

Effect of Pitching Restrictions and Mound Distance on Youth Baseball Pitch Counts

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Background: Studies have shown that higher pitch counts are directly related to a greater incidence of elbow and shoulder pain among youth baseball pitchers.

Purpose/Hypothesis: The purpose of this study was to examine the effect of different pitching restriction rules on the number of pitches thrown in youth baseball leagues. We hypothesized that more pitches would be thrown in leagues with inning restrictions versus leagues with pitch count restrictions as well as in leagues with a longer mound distance (from pitching mound to home plate).

Study Design: Cohort study; Level of evidence, 2.

Methods: Pitch count data were collected for 2 consecutive years over a 10-week season from 3 different leagues of 9- to 12-year-old baseball players in a single city. The Eastern league had a pitch count restriction and 46-ft (14.02-m) mound distance. The Southeastern and South leagues' pitching restrictions were based on innings per week. The Southeastern league had a 50-ft (15.24-m) mound distance, while the South league had a 46-ft mound distance. Comparisons of total seasonal pitches thrown were made of the 3 highest-volume pitchers on each team. League averages for each value were then compared utilizing analysis of variance with Bonferroni post hoc analysis. The number of pitchers in each league who threw >600 pitches per season was compared using the chi-square test.

Results: No significant difference in seasonal pitch counts or innings pitched was noted between the Eastern and South leagues, which differed only in their pitching restrictions. The Southeastern league, with a longer mound distance, was found to have higher seasonal pitch counts per thrower (598 ± 195 pitches) than the South league (463 ± 198 pitches) for the 3 highest-volume throwers for each team ($P = .004$). The Southeastern league also had a significantly larger number of pitchers who threw >600 pitches per season (33 vs 20 for Eastern and 13 for South; $P = .009$).

Conclusion: There was no significant difference in seasonal pitch counts when the leagues in this study differed based on pitching restrictions. However, the league with a greater mound distance (Southeastern) had higher seasonal pitch counts for the highest-volume throwers. Pitching restrictions based on pitch counts, as opposed to innings, may be advisable.

Keywords: youth baseball; pitch counts; overuse; elbow and shoulder injury; risk factors

Over 5 million children and adolescents participate in organized youth baseball leagues in the United States each year.^{1,16,20,22} Youth baseball players, particularly pitchers, are at risk for overuse injuries. It has been found that up to half of youth baseball pitchers experience pain in their throwing arm at some point during any given baseball season.^{11,12} Overuse injuries to the shoulder and elbow are of particular interest, as these can result in time lost from sport. In fact, 5% of all youth baseball pitchers sustain injuries that are significant enough to require surgery or retirement from baseball.⁸

Before 1996, many youth leagues had pitching limits and rest requirements based on innings pitched.⁷ Over time,

there was an evolution to count actual pitches thrown, as this was believed to be more important than innings, given that the number of pitches thrown in an inning could vary widely.⁷ In a report published in 1996, Andrews and Fleisig² surveyed 28 orthopaedic surgeons and baseball coaches in an effort to determine how many pitches should be thrown by a youth baseball pitcher. They are credited with heightening the awareness of overuse throwing injuries, putting emphasis on pitch counts in an effort to protect young pitchers and promoting longer periods of rest when symptoms of arm pain or fatigue were noted. Then, 5 years later, in a 2001 publication, Lyman et al¹² studied a large group of youth pitchers and, based on their data, recommended a limit of 75 pitches per game and 600 pitches per season. In 2004, the USA Baseball Medical and Safety Advisory Committee released a position paper that, among other recommendations, advocated pitch count limits.¹⁰

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TABLE 1
League Rules Regarding Pitching Restrictions and Mound Distance

League	Pitching Restrictions ^a	Mound Distance ^b
Eastern	Game pitch counts, Little League Baseball rules	46 ft (14.02 m)
South	Innings per week, Cal Ripken Baseball rules	46 ft (14.02 m)
Southeastern	Innings per week, Cal Ripken Baseball rules	50 ft (15.24 m)

^aLittle League Baseball rules: maximum of 85 pitches per pitcher per game (with exceptions to complete an at-bat) and mandated period of rest depending on the number of pitches thrown. Cal Ripken Baseball rules: maximum of 6 innings of pitching per week with at least 2 days of rest between outings

^bMound distance = pitching rubber to home plate.

Little League Baseball, the largest organization with >2.4 million participants each year, adopted pitch count regulations in 2007, changing from inning limits, and these rules remain in place regarding pitch count limits and mandated rest periods for pitchers.^{6,8} In 2014, Major League Baseball and USA Baseball published their Pitch Smart guidelines, with adjusted pitch count limits specific to age.⁷

In Lexington, Kentucky, 2 different organizations, Little League Baseball and Babe Ruth League, consist of popular youth baseball leagues. Both organizations include players aged 9 to 12 years, and both have a 10-week season with 2 games scheduled per week. In the Babe Ruth League, the 9- to 12-year age group division is known as Cal Ripken Baseball. At the time of this study, the 2 organizations had different rules regarding youth pitching limitations. The Little League Baseball rules limited pitchers to a pitch count, with a mandated period of rest depending on the number of pitches thrown. The maximum number of pitches allowed for a single pitcher in a game was 85, although the pitcher could exceed that number to complete pitching to an individual batter. Cal Ripken Baseball rules imposed a pitching restriction of 6 innings per week, along with a mandated 2-day rest between pitching outings.

Both Little League Baseball and Cal Ripken Baseball traditionally had used a 46-ft (14.02-m) distance between the pitching rubber (mound) and home plate. Cal Ripken Baseball also offered a separate league with a 50-ft (15.24-m) pitching distance. These separate rules allowed us to compare, over the course of 2 seasons, the effect of different regulations on the resultant youth pitch counts. To our knowledge, no studies have directly compared the effect of variant mound distances and league pitching rules on overall pitch counts among youth throwers.

The purpose of this study was to examine the effect of varied pitching rules, with regard to pitch counts and mound distance, on the number of pitches thrown in youth

baseball leagues. We hypothesized that pitchers would throw more pitches in leagues with inning restrictions versus leagues with pitch count restrictions. We also hypothesized that more pitches would be thrown in leagues with a longer mound distance (from pitching mound to home plate).

METHODS

Data were collected from 3 youth baseball leagues in Lexington, Kentucky, for the 2012 and 2013 seasons. These players were all part of the major, more competitive, division for their respective league. One league, Eastern, followed Little League Baseball rules (Table 1) and used a 46-ft mound distance. Both the Southeastern and South leagues followed the Cal Ripken Baseball rule of 6 innings per week. The Southeastern league had a 50-ft mound distance, while the South league had a 46-ft mound distance (Table 1). Pitch count data were prospectively recorded after each regular-season game for all 3 leagues. In all leagues, an official scorekeeper was required to enter pitch count numbers into a database at the completion of each game. The pitch count data were specific to each pitcher. Each league had a 10-week season that consisted of 20 games. Institutional review board approval was not needed for this study, as only deidentified data were used.

At the end of each season, data were compiled to determine the total number of pitches thrown by each pitcher. Data from the pitch count database were then analyzed for all pitchers on each team and subsequently compared among the highest-volume pitcher, 2 highest-volume pitchers, and 3 highest-volume pitchers on each team. League averages for each value were then compared utilizing analysis of variance with Bonferroni post hoc analysis. A comparison of the number of pitchers in each league who exceeded 600 pitches in a season was analyzed using

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Ethical approval was not sought for the present study.

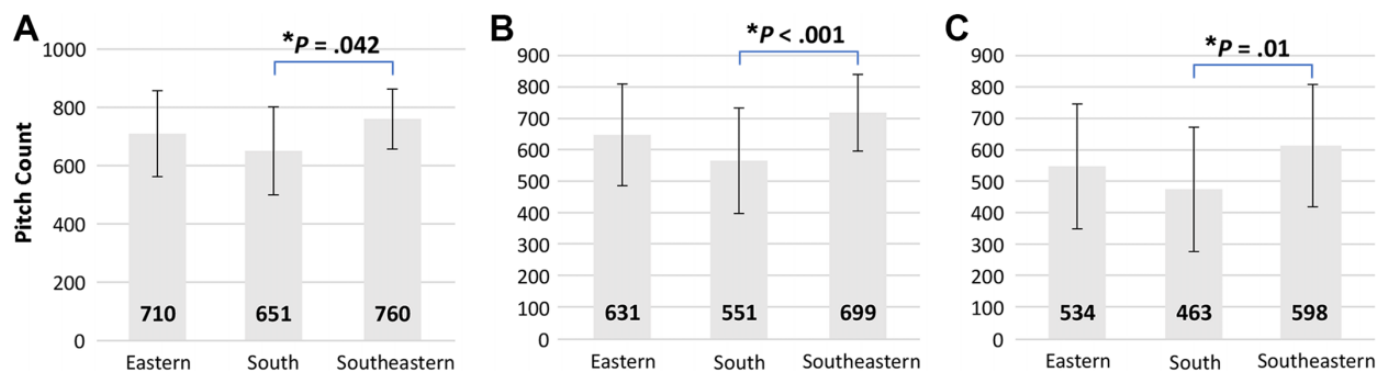


Figure 1. Comparison of seasonal pitch counts for the most utilized pitchers on each team: (A) highest-volume pitcher, (B) top 2 pitchers combined, and (C) top 3 pitchers combined. *Statistically significant difference between groups ($P < .05$).

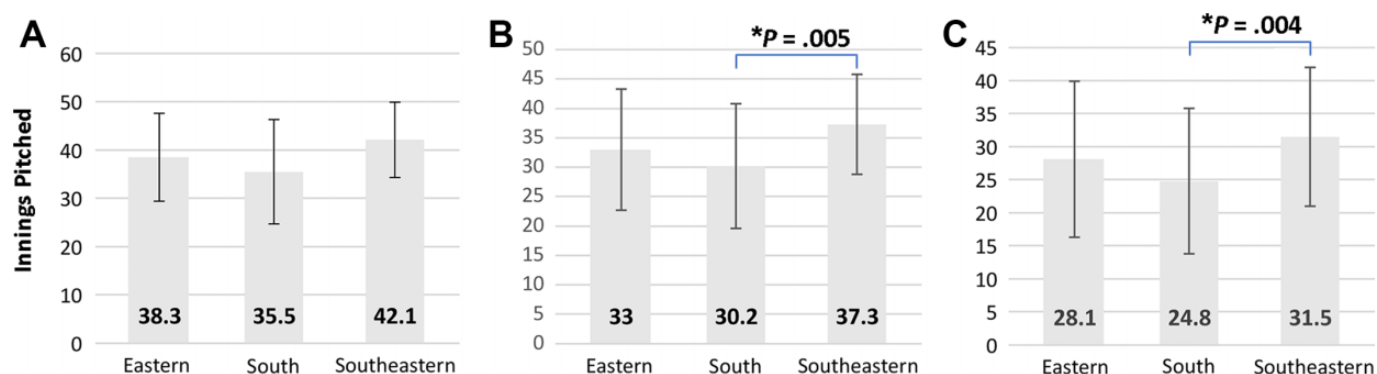


Figure 2. Comparison of seasonal innings pitched for the most utilized pitchers on each team: (A) highest-volume pitcher, (B) top 2 pitchers combined, and (C) top 3 pitchers combined. *Statistically significant difference between groups ($P < .05$).

chi-square testing. The threshold for statistical significance was set at $P < .05$. Statistical software used was SPSS, version 21 (IBM).

RESULTS

A total of 179 pitchers were studied from the 3 leagues during the first season, and 211 pitchers were studied during the second season. The average number of pitches thrown overall ($P = .26$) and pitches per inning ($P = .48$) were not significantly different among any of the leagues. Overall, the 3 highest-volume pitchers on each team accounted for 78% of the total pitches thrown. The Southeastern league had the highest percentage of pitches thrown by the 3 highest-volume pitchers (81%), followed by the South (75%) and Eastern (73%) leagues. None of these differences were statistically significant.

As summarized in Figures 1 and 2, no significant difference in pitch counts or innings pitched was noted between the Eastern and South leagues, which differed only in their pitching restrictions (pitch counts for Eastern and innings per week for South). The Southeastern league had significantly higher seasonal pitch counts for the highest-volume (760 vs 651, respectively; $P = .042$), 2 highest-volume (699

vs 551, respectively; $P < .001$), and 3 highest-volume (598 vs 463, respectively; $P = .01$) throwers compared with the South league. These 2 leagues differed only in the mound distance, with the Southeastern league (50-ft distance) having larger pitch count numbers than those of the South league (46-ft distance) (Figure 1). There was a larger but nonsignificant number of pitches per inning in the Southeastern league (22.5 vs 21.1, respectively; $P = .07$) compared with the South league. The number of innings per thrower was also significantly higher for the top 2 (37.3 vs 30.2, respectively; $P = .005$) and top 3 (31.5 vs 24.8, respectively; $P = .004$) pitchers in the Southeastern versus South league (Figure 2). Regarding the Eastern league, none of the values in Figures 1 and 2 were found to be significantly different than those of either of the other leagues.

The number of times a pitcher threw >600 pitches in a season was compared between the 3 leagues. Chi-square analysis revealed that the proportion was not equal among the 3 leagues; the Southeastern league had 33 pitchers exceed this volume compared to 20 from the Eastern league and 13 from the South league ($P = .009$). The 600-pitch count threshold was chosen based on previous research that identified that exceeding 600 pitches in a season increased the risk of elbow injuries.^{11,12} An interesting finding was that the largest number of pitches thrown in

a single game was 89 in the Eastern league (not a violation, as pitchers could complete an at-bat after reaching 85 pitches) as opposed to 128 in the Southeastern league and 135 in the South league.

DISCUSSION

The findings of our study show that an increased mound distance resulted in more pitches thrown in a season for the 3 highest-volume pitchers for each team when pitch count rules were the same. The most utilized pitchers were also more likely to exceed the 600-pitch threshold for the season in the league with the 50-ft mound distance. The difference in pitch counts was primarily because of a greater reliance on higher volume pitchers for each team, along with a slightly larger number of pitches thrown per inning.

Rules based on the absolute number of pitches, compared with limits on innings thrown, did not result in a significant difference in total pitches. However, the largest number of pitches thrown in a single game was much greater when the restrictions were based on innings. No pitcher threw >89 pitches in a game when pitch counts were utilized. In the 2 leagues in which rules were based on innings, the maximum number of pitches thrown in a game was 128 in the Southeastern league and 135 in the South league. This finding highlights the concern that pitching restrictions based on innings rather than pitch counts can lead to a disturbingly large number of pitches thrown in a single game.

Numerous studies of youth and adolescent baseball pitchers have demonstrated an association between increased pitch counts and shoulder or elbow pain and injuries.^{3,5,6,8,15-18} Lyman et al^{11,12} were among the first to correlate an increased incidence of shoulder and elbow pain with an increasing number of pitches thrown per season. These authors showed an increased risk of shoulder pain when youth throwers reached >75 pitches in an outing. They also found that throwing more than a cumulative 600 pitches in a season increased the risk of elbow pain. Olsen et al,¹⁷ in a study comparing adolescent pitchers who had shoulder or elbow surgery with a control group, found that pitchers who threw >80 pitches per game had a nearly 4 times greater risk of an injury requiring surgery than did those who did not. Erickson et al⁶ found that pitchers who had pitched in the Little League Baseball World Series before the implementation of pitch counts and violated current rules were more likely to later require ulnar collateral ligament reconstruction than were those adhering to current rules if they became a professional player. In a systematic review, Norton et al¹⁶ analyzed studies that investigated pitches per game as an independent risk factor for throwing arm injuries. These authors noted that the data collectively showed that pitches per game was a statistically significant risk factor for shoulder injuries in 3 of the 4 studies that met their inclusion criteria.

Pitching produces significant stresses on the shoulder and elbow of youth throwers. Sabick et al²¹ studied elite pitchers (average age, 12 years) and found that the amount of shear stress produced was great enough to lead to chronic

deformation of proximal humeral epiphyseal cartilage. Mair et al¹³ found that radiographically apparent physcal changes occur in 56% of youth baseball players in the dominant arm, including over half of asymptomatic throwers. In a magnetic resonance imaging (MRI) study of the elbow, it was noted that 12 of 25 players had MRI abnormalities at the completion of a 12-week season, and in 8 of these, abnormalities had not been present before the season.¹⁹

It has been suggested that too many pitches at an early age can result in fatigue and resultant overuse injuries.⁷ In the Olsen et al¹⁷ study, 52% of the injured group reported that they had regularly pitched despite arm fatigue compared with 11% of the uninjured control group. These authors found that a pitcher who regularly pitches despite arm fatigue is at a 36 times increased risk of injuries requiring shoulder or elbow surgery. Pitching with arm fatigue is a significant factor associated with shoulder or elbow pain and injuries.³

In 2007, Little League Baseball adopted its current pitch count restrictions that were in place during our study period.⁶ At that time, Cal Ripken Baseball continued to use innings pitched as a means to restrict pitchers from overuse. We had hypothesized that these inning restrictions might allow for more overall total pitches thrown. However, in 2 concurrent leagues (Eastern and South), with otherwise similar rules, we found no difference in the number of pitches thrown in the highest-volume pitchers. Cal Ripken Baseball began offering a separate league (Southeastern) with a 50-ft mound distance compared with 46 ft in its other league and in Little League Baseball. This league also differs in the distance between bases (70 vs 60 ft [21.33 m vs 18.28 m] for the other Cal Ripken Baseball league and Little League Baseball). These rule changes were adopted because some 12-year-old youth pitchers were able to reach a pitching velocity approaching 80 mph, which results in a reaction time for the batter that is equivalent to a >100-mph fastball at the standard Major League Baseball distance of 60 ft 6 in (18.44 m). This separate league allowed us to compare the effects of both differing pitch count rules and differing mound distance in resultant seasonal pitch counts. Within the Cal Ripken Baseball league in our city, mound distance was determined by which league the players were assigned based on their address.

It is possible that the longer mound distance placed more of a premium on the ability of the pitchers, resulting in coaches using their best pitchers at a higher proportion in the Southeastern league. It is also possible that some of the best pitchers in the city chose to participate in this league. It can be assumed that the best pitchers were utilized most frequently. While we do not have data on pitching velocity, it is likely that, in general, those pitchers who threw with a higher velocity were more likely to pitch a high volume.

Previous studies have shown that better pitchers and those who throw at a higher velocity are more likely to be injured.^{4,9,16} Holt et al⁹ found that 81% of players selected to an All-Star team had MRI shoulder abnormalities at the completion of a season, whereas only 14% of those not selected as All-Stars did. A systematic review concluded that 3 of 3 studies that investigated pitch velocity found it to be a risk factor for injuries.¹⁶ Chalmers et al⁴ found that,

in youth pitchers, pitch velocity correlated independently with injury status. These authors noted that this is compounded by the fact that these faster pitchers were more likely to be used more frequently by their teams.

In our study, despite following league pitching restrictions, numerous pitchers exceeded 600 pitches per season in only the 10 weeks studied in these leagues. It may be that current pitch count restrictions are not stringent enough. It is clear that continued efforts in educating players, parents, and coaches are crucial to prevent youth injuries. There is clearly work to be done, as recent surveys found that 45% of throwers pitched in a league without pitch counts and that 46% of players reported having been told to throw despite having arm pain.^{14,22} Zabawa and Alland²³ provided some data to support the importance of education in preventing overuse throwing injuries in youth. Their study found that parents who actively followed the Pitch Smart guidelines had much lower odds of having a player with an injury than did those who did not follow the guidelines. Additionally, parents who believed that children should pitch when they have a tired arm had greater odds of having a child with an injury than did those who disagreed. Clearly, further efforts on defining appropriate pitch volume guidelines and education of parents and coaches remain essential.

Limitations

There are some limitations to our study. While all 3 of these leagues are competitive, and players tended to participate in the league that corresponded to their address, players were not randomly assigned and could choose to play in either Cal Ripken Baseball or Little League Baseball. Within Cal Ripken Baseball, players were assigned to the Southeastern or South league based on their district, so they could not choose which mound distance they preferred. However, it is possible that some of the better pitchers may have chosen to play Cal Ripken Baseball, with the 50-ft mound distance, over Little League Baseball if they were assigned to the Southeastern league. We do not have any data on pitching velocity or other data that would help differentiate the quality of the pitchers. We also do not have injury data, so we do not know whether some pitchers were required to increase their pitch counts as the season continued if one of their teammates was injured. Finally, these data comprise only a 10-week summer season. Many of these pitchers went on to play in other leagues during other parts of the year, so we do not have data regarding the number of pitches that they threw for the entirety of the year. We were able to determine that no coaches knew of any player who was concurrently pitching in another league at the time of our study.

CONCLUSION

We were able to study the effect of different rules regarding pitching restrictions, along with the effect of differing mound distance, on seasonal pitch counts in youth baseball. The study findings indicated that there was no significant difference in seasonal pitch counts between 2 leagues

when one had a restriction based on pitch count and the other on innings pitched, with the other rules being the same. However, we found that a league with a greater mound distance (50 vs 46 ft) had higher seasonal pitch counts for the highest-volume pitchers. Moving to a greater mound distance may lead to unforeseen consequences, and in such leagues, pitching restrictions based on pitch counts, as opposed to innings, may be advisable to avoid high single-game and seasonal pitch counts and the potential for overuse injuries in youth baseball pitchers.

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