

Rate of Upper Extremity Injury in High School Baseball Pitchers Who Played Catcher as a Secondary Position

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Context: Many high school pitchers play another position after they have finished pitching for the day or on their rest days from pitching. Because of the cumulative demands on the arm, pitchers who also play catcher may have a greater risk of developing a throwing-related shoulder or elbow injury.

Objective: To compare the rate of throwing-related upper extremity injuries between high school baseball pitchers who also played catcher as a secondary position and those who did not play catcher.

Design: Prospective cohort study.

Setting: Field laboratory.

Patients or Other Participants: A total of 384 male high school baseball pitchers were recruited from 51 high school teams. Pitchers who reported their secondary position as catcher were classified into the pitcher/catcher group and those who did not report playing catcher as a secondary position were classified into the other group.

Main Outcome Measure(s): Participants completed a demographic questionnaire preseason and then athlete participation and injury status were tracked during the subsequent

season. Athlete-exposures were monitored and the shoulder and elbow injury proportion rates were calculated.

Results: Athlete-exposures did not differ between groups ($P = .488$). The pitcher/catcher group's risk of shoulder or elbow injury was 2.9 times greater than that of the other pitchers (15% versus 5%; injury proportion rate = 2.9; 95% confidence interval = 1.03, 8.12).

Conclusions: Pitchers who reported also playing catcher were at a greater risk of sustaining a throwing-related shoulder or elbow injury than the other pitchers. These findings suggest that pitchers should consider not playing catcher as their secondary position in order to allow adequate time for recovery and to decrease their overall throwing load. Serial physical examinations of pitchers/catchers during the season may be useful in determining if their physical characteristics are changing during the season because of the cumulative throwing load.

Key Words: injury risk factors, training load

Key Points

- Pitchers who played catcher as a secondary position were at a 2.9 times greater risk of developing a throwing-related shoulder or elbow injury than pitchers who played a different secondary position.
- Clinicians, coaches, and parents can use this information to assign pitchers secondary positions to decrease their injury risk.
- In baseball players, tracking cumulative loads rather than limiting pitch counts may be an important injury-prevention strategy.

During the 2014–2015 academic year, approximately 500 000 high school athletes played baseball for their schools.¹ Many of these athletes are pitchers because of the regulation limiting the number of pitches allowed per pitcher and the high number of games played over a short period of time. As a result of the significant mechanical demands placed on the upper extremity during pitching, the rates of shoulder and elbow injuries in baseball pitchers are high.^{2,3} Pitchers accounted for 73% of injuries in high school baseball players, of whom approximately 10% required surgery.⁴

Many high school pitchers play another position after they have finished pitching for the day or on their rest days from pitching. Some pitchers play catcher as a secondary position, which requires repetitive throwing and continues to place loads on the shoulder and elbow joints instead of allowing time for recovery.^{5–7} The USA Baseball Medical

and Safety Advisory Board and American Sports Medicine Institute combined research evidence with clinical expertise to create participation recommendations for youth and high school baseball players in the “Pitch Smart” guidelines.⁸ These guidelines specify the recommended number of pitches per day; however, they do not take into account the demands on the athlete when playing another field position.

Repetitive throwing and pitching results in large amounts of torque that develop about the shoulder and elbow complexes, causing microtrauma to the surrounding tissues.^{9,10} To help decelerate the arm after ball release, the posterior shoulder muscles and scapular stabilizers contract eccentrically.^{11,12} The effects of repetitive eccentric contractions are well documented and include sarcomere damage,¹³ shortened connective tissue, passive muscle stiffness, and decreased range of motion (ROM).^{14,15} Baseball pitchers who play catcher as a

Table 1. Athletes' Positions

Position	No. (%)
Pitcher only	10 (2.6)
Pitcher/second base	23 (6.0)
Pitcher/first base	29 (7.6)
Pitcher/catcher	32 (8.3)
Pitcher/shortstop	39 (10.2)
Pitcher/infield	51 (13.3)
Pitcher/third base	71 (18.5)
Pitcher/outfield	129 (33.6)

secondary position may not allow their body enough recovery time for muscle healing and return of prepitching ROM, strength, and scapular control from the levels that result from pitching or overhead fatiguing activity.¹⁶⁻¹⁹ The cumulative throwing load of pitchers who also play catcher as a secondary position may cause them to develop physical maladaptations, which may increase their risk of developing a throwing-related shoulder or elbow injury.

One group⁹ identified the secondary position of catcher as a risk factor for severe injuries that required surgery. However, whether playing catcher as a secondary position increases the risk of nonsurgical injuries, which constitute the majority of throwing-related upper extremity injuries, has not been investigated. Therefore, the purpose of our study was to compare injury rates between high school baseball pitchers who also played catcher as a secondary position and those who did not. This information can be used by clinicians, coaches, and parents in assigning high school baseball pitchers secondary positions to decrease the risk of injury as well as to provide evidence regarding the influence of cumulative training loads on their injury risk.

METHODS

Participants

Participants were recruited from 51 high school baseball teams over the course of 3 years. Volunteers were included in the research study if they were between the ages of 14 and 19 years, were pitchers on a school district-sponsored high school baseball team, were currently active without limitations in practice due to injury, and had no history of significant shoulder or elbow injury that required surgery or forfeiting an entire season.

Procedures

We used a prospective research design. All participants completed a demographic questionnaire, and then athletes' participation in practices and games and their injuries were recorded through the subsequent competitive spring baseball season. Typically, the competitive season ran from mid-February through April. All participants and their parents or guardians read and signed the informed consent form approved by a university institutional review board and a Health Insurance Portability and Accountability Act (HIPAA) release form before data collection.

The demographic questionnaire consisted of questions about sport involvement and injury history. Recruits provided information regarding injuries from the past 3 years; years of participation in organized baseball; primary position of play; secondary positions of play (if any); months

out of the past 3 years that they participated in baseball competition, practice, and training; nature and number of leagues and teams played for in the past 3 years; and other organized sports in which they were currently participating. Pitchers who reported their secondary position as catcher were classified into the pitcher/catcher group. Participants who did not report playing catcher as a secondary position were classified into the pitcher/other group.

Athlete tracking was conducted by the full-time athletic trainer (AT) at each high school using an online reporting database created for this study. The ATs reported whether participants were at practice, practice status (*full, limited, or out*), and the reason for a missed practice. *Game participation* was determined via review of the team scorebook and defined as an exposure when the participant was entered into the scorebook and was involved in at least 1 play. Athlete-exposures (AEs) were calculated as the total number of practice and game participations during the competitive season. This information is an indicator of days of games and practices but does not evaluate the workload performed during those games and practices. The ATs also reported any injuries that occurred during the season. For this study, injuries that occurred to the shoulder or elbow as a result of baseball throwing (*throwing-related upper extremity injury*) that resulted in at least 1 missed AE were included in the analysis. The ATs also reported whether the injury was new or recurring. Only injuries that were classified as new were included in the analysis. The research team verified participation and injuries with the ATs and baseball coaches at the end of the competitive season.

Statistical Analyses

We calculated descriptive statistics for position data to evaluate pitchers' secondary positions, years of experience, and injury histories. An independent-samples *t* test was used to evaluate differences in AEs between the pitcher/catcher and pitcher/other groups. An a priori α level of .05 determined statistical significance. The injury rate was calculated for each group as the number of injured players in the group divided by the total number of athletes in the group. An injury proportion rate and 95% confidence interval were calculated to compare the risk of injury between groups. All statistical analyses were performed using SPSS (version 20; IBM Corp, Armonk, NY).

RESULTS

Ninety-seven percent of the baseball pitchers also reported playing another position, and 8.3% of the pitchers reported playing catcher as their secondary position. A complete list of reported positions is provided in Table 1. Participant demographics are shown in Table 2. Age, height, mass, and years of baseball participation did not differ between the pitcher/catcher and pitcher/other groups. Seasonal AEs also did not differ between groups ($P = .488$): the pitcher/catcher group reported 53.72 ± 10.8 AEs and the pitcher/other group reported 52.1 ± 13.1 AEs.

Twenty-four throwing-related shoulder or elbow injuries in pitchers were reported during the study period. Five injuries occurred in the pitcher/catcher group, resulting in an injury rate of 15.6%, and 19 injuries occurred in the pitcher/other group, resulting in an injury rate of 5.4% (Table 3). Shoulder and elbow injury descriptive statistics

Table 2. Participant Demographics

No.	Group	
	Pitcher/Catcher	Pitcher/Other
	32	352
	Mean ± SD	
Age, y	16.9 ± 1.0	16.7 ± 1.0
Height, cm	182.7 ± 5.3	182.4 ± 6.5
Mass, kg	81.5 ± 8.7	78.6 ± 12.2
Baseball participation, y	11.9 ± 1.1	11.4 ± 1.8

are presented in Tables 4 and 5. The proportion of pitchers who developed a throwing-related shoulder or elbow injury during that baseball season was 2.9 times greater in pitcher/catchers compared with pitcher/others (15% versus 5%; injury proportion rate = 2.9; 95% confidence interval = 1.03, 8.12). Baseball pitchers who also played catcher were at a greater risk of injury during the baseball season than those pitchers who did not play catcher.

DISCUSSION

Of the 384 high school baseball pitchers who were surveyed, 2.6% identified themselves as pitchers only; the remainder reported playing another position when they were not pitching. Pitchers who reported playing catcher as a secondary position were at a 2.9 times greater risk of injury than pitchers who reported playing a different secondary position. Reported AEs did not differ between the groups, indicating that they participated in an equal number of games and practices throughout the season. Despite equal exposure throughout the year, injury rates were greater in the pitcher/catchers, suggesting that position participation factors during the season may be responsible for the greater risk of injury in that group.

Pitching results in microdamage to the posterior shoulder structures because of high eccentric loads on the tissue. Eccentric loading of the shoulder external rotators that simulated a bout of pitching has been shown to increase infraspinatus cross-sectional area for more than 24 hours.²⁰ Passive ROM in the shoulders and elbows of pitchers has been reported to decrease immediately after a bout of pitching and remain decreased for more than 24 hours.¹⁶ Significant postgame reductions in shoulder flexion, internal rotation, and adduction strength were also reported after a bout of pitching.¹⁷ In another study,¹⁸ shoulder internal- and external-rotation and abduction strength decreased after a 100-pitch bullpen and remained lower than prepitching values for up to 2 days. Additionally, a decrease in acromiohumeral distance, which may be due to periscapular muscle fatigue or weakness,²¹ was found after an overhead fatiguing shoulder protocol.¹⁹ If they are not restored before the next pitching opportunity, these acute changes may lead to gradual maladaptation of physical

Table 3. Injury Descriptive Statistics

Variable	Group	
	Pitcher/Catcher	Pitcher/Other
Total injuries	5	19
Injury rate, %	15.6	5.4
Shoulder injuries, No. (%)	3 (60)	12 (63)
Elbow injuries, No. (%)	2 (40)	7 (37)

Table 4. Shoulder Injury Descriptive Statistics

Shoulder injuries	Group, No. (%)	
	Pitcher/Catcher (n = 3)	Pitcher/Other (n = 12)
Muscle strain	1 (33)	5 (42)
Biceps tendinitis	1 (33)	1 (8)
Impingement	1 (33)	0 (0)
SLAP lesion	0 (0)	2 (16)
Salter-Harris fracture	0 (0)	1 (8)
Bursitis	0 (0)	1 (8)
General soreness	0 (0)	2 (16)

Abbreviation: SLAP, superior labrum anterior and posterior.

characteristics. Playing catcher as a secondary position between pitching bouts may delay the recovery and restoration of normal physical characteristics. The resulting maladaptation of physical characteristics may lead to a throwing-related shoulder or elbow injury.

Our results support previous work indicating that playing catcher as a secondary position was a risk factor for severe injuries requiring surgery,⁹ as well as supporting the “Pitch Smart”¹⁸ recommendation of not playing catcher as a secondary position and the Little League baseball rule²² preventing pitchers who throw more than 41 pitches in a game from entering as catchers. Although pitch limits are well established in baseball, our findings indicate that the 2.9 times greater injury risk may be a product of the cumulative throwing load from pitching and nonpitching activities. It is important to take into account the cumulative external training load baseball players experience in order to understand the aggregate stress placed on the athlete’s body. External training load represents work completed by an athlete and is one of the primary measurable factors associated with sport-related musculoskeletal injury.^{23,24} The results of this study can be used to educate parents and coaches about selecting a secondary position for a pitcher to play. To provide information for the development of evidence-based interventions, future researchers should evaluate physical characteristic adaptations during the season that might be putting pitcher/catchers at a greater risk of injury.

Several limitations in our study should be addressed. Currently, participation tracking is based on exposure—indicating that the athlete participated in either a game or a practice—and may not represent the repetitive stresses placed on the shoulder and elbow during baseball.²⁵ We were unable to report injury rates per exposure because of limitations in exposure tracking. For example, an athlete who pitched 100 pitches would have the same exposure as an athlete who only pitched 10 pitches or an athlete who played in the outfield. In addition, our methods did not differentiate between pitching exposures and exposures at other positions. We do not believe that AE data collected using traditional definitions of exposure

Table 5. Elbow Injury Descriptive Statistics

Elbow Injuries	Group, No. (%)	
	Pitcher/Catcher (n = 2)	Pitcher/Other (n = 7)
Ulnar collateral ligament sprain	1 (50)	4 (57)
Medial elbow pain	1 (50)	2 (29)
Posterior elbow impingement	0 (0)	1 (14)

truly represent the time engaged in the event that may be causing injury in baseball players and do not accurately reflect the differences in demands based on position. Future investigators in baseball injury tracking should consider calculating a cumulative throwing load to more accurately represent the training demand and should use these data to more accurately calculate injury rates. In addition, the numbers of reported injuries and of athletes who were pitchers and catchers were relatively small. Additional participants and injuries might have provided different results. Although the injury rates were low, we believe we are the first authors to prospectively calculate injury rates in this subset of athletes. Future multisite prospective studies are needed to track a larger number of athletes and to enhance our knowledge of the influence of secondary positions on injury risk.

The results of this prospective study indicated that pitchers who played catcher as a secondary position were at a 2.9 times greater risk of developing a throwing-related shoulder or elbow injury than pitchers who played a different secondary position. Clinicians, coaches, and parents can use this information to assign pitchers secondary positions to decrease their injury risk. Our findings suggest that tracking cumulative loads in baseball players, rather than just limiting pitch counts, may be an important injury-prevention strategy. Future researchers should evaluate changes in physical characteristics during the season that cause injury to determine how the cumulative throwing load relates to injury, so that evidence-based intervention programs can be developed.

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