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Increased Utilization of Pitchers in NCAA Women's Softball Compared to Men's Baseball

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BACKGROUND: Pitch count and rest time guidelines are widely employed in youth baseball to mitigate injury risk among pitchers. Similar recommendations are lacking in youth softball, despite evidence of potential overuse injuries from the underhand windmill pitching motion. This disparity in regulation may heighten injury susceptibility. Additionally, the composition of collegiate softball and baseball rosters differs significantly, with softball teams typically featuring fewer pitchers. This discrepancy may lead to increased pitching demands for individual softball pitchers, potentially exacerbating injury risks. Therefore, understanding the relationship between the number of pitchers, game appearances, and injury incidence is crucial for informing injury prevention strategies in both baseball and softball. We hypothesize that individual softball pitchers will have significantly more game appearances per season and pitch more innings per game and season as compared to baseball pitchers, and that softball rosters will average significantly fewer pitchers per team than baseball rosters.
METHODS: A retrospective analysis was conducted of National Collegiate Athletic Association Division I softball and baseball College World Series teams from 2016 to 2021. Individual data consisting of game appearances and season innings pitched facilitated calculations for innings per game. Team data included the number of athletes and pitchers per team. Statistical analysis comparing baseball and softball team continuous variables utilized Student's t-test. Individual data, characterized by non-normal distribution, was evaluated with the Wilcoxon-Mann-Whitney Test. A significance level of $p < 0.05$ was applied to all analyses.
RESULTS: Softball pitchers had a significantly greater number of innings pitched per season (median 84.1 (21.0-143.2) vs 29.2 (10.0-56.1) $p < 0.0001$), game appearances per season (median 23.0 (10.0-32.0) vs 16.0 (9.0-21.0), $p < 0.0001$), and innings pitched per game (median 3.6 (2.2-4.7) vs 1.6 (1.1-2.8), $p < 0.0001$). Baseball rosters averaged significantly more total players (35.7 ± 3.9 vs 21.5 ± 2.8, $p < 0.0001$), more pitchers (15.7 ± 2.3 vs 4.5 ± 1.1, $p < 0.0001$), and a greater percentage of their roster was made up of pitchers (44.2% ± 6.4% vs 21.0% ± 4.4%, $p < 0.0001$).
CONCLUSION: This study highlights a notable difference in collegiate softball pitcher utilization compared to baseball pitchers. Fewer pitchers on softball teams led to a higher cumulative workload per pitcher, with increased innings pitched per season, per game, and more game appearances. While the relationship between pitch count and injury risk is established in baseball, further research is needed to understand its implications for softball pitchers.

INTRODUCTION

Acute and overuse pitching injuries are common among baseball and softball pitchers despite inherent differences in pitching mechanics.[1,2] There has been considerable attention placed on injury risk mitigation for baseball pitchers due to the high profile nature of these athletes and the readily identified injury risk factors.[3] Through a combined effort by USA Baseball and Major League Baseball (MLB), the "Pitch Smart" campaign established guidelines for safe pitching and an online resource for information on injury risk factors in pitchers.[4] As youth pitchers progress through Little League, pitch limits and required rest periods defined by Pitch Smart (Table 1) are implemented to decrease the risk of injury.[30] While these efforts have largely been successful in decreasing injury risk, several other factors including a pitcher's stature, athleticism, pitching style, and pitch type also play a role in how many

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pitches a pitcher can throw in a single game while maintaining effectiveness and minimizing injury.[5-7] Pitch counts are monitored, but not necessarily enforced at the collegiate level, which places these players at higher risk for pain and overuse injuries.[8-10]

Table 1. Pitch Smart Baseball Pitch Count Limits and Required Rest Recommendations[30]

Age (years)	*Daily Max Pitches*	*0 Days Rest*	*1 Days Rest*	*2 Days Rest*	*3 Days Rest*	*4 Days Rest*	*5 Days Rest*
7-8	*50*	*1-20*	*21-35*	*36-50*	*N/A*	*N/A*	*N/A*
9-10	*75*	*1-20*	*21-35*	*36-50*	*51-65*	*66+*	*N/A*
11-12	*85*	*1-20*	*21-35*	*36-50*	*51-65*	*66+*	*N/A*
13-14	*95*	*1-20*	*21-35*	*36-50*	*51-65*	*66+*	*N/A*
15-16	*95*	*1-30*	*31-45*	*46-60*	*61-75*	*76+*	*N/A*
17-18	*105*	*1-30*	*31-45*	*46-60*	*61-80*	*81+*	*N/A*
19-22	*120*	*1-30*	*31-45*	*46-60*	*61-80*	*81-105*	*106+*

Despite the emphasis on regulating baseball pitch counts, there are considerably fewer guidelines for softball pitchers (Table 2). There are no rules limiting pitch counts or rest periods in high school softball nor any of the largest travel leagues. Thus, young softball pitchers' playing time is only regulated by the demands, or lack thereof, of the team and coach. Typically, the most skilled pitcher on a high school or youth travel softball team pitches nearly all games, which can result in a single pitcher throwing 1200 to 1500 pitches in a 3-day tournament compared to 100 to 120 for baseball pitchers.[11] As such, softball teams typically recruit fewer pitchers than baseball teams. This relative lack of pitchers makes adherence to any potential pitch count and rest requirements challenging, if not impossible for softball teams as they are currently comprised.

Further, the windmill motion has inherent biomechanical differences relative to the overhanded baseball pitch. In baseball pitching, rotator cuff activity peaks during the late cocking phase with significant abduction and external rotation of the shoulder, but maximal shear stresses are seen at the glenohumeral joint during the deceleration phase due to high eccentric muscular loads. The softball pitcher circles a fully extended arm above their head, rotates the trunk and strides forward with the leg opposite the pitching arm, and snaps their wrist to release the pitch.[12,13] Previous conjectures of lower injury risk in windmill pitching have been attributed to maintaining humeral motion in plane with the body and lesser follow-through demands with the underhanded pitching motion, but these assumptions have not been substantiated.[14] EMG data demonstrates that forces through the biceps-labral complex during windmill pitching exceed those seen in overhand throwing and can result in morphologic changes in the long head of the biceps tendon in youth softball pitchers.[15,16] The unique mechanics of this pitching motion coupled with fatigue-related deterioration further increases injury risk.[17,18]

With the lack of regularly enforced pitching guidelines in softball, there is an unmitigated risk for acute and overuse injuries. In fact, more than 70-80% of elite collegiate softball pitchers report an injury each season.[34,35] Softball pitchers have a high risk of same-season re-injury and as compared to position players, they are more likely to sustain injuries resulting in substantial loss of playing time.[36,37,38] This study sought to define the physical demand experienced by softball pitchers by comparing the patterns of pitcher utilization between elite collegiate softball and baseball teams. Pitcher utilization was evaluated by comparing roster composition and individual pitcher statistics. We hypothesized that, when compared to collegiate baseball pitchers, collegiate softball pitchers would have an increased utilization demonstrated by more innings pitched per game and per season, and more game appearances per season. We also hypothesized that the increased utilization of softball pitchers would be supported by a trend for collegiate softball rosters averaging fewer pitchers per team than baseball.

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Table 2. Baseball and Softball Pitching Rules by League

Level of Play	*Organization*	*Baseball Pitching Limits*	*Softball Pitching Limits*
Youth	Little League[19]	Pitch Smart Guidelines	**≤12U:** Maximum 12 innings/day If 7+ innings in one day, then must rest 1 day **12+:** No restrictions
High School	National Federation of State High School Associations[20,21]	Each state must have pitching restriction policy regulating number of pitches thrown and required rest period	No restrictions
Travel	Amateur Athletic Union (AAU)[22,23]	**9U-12U:** Maximum 6 innings in consecutive days followed by 1 day rest **13U-14U**: maximum 10 innings in consecutive days followed by 1 day rest	No restrictions
	National Softball Association[24]	N/A	No restrictions
	Perfect Game[25,26]	Pitch Smart Guidelines	No restrictions
	Triple Crown[27,28]	Innings allowed per tournament through first 4 games played by age bracket: -7's = 6 innings -8's = 6 innings -9's = 6 innings -10's = 6 innings -11's = 6 innings -12's = 6 innings -13's = 7 innings -14's = 7 innings -15's = 8 innings -16's = 8 innings -18's = 8 innings Each player is allowed one additional inning per game at the start of the team's 5th game and thereafter	No restrictions
	USA Baseball / USA Softball[4,29]	Pitch Smart Guidelines	No restrictions
	United States Specialty Sport Association (USSSA)[30,31]	**7U-12U**: 0-3 innings: 0 rest days 3-6 innings: 1 rest day Maximum 6 innings/day, 8 innings/ 3 days **13U-14U** 0-3 innings: 0 rest days 3-7 innings: 1 rest day Maximum 7 innings/day, 8 innings/ 3 days **15U-18U** No restrictions	No restrictions
Collegiate	NCAA[32,33]	None	None

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METHODS

A retrospective review of National Collegiate Athletic Association (NCAA) Division I softball and baseball teams and athletes was conducted. Inclusion criteria were athletes and teams that participated in the NCAA Division I softball and baseball College World Series from the years 2016 through 2021, and pitchers listed as having greater than zero innings pitched for the season. Exclusion criteria included statistics from the year 2020, given the shortened season related to the COVID-19 pandemic. Official team websites were reviewed to obtain team and individual data. Same-year rosters and season statistics were reviewed. Concordant-season individual pitching statistics were not available on public facing websites for five softball teams and one baseball team. In these cases, same-year rosters were referenced to determine the total number of players and pitchers for the team.

Individual pitcher data included the season total number of innings pitched and the total number of game appearances. The number of innings pitched per game was subsequently calculated using these data. While every effort was made to obtain total pitch count data, this was frequently unavailable on a majority of publicly available team websites and as such, could not be utilized for analysis. Team data included total number of athletes and total number of pitchers on each team roster. The percentage of each team made up of pitchers was calculated by dividing the total number of pitchers per team by total number of athletes on the team.

Summary statistics are reported. Differences between baseball and softball team continuous variables were normally distributed and thus compared using Student's t-test. Individual data were variable with non-normal distributions and were evaluated using a Wilcoxon-Mann-Whitney Test. A p-value < 0.05 was considered statistically significant for all calculations. All analyses were completed using STATA (SE version 17.0; StataCorp College Station, TX, USA).

RESULTS

Forty collegiate softball teams and forty collegiate baseball teams were included. A total of 158 softball pitchers and 612 baseball pitchers were included for analysis. The number of innings pitched per pitcher in a single season was highly variable and had a non-normal distribution, with a range of 0.2 to 287.0 innings per season for softball pitchers and 0.1 to 134.2 innings per season for baseball pitchers. As such, individual data was compared using median values. Compared to baseball pitchers, softball pitchers had a significantly greater number of innings pitched per season, game appearances per season, and innings pitched per game, as summarized in Table 3.

Team roster data is summarized in Table 4. Baseball team rosters averaged significantly more total players and pitchers. A significantly greater percentage of their roster was comprised of pitchers as compared to softball teams. The range for the data points pertaining to pitchers is also worth noting, with baseball teams listing 12 to 24 pitchers as compared to softball, with 3 to 7 pitchers per team. The percentage of the roster comprised of pitchers ranged from 34.29% to 63.16% in baseball as compared to 13.04% to 31.82% in softball.

Table 3. 2016-2021 Baseball and Softball Individual Pitcher Data

	Baseball (n=612)	***Softball (n=158)***	***p-values***
IP/Season	29.2 (10.0 - 56.1)	84.1 (21.0 - 143.2)	<0.0001
Game appearances	16.0 (9.0 - 21.0)	23.0 (10.0 - 32.0)	<0.0001
IP/Game	1.6 (1.1 - 2.8)	3.6 (2.2 - 4.7)	<0.0001

IP, Innings pitched

All values are reported as median (interquartile range 25th -75th percentiles)

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Table 4. 2016-2021 Baseball and Softball Team Roster Data

	Baseball (n=40)	*Softball (n=40)*	*p-values*
Number of pitchers per team	15.7 ± 2.3	4.5 ± 1.1	<0.0001
Total players per team	35.7 ± 3.9	21.5 ± 2.8	<0.0001
% Roster pitchers	44.2 ± 6.4	21.0 ± 4.4	<0.0001

All values are reported as mean ± SD

DISCUSSION

This analysis of elite collegiate baseball and softball teams highlights a significant difference in the demands placed on their respective pitchers. The lesser number of pitchers on softball teams as compared to baseball undoubtedly contributes to the increased playing time seen by softball pitchers. Collegiate baseball teams averaged 3.5 times more pitchers on their roster than softball. Moreover, the baseball team with the fewest pitchers (twelve) still had significantly more pitchers than the softball team with the most pitchers in this study (seven). This lesser number of softball pitchers increases cumulative physical demand and may be responsible for the high risk of same-season re-injury. With fewer pitchers on rosters, adequate rest and recovery may not be feasible which further strains the remaining pitchers.[36]

Somewhat counterintuitively, despite softball games consisting of two fewer innings than baseball, softball pitchers throw 2.3 times more innings per game and 2.9 times more innings per season than baseball pitchers. In a 10-year prospective study of youth baseball pitchers, Fleisig et al. found that pitchers who threw more than 100 innings per year were 3.5 times more likely to be injured.[39] Using this same benchmark, the current study found that 43.7% of softball pitchers exceeded 100 innings pitched per season, as compared to only 7.35% of baseball pitchers. While no such study exists to define a critical limit for collegiate baseball pitchers nor softball pitchers at any level, our finding in particular highlights the magnitude of the disparity in innings pitched. There is a need for further study on the tie between pitch count and injury in softball pitchers.

The relative paucity of pitching guidelines in youth and adolescent softball fosters overutilization of young pitchers which carries through to the collegiate level. Both the Little League organization and the Stop Sports Injuries guidelines from the American Orthopaedic Society for Sports Medicine and National Council for Youth Sports recommend age-based limitations on softball pitch counts which resemble the guidelines utilized in youth baseball.[19,40] Unfortunately, these recommendations are not adopted by high school leagues nor travel leagues (Table 2) where there is significant amount of crossover among elite youth softball players.

Despite pitchers comprising a minority of the typical softball team roster, a study by Smith et al. found that pitching was responsible for 36.7% of youth softball injuries.[41] As Andrews and Fleisig did for baseball in their 1998 study linking pitch count to injury risk, a study of this link in softball would certainly be worthwhile.[42] Unfortunately, at the time of this study, the NCAA Injury Surveillance Program had been on a moratorium since 2018 precluding access to any form of streamlined data collection in this population. Nonetheless, efforts to define any relationship between softball pitcher utilization and injury should be pursued in order to establish the groundwork for potential pitch count limitations and enforced rest periods. Ultimately, a shift in culture to foster development of more youth softball pitchers would be required in order to build rosters with enough pitchers to be capable of abiding by pitch count limitations. A larger pool of youth pitchers can subsequently improve balance at the collegiate level, similar to that seen in baseball.

To our knowledge, this study is the first to quantify pitcher utilization in collegiate baseball and softball. However, there are limitations to this study. By utilizing publicly available data, pitch

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counts were not available for individual pitchers which may be more useful in future efforts to provide guidelines for softball pitchers. Innings pitched is a reasonable alternative to pitch count, but we acknowledge that there can be a large range for number of pitches thrown per inning. This level of granularity is not reflected in this study's data set. A study of pitch counts would require collection of team and player statistics from each individual team; given the lack of publicly available pitch count data, this was not felt to be feasible for this study. Utilization of elite collegiate baseball and softball teams ensures inclusion of highly skilled pitchers, but may not be generalizable to more amateur levels of play where season length, pitcher skill level, and batter skill level may create differences in pitch count. Finally, the principal limitation of this study is the inability to incorporate injury data to establish an association between pitcher utilization and injury risk as, at the time of this study, the NCAA Injury Surveillance System has remained inaccessible since 2018.

CONCLUSION

This analysis underscores a significant disparity in the utilization of collegiate softball pitchers compared to their baseball counterparts. With significantly fewer pitchers on softball teams, each individual pitcher faces a higher workload, including more innings pitched per season, innings pitched per game, and game appearances. The biomechanical stresses of windmill-style softball pitching, combined with the impact of fatigue due to over-utilization, warrant attention. While the link between pitch count and injury risk is well established in baseball, further research should explore its implications for softball pitchers. Efforts to define this relationship could inform the implementation of pitch count limitations and enforced rest periods, particularly in developmental youth leagues. Ultimately, fostering the development of more youth softball pitchers may be necessary to build rosters capable of abiding by such guidelines, mirroring practices in baseball.

Conflict of Interest Statement

The authors declare no conflicts of interest with the contents of this study.

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