Q39 Do you believe expanding the number of pitchers on a roster will decrease the risk of UCL injuries?

- Yes (1)
- No (2)

Q40 A "Rest" disabled list for pitchers would decrease the risk of UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q41 A large increase in innings pitched from one season to the next leads to UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q42 Warm-up throws before a game and between innings can lead to quicker fatigue.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q43 Managers/Coaches overuse of pitchers can increase the risk of UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q44 Inadequate rest from throwing in the off-season increases the risk of UCL injuries.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q45 During a season, inadequate rest between outings increases the risk of UCL injury.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q46 Estimate what percentage of Major League pitchers have torn their UCL.

- 15% (1)
- 25% (2)
- 35% (3)
- 50% (4)

#### **Surgical Variables**

Q47 A pitcher's velocity increases after Tommy John surgery.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

(continued)

Q48 Pitchers return to pre-injury performance levels after Tommy John surgery.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q49 Having Tommy John surgery NEGATIVELY impacts the signing of future contracts and/or college recruitment.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q50 Having Tommy John surgery POSITIVELY impacts the signing of future contracts and/or college recruitment.

- Strongly Disagree (1)
- Disagree (2)
- Neutral (3)
- Agree (4)
- Strongly Agree (5)

Q51 If you have undergone UCL reconstruction, please list the factors you believe may have led to the initial injury.

Q52 If you have not injured your UCL, what factors do you believe have helped you avoid injury?

Thank you for your participation in this anonymous survey!