

# Exceeding Pitch Count Recommendations in Little League Baseball Increases the Chance of Requiring Tommy John Surgery as a Professional Baseball Pitcher

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**Background:** Empirical evidence has suggested a connection between youth pitch counts and subsequent elbow injury. For players within the Little League World Series (LLWS), detailed historical player data are available. Some of these players progress to both professional play and require an ulnar collateral ligament reconstruction (UCLR).

**Purpose:** To determine the percentage of LLWS pitchers who proceed to play professional (major or minor league) baseball, the rate of UCLR in former LLWS pitchers who played professional baseball, and the risk to those who exceeded current pitch count recommendations while playing in the LLWS.

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

**Methods:** All LLWS pitchers from 2001 through 2009 from all teams and countries were identified, and all performance data were extracted. A professional (major and minor league) baseball database was then searched to determine whether each former LLWS pitcher played professional baseball. These professional players were then searched for using publicly available databases to determine whether they underwent UCLR.

**Results:** Overall, 638 adolescents pitched in the LLWS between 2001 and 2009; 62 (10%) progressed to professional play. Of the 56 minor league players, 25 (45%) pitched. Of the 6 Major League Baseball players, 3 (50%) pitched. Three former LLWS pitchers (5%) who played professionally underwent UCLR. In former LLWS pitchers who exceeded pitch counts and played professionally, 50% (2/4) required UCLR, while only 1.7% (1/58) of those who did not exceed pitch count recommendations required UCLR ( $P = .009$ ). Similarly, among former LLWS pitchers who subsequently played professionally, 23.1% of those who played as a pitcher required UCLR while 0% of those who also played other positions required UCLR ( $P = .008$ ).

**Conclusion:** Progression from LLWS pitching to professional baseball is uncommon. Among youth players, both diversification (playing other positions besides pitcher) as well as following current pitch limit regulations may protect against UCLR.

**Keywords:** ulnar collateral ligament reconstruction; baseball; Tommy John; Major League Baseball; Little League World Series; pitch count

The number of injuries to Major League Baseball (MLB) pitchers, specifically injuries involving the ulnar collateral ligament (UCL), have been rising in recent years.<sup>8,19</sup> The rate of elbow injuries and elbow surgeries in adolescent pitchers has also dramatically increased over this same time period.<sup>3,5</sup> Studies have shown that the most common age group for undergoing a UCL reconstruction (UCLR) is between 15 and 19 years, and this rate has risen to the point of becoming an “epidemic.”<sup>3,5,7,11</sup> There have been

multiple studies that have attempted to determine the cause of this increase in injury rates in adolescent pitchers.<sup>2,13,15</sup> Several risk factors, including high pitch counts, pitch velocity, pitching year round, geography, loss of shoulder motion, elbow torque, sports specialization, and others, have been shown to increase a pitcher’s risk for injury.<sup>¶</sup> Sports specialization refers to a practice in which children choose a single sport to play, spend more than 8 months of the year participating that single sport, and often stop participation in all other sports.<sup>20,21</sup> Recent studies have suggested that this practice increases rates of both

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injury and burnout.<sup>20,21</sup> However, despite empirical demonstration of these risk factors, to date, no study has demonstrated that strategies for injury rate reduction are effective.

The Little League World Series (LLWS) is an annual baseball tournament for children aged 11, 12, and those who turned 13 years old after April 30. The tournament was first held in 1947 and has been held in August each year since in South Williamsport, Pennsylvania, USA. Some of the best youth baseball players, specifically pitchers, in the world compete in the LLWS each year. These pitchers are elite.<sup>2</sup> The tournament has grown from a 2-team competition to a round robin tournament of 16 teams from across the world (8 teams from varying regions of the United States and 8 teams from international regions).<sup>17</sup> Detailed game-play data for this tournament are available since 2001. Pitching regulations for Little League Baseball changed in 2007 from an inning limit to a pitch count limit, but no study to date has evaluated the effectiveness of this change.<sup>13,17,18</sup> Furthermore, a minimum number of days of rest was implemented; more days of rest were required when the pitcher had a higher pitch count. The LLWS thus represents a natural experiment that allows comparison of injury rates with and without pitch limit regulations.

If fatigue and repetitive microtrauma are the primary causes of UCL injury, exceeding current pitch limit regulations and specialization as a pitcher may correlate with subsequent UCLR. The purpose of this study was to determine the percentage of LLWS baseball pitchers who progressed to professional baseball, the rate of UCLR among these pitchers, and the influence of exceeding current pitch limit recommendations and specialization as a pitcher on that rate. The authors hypothesize that while very few former LLWS pitchers will progress to playing professional baseball and the injury rates in these athletes will be low, UCLR will be more common in those former LLWS athletes who exceeded current pitch limit recommendations and specialized as a pitcher.

## METHODS

All players who pitched in at least 1 game during the LLWS from 2001 to 2009 were included in this study, as data on players from these years were complete and athletes were old enough at the time of this analysis to have reached the professional level. Players from all countries who competed in the LLWS were included. The authors used a public website to obtain the names of all players who pitched in at least 1 game in the LLWS (<http://www.littleleague.org/series/history/historicalresults.htm>). Once a list of former

LLWS pitchers was created, performance data from these players were extracted from this website. This data included the year the players pitched in the LLWS, the team pitched for, whether they played positions in the LLWS other than pitcher (and if so, which position), number of years the player pitched in the LLWS, number of games pitched in the LLWS in their careers, total number of innings pitched, total number of runs allowed, total number of earned runs allowed (ERA), overall ERA, number of hits allowed, number of strikeouts, number of walks issued, number of batters hit, total number of pitches thrown in their LLWS career, total number of strikes thrown in their LLWS career, total number of balls thrown in their LLWS career, number of wins, number of losses, and number of saves. Pitch speed was not recorded. All this information was available by game and summed over the player's LLWS career. Current pitch limit recommendations for LLWS pitchers aged 11 to 13 years were set forth in 2007, which include a daily maximum of 85 pitches for players 11 to 12 years and 95 pitches for players aged 13 to 16 years. Pitchers who played in the LLWS prior to 2007 were divided into those who exceeded the daily maximum pitch count of 95 pitches and those who did not. We chose 95 pitches as the cutoff as player age was unavailable, and by choosing 95 instead of 85, we used less stringent guidelines, thereby reducing the likelihood of type II error. These groups were then compared to determine subsequent need for UCLR.

A database of all MLB and minor league players was then used to search the name of each former LLWS pitcher individually (<http://www.baseball-reference.com>). The database was first searched to determine whether the LLWS pitcher ever played in an MLB or minor league game. If he did play in a game, position played was recorded (pitcher or not). For those who were pitchers, their pitching position (starter, reliever, closer) was recorded. Finally, each LLWS pitcher who played in either a major or minor league game was then searched using publicly available data to determine whether he underwent a UCLR, and if he did, whether he required a revision UCLR. This search method has been used by multiple prior studies and provides reliable results.<sup>8,9,22,23</sup>

## Statistical Methods

Descriptive statistics including means and standard deviations were calculated. Most data within the study are categorical. For categorical variables, chi-square tests and Fisher exact tests were used as appropriate depending on cell populations. For continuous variables, we first determined data normality using the Kolmogorov-Smirnov test. All data were non-Gaussian, and thus, nonparametric tests

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Ethical approval was not sought for the present study.

TABLE 1  
All LLWS Pitchers (2001-2009) by Year and Professional Status<sup>a</sup>

	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Total no. of LLWS pitchers	60	63	75	72	70	56	75	82	85	638
No. of LLWS pitchers who <i>play</i> in MLB	1 (1.7)	0 (0)	2 (2.7)	2 (2.8)	0 (0)	0 (0)	0 (0)	1 (1.2)	0 (0)	6 (0.9)
No. of LLWS pitchers who <i>pitch</i> in MLB	1 (1.7)	0 (0)	0 (0)	1 (1.4)	0 (0)	0 (0)	0 (0)	1 (1.2)	0 (0)	3 (0.5)
No. of LLWS pitchers who <i>play</i> in minors	7 (11.7)	15 (23.8)	6 (8.0)	6 (8.3)	8 (11.4)	6 (10.7)	0 (0)	7 (8.5)	1 (1.2)	56 (8.8)
No. of LLWS pitchers who <i>pitch</i> in minors	2 (3.3)	14 (22.2)	1 (1.3)	0 (0)	3 (4.3)	1 (1.8)	0 (0)	4 (4.9)	0 (0)	25 (3.9)

<sup>a</sup>Data presented as n (%). LLWS, Little League World Series; MLB, Major League Baseball.

TABLE 2  
Breakdown of LLWS Pitchers From the United States by Region<sup>a</sup>

	No. of Pitchers in LLWS	No. Who Played in Minors (%)	No. Who Played in MLB (%)	UCLR, n (%)
US Great Lakes	36	3 (8.3)	0 (0)	0 (0)
US Gulf States	4	1 (25)	0 (0)	0 (0)
US Midatlantic	32	0 (0)	0 (0)	0 (0)
US Midwest	32	2 (6.3)	0 (0)	0 (0)
US New England	36	2 (5.6)	1 (2.8)	0 (0)
US Northwest	39	3 (7.7)	0 (0)	1 (2.6)
US Southeast	38	4 (10.5)	1 (2.6)	0 (0)
US Southwest	40	5 (12.5)	0 (0)	0 (0)
US West	49	3 (6.1)	0 (0)	0 (0)

<sup>a</sup>LLWS, Little League World Series; MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

were used. Groups were compared using Mann-Whitney *U* tests. All analyses were conducted in Excel X (Microsoft) and SPSS 22 (IBM Corp).

## RESULTS

Overall, 638 boys between the ages of 11 and 13 years pitched in the LLWS between 2001 and 2009: 306 (48%) for the United States and 332 (52%) for foreign countries. Of these, 62 (10%) went on to play either professional major or minor league baseball. Of those who played at least 1 game professionally, 56 (90%) went on to play in the minors and 6 (10%) went on to play in the majors (Table 1). Of the former LLWS pitchers who went on to play minor league baseball, 25 (45%) were pitchers in the minors while 31 (55%) were position players. Of the former LLWS pitchers who went on to play MLB, 3 (50%) were pitchers and 3 (50%) were position players (Table 1). Of these 28 (25 minors, 3 majors) former LLWS pitchers who pitched professionally, currently 13 (46%) are starting pitchers, 12 (43%) are relief pitchers, and 3 (11%) are closers. Thirty-eight of the 638 LLWS pitchers (6%) had a documented pitch count excess.

Former LLWS baseball pitchers who went on to pitch in the minors played an average of  $2.6 \pm 1.6$  seasons in the minor leagues, with 28 (50%) still currently active in the minor league. Those who went on to pitch in the majors played an average of  $1.3 \pm 0.5$  seasons, with 5 (80%) still currently active in the majors. No difference in either progression to professional play or need for UCLR existed between US players and non-US players (8% [25/306] vs 11% [37/332],  $P = .063$  and 4.0% [1/25] vs 5.4% [2/37],

$P > .999$ , respectively). The breakdown of pitchers from each of the US and foreign regions, as well as whether these pitchers went on to play professionally and whether they underwent a UCLR, can be found in Tables 2 and 3, respectively.

Progression to professional play as well as those who required UCLR can be found in Table 4. UCLR was not performed more frequently in former LLWS pitchers who progressed to play in the major or minor leagues (17% vs 4%,  $P = .267$ ). A post hoc power analysis determined that achieved power for this particular comparison was 0.25. Of the LLWS pitchers who went on to pitch in MLB, 33% (1/3) required a UCLR, whereas only 8% (2/25) of former LLWS pitchers who went on to pitch in the minor leagues underwent UCLR. No former LLWS pitcher who played any position (infield, outfield, catcher) other than pitcher in the major or minor leagues underwent UCLR. However, UCLR was not performed more frequently in LLWS athletes who pitched professionally than in those who played another position (infield, outfield, catcher) (11% vs 0%,  $P = .087$ ). A post hoc power analysis determined that achieved power in this particular comparison was  $>0.99$ . All former LLWS pitchers who underwent UCLR pitched in the LLWS prior to the institution of pitch count limits in 2007 (2004, 2005, 2006 [revision UCLR]).

Of those who exceeded current pitch limit recommendations, 50% (2/4) required UCLR, while of those who did not, 1.7% (1/58) required UCLR ( $P = .009$ ) (Table 5). In the LLWS, there were players who were exclusively pitchers and those who played other positions in addition to pitcher. Of those LLWS pitchers who progressed to professional play, 23.1% of those who played only as a pitcher during

TABLE 3  
Breakdown of LLWS Pitchers From Foreign Countries by Region<sup>a</sup>

	No. of Pitchers in LLWS	No. Who Played in Minors (%)	No. Who Played in MLB (%)	UCLR, n (%)
Asia	25	1 (4)	1 (4)	0 (0)
Asia-Pacific	15	0 (0)	0 (0)	0 (0)
Canada	35	6 (17.1)	0 (0)	1 (2.9)
Caribbean	36	6 (16.7)	1 (2.8)	1 (2.8)
EMEA	21	0 (0)	0 (0)	0 (0)
Europe	23	1 (4.3)	0 (0)	0 (0)
Japan	14	0 (0)	0 (0)	0 (0)
Latin American	54	9 (16.7)	0 (0)	0 (0)
MEA	7	0 (0)	0 (0)	0 (0)
Mexico	49	8 (0.3)	1 (2.0)	0 (0)
Pacific	30	1 (3.3)	1 (3.3)	0 (0)
US Transatlantic	23	1 (7.7)	0 (0)	0 (0)

<sup>a</sup>EMEA, Europe, Middle East, and Africa; LLWS, Little League World Series; MEA, Middle East-Africa; MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

TABLE 4  
UCLRs in Former LLWS Pitchers Who Went on to Pitch Professionally<sup>a</sup>

	Total (% of All LLWS Pitchers)	No. of Pitchers Who Had UCLR (% of LLWS Pitchers Who Played Professionally)	No. of Pitchers Who Had Revision UCLR (% of Those Who Had a UCLR and Needed a Revision UCLR)
LLWS pitchers who pitched in MLB	3 (4.8)	1 (1.6)	0 (0)
LLWS pitchers who pitched in minors	25 (3.9)	2 (3.2)	1 (50)
LLWS pitchers who played but did not pitch in MLB	3 (0.5)	0 (0)	0 (0)
LLWS pitchers who played but did not pitch in minors	31 (4.9)	0 (0)	0 (0)

<sup>a</sup>LLWS, Little League World Series; MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

TABLE 5  
Comparison Between Those Who Exceeded Current Pitch Count Recommendations (95 Pitches/Game) and  
Those Who Did Not<sup>a</sup>

	Pitch Count Violators	Pitch Count Adherents	P Value
% who progressed to professional play	11	10	.779
% who required subsequent UCLR	50	2	.009

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

their time in the LLWS required UCLR, while 0% of those who played other positions aside from pitcher in the LLWS required UCLR ( $P = .008$ ). LLWS pitchers who progressed to professional play were no more likely to play positions other than pitcher in the LLWS than those who did not progress to professional play (64.5% [40/62] vs 58.9% [339/576],  $P = .417$ ) nor were they more likely to exceed pitch count limitations than those who did not progress to professional play (22.6% [14/62] vs 14.2% [82/576],  $P = .081$ ). Furthermore, former LLWS pitchers who progressed to professional play were no more likely to have also played catcher ( $P = .608$ ), infield ( $P = .388$ ), or outfield ( $P = .403$ ) in the LLWS than those who did not progress to play professionally.

Those former LLWS pitchers who also played catcher in the LLWS in addition to pitcher were no more likely to require UCLR than those who did not play catcher in the LLWS (0% [0/3] vs 5.1% [3/59],  $P = .999$ ). Those former LLWS pitchers who also played outfield in the LLWS were no more likely to require UCLR than those who did not play outfield in the LLWS (0% [0/17] vs 6.7% [3/45],  $P = .555$ ). Of those former LLWS who did not play infield, 13.6% (3/22) required UCLR, while 0% (0/40) of those who played the infield required UCLR ( $P = .041$ ). There were no differences among LLWS performance data between those who progressed to professional play and those who did not (total number of innings pitched,  $P = .309$ ; total number of runs allowed,  $P = .273$ ; ERA,  $P = .787$ ; overall ERA,  $P = .645$ ;

number of hits allowed,  $P = .936$ ; number of strikeouts,  $P = .117$ ; number of walks issued,  $P = .461$ ; number of batters hit,  $P = .142$ ; total number of pitches thrown in their LLWS career,  $P = .209$ ; total number of strikes thrown in their LLWS career,  $P = .322$ ; total number of balls thrown in their LLWS career,  $P = .148$ ; number of wins,  $P = .581$ ; number of losses,  $P = .525$ ; and number of saves,  $P > .999$ . There were no differences among LLWS performance data between those who required subsequent UCLR and those who did not ( $P > .055$  in all cases), with the exception of earned runs. Those who required subsequent UCLR allowed an average of  $5.3 \pm 1.5$  earned runs while pitching in the LLWS, while those who did not allowed an average of  $2.6 \pm 2.3$  earned runs while pitching in the LLWS ( $P = .042$ ).

## DISCUSSION

The purpose of this study was to determine the percentage of LLWS baseball pitchers who progressed to professional baseball, the rate of UCLR among these pitchers, and the influence of pitch count excesses and specialization as a pitcher on that rate. Within our dataset, the number of former LLWS pitchers who went on to play minor or major league baseball is just 10% (62/638), with a rate of UCLR of 4.8% (3/62). Of those who exceeded current pitch limit recommendations, 50% required UCLR while only 1.7% of those who did not exceed pitch count recommendations required UCLR, demonstrating that pitch limits are protective. Furthermore, no former LLWS pitcher who participated in the LLWS after the pitch count limit was instituted in 2007 required UCLR. Of those who played only as a pitcher in the LLWS, 23.1% required UCLR, while none of those who played other positions required UCLR, demonstrating that diversification into positions other than pitcher may be protective.

Our data suggest that compliance with pitch limit recommendations may be protective against subsequent UCLR. Significantly more former LLWS pitchers who exceeded the current daily pitch count maximum before it was implemented in 2007 and went on to play professionally underwent UCLR than those who did not exceed these pitch count limits. Furthermore, all former LLWS pitchers who went on to pitch professionally and require a UCLR participated in the LLWS prior to 2007, when the pitching regulations switched from an inning limit to a pitch count limit. Pitch counts, pitch velocity, geography, elbow torque, and sports specialization increase a pitcher's risk for injury. For the first time it now appears that the pitch count regulations set forth in 2007 may be effective in preventing UCLR.<sup>1,10,13,20</sup> No comparisons to prior studies can be made in this regard as no study to date has looked at the effectiveness of pitch count recommendations.

Our data suggest that having youth pitchers play multiple positions, rather than specializing as a pitcher, may be protective against injury. No single former LLWS pitcher included in this study who played professional baseball at any position other than pitcher underwent UCLR. Similarly, of those LLWS pitchers who progressed to professional play, 23.1% of those who played only as pitchers

during the LLWS required UCLR, while none of those who played other positions in addition to pitcher required UCLR. There have been several recent studies that have looked at sports specialization both from a risk for injury perspective as well as from a progression to professional play prospective.<sup>12,20,21</sup> These studies have found an increased risk of burnout as well as an increased risk of injury in children and adolescents who specialized in sports, with no significant benefit in progression to professional play.<sup>16,20,21</sup> Fleisig et al,<sup>13</sup> in a well-done 10-year prospective study, also recommended adolescent pitchers play other positions besides just pitcher to reduce their risk of injury. Interestingly, however, they also found that the pitchers in their study who also played catcher for more than 3 years showed a trend toward higher injury rates, whereas in the current study, no pitcher who also played catcher required UCLR. The difference in these findings is likely because Fleisig et al<sup>13</sup> looked at more injuries than just UCLR, and playing catcher in addition to pitcher may in fact increase a player's risk for these other injuries, but not for UCLR. The results of these prior studies as well as the current study suggest that youth pitchers should pitch less and consider playing other positions (infield, outfield, or even catcher) to decrease their risk of injury to the UCL.

Within our dataset, only 8% of former LLWS pitchers who went on to pitch in the minors underwent UCLR—half the rate of 15% found in a survey study by Conte et al.<sup>6</sup> It is unclear why former LLWS pitchers who pitched in the minors had a lower rate of UCLR than those minor league pitchers who were surveyed. Aside from sampling and lead time bias, one possible explanation is that former LLWS pitchers were taught better pitching mechanics at an earlier age than those who did not participate in the LLWS. This could have translated into lower injury rates in former LLWS pitchers. A second possibility is that former LLWS pitchers underwent UCLR at an earlier age (in either high school or college) due to their increased workload as an adolescent and therefore were not captured in this study.

## Limitations

Although this was the first study to evaluate progression of and risk of UCL injury to truly elite LLWS pitchers who went on to play professional baseball, there are several limitations. The injury reports for this study were obtained from publicly available sources, and as such, could have been subject to inaccuracies that either overestimated or underestimated the number of UCLRs in this patient population. Furthermore, no comparison between the rate of UCLR of prior Little League players going onto the major or minor league and the rate of UCLR in major or minor league players who did not play in the Little League was made. The LLWS data were obtained from the Little League website, so the likelihood of incorrect information from this source is low. As player age was unavailable, a pitch limit of 95 was chosen to delineate those pitchers who threw excessive pitches based on current guidelines instead of 85 to attempt to limit the amount of type II error. LLWS pitchers from the later years included in this study may still go on to play professional baseball or possibly undergo UCLR.

It is possible that some of the LLWS pitchers decided not to play professionally for other reasons. It is possible that players contained in the non-UCLR group underwent UCLR and this was not discovered on the search and may be a group to study in the future. Also, it is unclear whether the former LLWS pitchers who did not end up playing professionally sustained an injury, specifically a UCL tear, which precluded them from playing professionally, as injury reports for nonprofessional players are not readily available. This study focused on former LLWS pitchers, 10% of whom progressed to professional play, so some of the findings may not be generalizable to all adolescent pitchers. A classification system for all youth pitchers may aid in studying a larger sample of youth baseball pitchers.<sup>2</sup>

## CONCLUSION

Progression from LLWS pitching to professional baseball is uncommon. Among youth players, both diversification (playing other positions in addition to pitcher) as well as following current pitch limit regulations may protect against the need for subsequent UCLR.

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