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*Original Research*

# Shoulder Strength and Range of Motion Between Collegiate Pitchers and Position Players in Baseball

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ABSTRACT

***International Journal of Exercise Science 13(6): 123-130, 2020.*** Baseball is a sport that places excessive strain on the shoulder complex caused from repetitive overhead throws. In the sport of baseball, shoulder strength and range of motion (ROM) are paramount for success on the field. The purpose of this study was to determine strength and ROM differences between collegiate baseball pitchers and position players. It was hypothesized that pitchers would have higher strength and ROM values, due to the volume of throwing a pitcher performs. A total of nine collegiate baseball pitchers and position players ($n$ = 18) volunteered for the study (age = 20.94 ± 1.21 years, height = 183.42 ± 4.74 cm, and mass = 89.56 ± 10.76 kg). Shoulder strength was measured using a Humac Norm isokinetic dynamometer at 180°sec$^{-1}$ and 300°sec$^{-1}$ and ROM was measured using a goniometer. All participants completed a five-minute warm-up at 50 rpm on an upper body ergometer. Following the warm-up, passive internal and external ROM were measured for the throwing (dominant) arm. No statistical differences were found in external ROM ($p$ = 0.319), internal ROM ($p$ = 0.258), external peak torque @180°sec$^{-1}$ ($p$ = 0.467), internal peak torque @180°sec$^{-1}$ ($p$ = 0.156), external peak torque @300°sec$^{-1}$ ($p$ = 0.225), or internal peak torque @300°sec$^{-1}$ ($p$ = 0.137). The findings indicate similar isokinetic strength and flexibility in the throwing shoulder of collegiate athletes who perform repeated overhead throwing motions. Thus, in this study the player's baseball position (pitchers vs. position player) did not influence throwing shoulder strength and ROM characteristics.

KEY WORDS: Throwing, dominant shoulder, isokinetic dynamometer, goniometer

## INTRODUCTION

Baseball is an internationally acclaimed sport consisting of throwing and hitting at maximal speeds (7). Baseball is an extremely demanding sport on the upper extremities, specifically on the shoulder complex (10). Baseball consists of pitchers, infielders, outfielders, and catchers (13). Pitchers are players that throw the ball to the catcher with the intent of making the hitters miss. Pitchers consist of starters, relievers, and closers (9). Starting pitchers typically only pitch once every four games throughout the season compared to relief pitchers who play as needed, which could result in facing one batter or pitching for several innings per game (9). Position players make up the remainder of a baseball team and are not traditionally members of the pitching staff (12). Pitchers and position players need to throw the ball to different players to complete

different plays in baseball. For this reason, being able to throw the baseball with velocity and accuracy is important to success in the sport.

The shoulder joint is an essential part of the body in baseball players, due to its role in throwing the baseball. The strength and range of motion (ROM) of pitchers and position players is important when it comes to sports performance. The shoulder joint goes through numerous planes of motion, including extreme ranges of velocities and angular displacements during the act of throwing a ball (17). Previous studies have shown that excessive eccentric contractions cause a decrease in joint ROM in both upper and lower extremities (19,21). This study could help provide additional knowledge for baseball specific training needed for different players based upon the position they play (12,13).

Relationships between above average ROM and high levels of strength in the glenohumeral joint have been linked to longer careers in baseball and less injuries throughout the course of a baseball season (2,7,8). While strength training imbalances will occur between pitchers and position players it has been noted that higher levels of ROM are prevalent in pitchers due to the high volume of throws (10,13,17). A study by Brown, Niehues, Harrah, Yavorsky, and Hirshman (4), reported high level of shoulder strength and a slightly higher range of motion in major league pitchers compared to position players. Although this research has been done on major league pitchers, little has been done on collegiate level pitchers and position players. Thus, the purpose of this study was to determine the differences in shoulder strength and ROM in collegiate baseball pitchers and position players. It is hypothesized that National Collegiate Athletic Association (NCAA) Division II baseball pitchers will have higher shoulder strength, internal rotation (IR), and external rotation (ER) flexibility compared to position players.

## METHODS

*Participants*

Prior to data collection, a power analysis performed with G*POWER 3.1.9.1 (Universität Kiel, Germany) determined that a total of 18 participants would be necessary for a power of .80, with an effect size of 0.5 and an $\alpha = 0.05$. As a result, eighteen participants were recruited (9 pitchers, 9 position players) for the study. The participants were college-aged (between 18-24 years) NCAA Division II collegiate baseball players. Exclusion criteria for the study includes previous history of shoulder injuries and any shoulder surgeries in the last 12 months (14). All participants signed informed consent prior to participation in the study, which was approved by the Institutional Review Board at The University of Alabama in Huntsville.

**Table 1.** Participant characteristics for pitchers ($n$ = 9) and position players ($n$ =9).

| Variable | *M* ± *SD* |
|---|---|
| Age | 20.94 ± 101.21 |
| Height (cm) | 183.42 ± 4.74 |
| Weight (kg) | 89.56 ± 10.76 |

Note: Values are mean ± standard deviation.

*Protocol*

All testing was performed in the university exercise physiology laboratory. After completing informed consent, each subject completed a warm-up. The participants performed 5 minutes of upper body cycle ergometry at 50 rpm on a Monark 881E ergometer (Kroons väg 1, Vansbro, Sverige) (5). After completing the warmup, the participants had the shoulder flexibility of their throwing arm evaluated with the same investigator preforming all flexibility measurements. Participants were randomized and positions played were blinded to investigators prior to data collection.

Measurements for shoulder ROM were evaluated twice for the throwing arm. The participants were tested lying in a supine position on a table with their shoulder and elbow flexed at 90 degrees (6,11). The examiner placed one hand over the clavicle and humeral head to stabilize the glenohumeral joint (13) and a small towel was rolled and placed under the humerus to place the shoulder in a neutral position (13). For the ER measurements, the tester placed one hand on the elbow that was flexed at 90 degrees and rotated the participant's forearm posteriorly until the participant's stopping point was reached. The stopping point was identified as the point when there was an end in motion or at the point when scapular movement was appreciated (11,13,15,21). To measure ER, one arm of the goniometer was positioned by another researcher perpendicular to the ground, and the other was positioned along the ulnar styloid process (13,21). All goniometer measurements were performed based upon the techniques by Norkin and White (13,18). A total of two measurements were taken to determine glenohumeral external ROM. Prior to conducting the study, the test-retest reliability of measuring internal and external ROM was assessed in a sample ($n$ = 13) of injured collegiate students, the intraclass correlation coefficients for both measurements was between .910 to .993.

The order measurement of IR and ER was randomized for each participant in the study. During glenohumeral IR measurements, the same techniques were used for patient positioning (6,11), shoulder stabilization (11,13), and determining the stoppage point (11,13,15,21) of passive ROM. The tester kept the elbow flexed at 90 degrees and rotated the participant's shoulder at the elbow anteriorly until the participant's stoppage point of passive ROM was reached. To further control scapular motion, if the scapula appeared to leave the table the internal ROM tests was stopped (4,13). Once again, to determine the amount of glenohumeral IR, one arm of the goniometer was positioned perpendicular to the ground, and the other was positioned along the ulnar styloid process (13,15). After internal ROM was measured twice, the participants rested for 1 minute and proceeded to test isokinetic shoulder strength.

Internal and external isokinetic strength of the dominant shoulder was measured using the Humac Norm Isokinetic Dynamometer (17). During testing, participants were positioned lying supine with their shoulder abducted to 90 degrees and the elbow flexed to 90 degrees. The participants throwing arm was secured and held in place with the proper strapping from the manufacturer (17). The participants shoulder IR and ER strength were tested filtered and windowed at speeds of 180 degrees $sec^{-1}$ and 300 degrees $sec^{-1}$ (3). The participant positioning and speeds tested were chosen based on joint position angles and specificity of muscular function during the throwing motion for baseball players (1,9,20,22,23). The stops for the

isokinetic testing device were set to a standardized 90 degrees for external rotation and 65 degrees for internal rotation, due to manufacturer guidelines (8). Each participant completed 5 maximal repetitions at each velocity, 5 repetitions at 180 degrees $sec^{-1}$ and 5 repetitions at 300 degrees $sec^{-1}$ (4).

The participants performed the warmp-up on a Monark 881E upper body ergometer (Monark Exercise AB, Kroons väg, Sweden). The instrument that was used to measure ROM for IR and ER was a long-arm goniometer (Baseline, White Plains, NY). The instrument that was used to measure strength was a Humac Norm Isokinetic Dynamometer (Computer Sports Medicine Inc., Stoughton, MA) (17). This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science.

*Statistical Analysis*

Data was analyzed using the Statistical Package for Social Sciences, version 25.
Independent sample *t*-tests were used to compare all ROM and strength (peak torque) values between pitchers and position players. Alpha level was set at ($p < 0.05$) for determination of significant values.

**RESULTS**

There was a total of eighteen NCAA Division II baseball players that participated in the study, with an average age of 20.94 ± 1.2 years. Participant height was measured in centimeters (cm) mean and SD values were 183.42 (SD ± 4.74 cm), weight was measured in kilograms (kg) mean and SD values were 89.56 (SD ± 10.75 kg) (see Table 1).

Range of Motion: The pitchers dominant throwing arm had a mean external ROM value of 115.56 ± 15.71 degrees. Position players had an average dominant throwing arm ER ROM value of (109.67 ± 6.95) (see Table 2) degrees. There was no significant difference between the two variables ($p = 0.319$). Dominant IR ROM showed the pitchers had a mean value of 84.72 ± 17.85 degrees, and position players had a mean value of 74.61 ± 18.68 degrees. There was no significant difference found between the two variables ($p = 0.258$).

Isokinetic Strength: Dominant arm external peak torque values measured in Newton-meters at 180°sec-1 for pitchers had a mean value of 20.67 ± 7.14 (Nm) (Table 2), when compared to position players at 23.22 ± 7.41 (Nm) (Table 2). No significant difference between the two variables was shown ($p = 0.467$), while dominant arm internal peak torque values at 180°sec-1 for pitchers had a mean value of (27.44 ± 12.31 Nm) (Table 2), when compared to position players at (37.22 ± 15.40 Nm) (Table 2), with no significant findings between the two variables ($p = 0.156$). Dominant arm external peak torque values at 300°sec-1 for pitchers had a mean value of (16.44 ± 7.14 Nm) (Table 2), when compared to position players at 19.90 (SD ± 3.99 Nm) (Table 2). No significant difference between the two variables ($p = 0.225$). Dominant arm internal peak torque values at 300°sec-1 for pitchers had a mean value of (22.22 ± 10.21 Nm) (Table 2), when compared to position players at 31.00 (SD ± 13.39 Nm) (Table 2). There was no significant difference between the two variables ($p = 0.137$).

**Table 2.** Flexibility and isokinetic strength values for pitchers and position players.

| Variable | Pitchers (*M* ± *SD*) | Position Players (*M* ± *SD*) |
|---|---|---|
| Shoulder External ROM | 115.56 ± 15.71 | 109.67 ± 6.95 |
| Shoulder Internal ROM | 84.72 ± 17.85 | 74.61 ± 18.68 |
| Shoulder External Peak Torque @ 180°sec$^{-1}$ | 20.67 ± 7.14 | 23.22 ± 7.41 |
| Shoulder Internal Peak Torque @ 180 °sec$^{-1}$ | 27.44 ± 12.31 | 37.22 ± 15.40 |
| Shoulder External Peak Torque @ 300°sec$^{-1}$ | 16.44 ± 7.14 | 19.90 ± 3.99 |
| Shoulder Internal Peak Torque @ 300°sec$^{-1}$ | 22.22 ± 10.21 | 31.00 ± 13.39 |

Note: Values are mean ± standard deviation.

## DISCUSSION

The purpose of this study was to determine if there were any differences in ROM and isokinetic strength values in the throwing arms of collegiate baseball pitchers and position players. It was hypothesized that pitchers would have higher glenohumeral ER and IR ROM values, as well as isokinetic strength values. As a result, IR ROM, ER ROM, as well as all isokinetic strength values were shown to be similar between pitchers and position players ($p > 0.05$).

Range of Motion: There was no difference in passive glenohumeral IR ($p = 0.258$) or ER ($p = 0.319$) values between pitchers and position players. The findings of this article are in contrast to the findings of a previous study by Brown et al. (4), which indicated that major league baseball pitchers have significantly more external rotation compared to position players. Although pitchers in this study, on average had higher amounts of external and internal glenohumeral rotation compared to position players, there was not a statistically significant difference between the two groups. The lack of statistical difference could be due to the large standard deviation seen for internal and external ROM within the pitching sample. The similarities in glenohumeral IR and ER between pitchers and position players, could also be due to the fact that the participants in the study are younger compared to the participants used in the study by Brown et al. (4) (mean age = 20 vs 27 years of age). This would result in less repetitive throwing by the collegiate athletes compared to the increased amount of throwing undergone by professional baseball players and could result in less alterations in shoulder ROM (3,5,6).

The similarities in ROM between pitchers and position players found in this study are similar to the findings of a study performed by Bigliani et al. (2), which compared shoulder ROM and laxity between major league pitchers and position players. The lack of difference in glenohumeral IR and ER between pitchers and position players is also similar to the findings of a study by Carter et al. (5), which compared IR and ER ROM values in collegiate baseball players (5). The findings of our study suggest that the similarities in glenohumeral ROM are not based upon the position played by the player. The amount of IR an ER ROM is more than likely due to the adaptive changes caused from repetitive microtraumas (13) that take place in adolescence (the early formative years of a player's career) or due to pre-existing inherited differences (3,5).

Isokinetic Strength: The amount of isokinetic shoulder strength in baseball players from a variety of competitive levels and age groups has been previously investigated (1-3, 5-7,9,20,25). However, there has been limited studies conducted on isokinetic strength differences between

collegiate pitchers and position players. Similar to ROM, there were no statistically significant differences in shoulder ER and IR peak torque values at 180 °sec$^{-1}$ (ER $p$ = 0.467, IR $p$ = 0.156) and 300 °sec$^{-1}$ (ER $p$ = 0.225, IR $p$ = 0.137). These findings contrast with the findings of studies by Cook et al. (7) and Brown et al. (4), which showed positional differences in IR and ER isokinetic shoulder strength at 180 °sec$^{-1}$ and 300 °sec$^{-1}$ in both collegiate (7) and professional (4) baseball players. The similarities in IR and ER isokinetic strength values in this study could be due to similar adaptations in rotational shoulder motion in this sample of collegiate athletes, which could be due to their younger age compared to average professional baseball players. Differences in isokinetic shoulder strength by position may become more pronounced as the players age and undergo more pitching specific training, which is seen in professional baseball players compared to collegiate baseball players (13,22-24). Also, repetitive throwing by overhead athletes results in adaptations of the joint range of motion. Thus, an increase in age and throwing volume completed by being a pitcher could result in larger differences in glenohumeral IR and ER isokinetic strength (4,8,11,22).

One of the limitations in this current study was the sample size and only utilizing one collegiate baseball team, which could have possibly limited significant differences between pitchers and position players. Even though no significant differences were found, position players had higher mean values in all shoulder isokinetic peak torque measurements; and pitchers had higher mean values in ROM compared to position players. Lastly, the baseball players participated while in season, which could have potentially affected results. During season, the amount of throwing increases because of sport specific training and game play. This could cause muscle soreness or tightness, which could reduce shoulder strength and ROM values (25).

In conclusion, this study provides additional understanding regarding collegiate baseball pitcher's and position player's glenohumeral IR/ER ROM and isokinetic strength. This information can be used to help further research into exercise testing and training protocols for collegiate baseball players. The results of the study indicate that Division II collegiate baseball players are similar in both shoulder strength and ROM. Thus, differences in IR and ER isokinetic strength that are seen in professional baseball players are not shown in Division II collegiate baseball players. The adaptations that occur in regards to glenohumeral ROM in baseball players more than likely occurs during the time frame of adolescent development (2). The similarities in isokinetic strength are more likely due to the fact that collegiate level athletes may not undergo the increased volume of throwing performed by professional athletes. As a result, the findings of this study provide further insight into collegiate baseball positional differences and also allowed each player to obtain their individual values, which can be tracked over the span of their baseball playing careers.

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