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# Isokinetic Strength of Collegiate Baseball Pitchers During a Season

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**Abstract.** Wilkin, L.D., and B.L. Haddock. Isokinetic strength of collegiate baseball pitchers during a season. *J. Strength Cond. Res. 20(4):829–832. 2006.*—Pitching is suggested to expose the arm to physical stress that may lead to a decrease in strength. The purpose of this study was to examine the isokinetic internal and external rotational shoulder strength of Division II pitchers preseason, midseason, and postseason. The 9 pitchers were 23 ± 0.67 years of age and weighed 91.2 ± 3.14 kg. Each subject was evaluated utilizing a Biodex Isokinetic Dynamometer. Isokinetic internal and external concentric strength was assessed at 90° of shoulder abduction and 90° of elbow flexion at 300 and 450°·s$^{-1}$ at each time point. A repeated-measures analysis of variance statistical analysis was performed using SPSS software. All data are reported as mean ± *SEM*. Mean internal peak torques at 300 and 450°·s$^{-1}$ preseason, midseason, and postseason were 50.66 ± 2.27, 49.70 ± 2.54, and 51.70 ± 2.94 N·m and 37.14 ± 2.54, 37.36 ± 2.74, and 38.26 ± 2.50 N·m, respectively. Mean external peak torques at 300 and 450°·s$^{-1}$ preseason, midseason, and postseason were 30.16 ± 1.69, 29.50 ± 2.22, and 29.79 ± 2.08 N·m and 17.68 ± 2.15, 16.89 ± 2.46, and 18.20 ± 2.35 N·m, respectively. There were no differences in isokinetic internal or external concentric shoulder rotational mean peak torque of Division II pitchers at any speed tested or time point examined.

Key Words. muscular strength, shoulder, throwing

## Introduction

Pitching, throughout a typical National Collegiate Athletic Association (NCAA) Division II college baseball season, exposes the shoulder muscles to physical stress. This repeated stress on the shoulder muscles may lead to changes in strength over the course of the season. Dillman et al. (3) suggested that during pitching a peak internal rotational angular velocity of almost 7,000°·s$^{-1}$ is reached. They also suggested that pitching is one of the fastest human movements in any sport skill.

Although it is technically impossible to simulate the velocity suggested by Dillman et al., there are many studies that have evaluated shoulder rotational strength at several different rotational speeds. There are studies that have examined the shoulder strength of pitchers compared with other position players (1) and compared with other types of athletes (2). There are several studies that have established normative shoulder rotational strength data for professional pitchers (4, 5, 9, 11, 12), collegiate pitchers (8), and high school pitchers (6, 10). In addition, several studies have examined dominant vs. nondominant shoulder rotational strength (1, 5, 6).

However, there remains a paucity of research investigating changes in internal and external rotational strength of the shoulder of collegiate pitchers throughout a typical 4-month baseball season. One such pilot study conducted by Whitley and Terrio (10) utilized high school pitchers. The results suggested a significant loss in adduction strength in both throwing and nonthrowing shoulders at 180°·s$^{-1}$, a decrease in internal rotation strength for both sides, but no differences at 300°·s$^{-1}$. They further suggested that this loss of strength at 180°·s$^{-1}$ would potentially be associated with injuries to the pitching arm.

The purpose of this study was to examine the isokinetic internal and external concentric rotational strength of the shoulder musculature in pitchers of an NCAA Division II collegiate baseball team preseason, midseason, and postseason to determine if a loss of rotational strength occurs. We hypothesized that the repeated stress of the shoulder musculature, throughout a 4-month season, would result in a decline in isokinetic internal and external concentric rotational strength.

## Methods

### Experimental Approach to the Problem

This study was designed to examine the isokinetic internal and external concentric rotational strength of the shoulder musculature of pitchers playing on an NCAA Division II collegiate baseball team over the entire season. For the purposes of the study, rotational strength was defined by the mean peak torque measurements obtained at angular velocities of 300 and 450°·s$^{-1}$. To approximate changes over the entire season, the subjects were measured 3 times: preseason, midseason, and postseason.

The independent variables for this experiment were time examined at 3 levels: preseason, midseason, and postseason; angular velocity was examined at 2 levels: 300 and 450°·s$^{-1}$; and direction was examined at 2 levels: internal rotation and external rotation. This dictated a 3 × 2 × 2 repeated-measures design. The dependent variable for the design was mean peak torque.

### Subjects

This study was approved by the Institutional Review Board of the University and all subjects signed an informed consent before testing. Thirteen male pitchers were recruited from an NCAA Division II baseball team. Nine (age, 23 ± 0.67 years; weight, 91.2 ± 3.14 kg) of the 13 pitchers completed the study. Three of the 4 who did not complete the testing dropped out due to eligibility issues or they were unable to make their appointment and the other was injured. Throughout the entire season, all 9 subjects were free of any musculoskeletal injuries or conditions that might result in pain or restriction of internal and external rotation of the shoulder.

**TABLE 1.** Study design.

| Familiarization | Preseason testing | Midseason testing | Postseason testing |
|---|---|---|---|
| Early January before the beginning of regular season play | Mid-January before the beginning of the regular season play | Early March the midpoint of season play | Mid-May the end of regular season play |

### Procedures

Each subject reported to the human performance laboratory 1 week prior to preseason testing for familiarization. The subjects were positioned on a Biodex Isokinetic Dynamometer (Biodex, Inc., Shirley, NY) according to the manufacturer's suggestion, and the trunk was secured with straps across the chest and waist. The evaluation of internal and external concentric isokinetic strength of the shoulder was conducted with 90° of shoulder abduction and 90° of elbow flexion. The complete set-up information for each subject was recorded for future testing to assure consistent positioning.

One week following familiarization (Table 1), subjects reported to the laboratory and a warm-up was performed on an Upper Body Ergometer (Monark, Varberg, Sweden) for 5 minutes at the subject's selected intensity. The intensity was recorded during familiarization for replication during future testing. Following calibration of the dynamometer and proper positioning, the subject's arm was statically weighed to provide a gravity correction of the data. Each subject performed 10 maximal repetitions at $300°\cdot s^{-1}$ followed by a 90-second rest period before performing 10 maximal repetitions at $450°\cdot s^{-1}$ through a standardized 90° range of motion. The isokinetic dynamometer reported the data as mean peak torque. All subjects received uniform commands and encouragement throughout each testing session. The identical testing procedure was utilized for familiarization preseason, midseason, and postseason testing. Preseason testing was completed 1 week before the start of the baseball season. Midseason testing was completed during the week determined as the middle of the season. Postseason testing was completed during the week following the end of the regular season play.

### Statistical Analyses

Demographic data were analyzed by descriptive analysis and are reported as mean ± *SEM*. The isokinetic internal and external concentric rotational shoulder strength data reported as mean peak torque at 300 and $450°\cdot s^{-1}$ over time were analyzed with a 3 × 2 × 2 repeated-measures analysis of variance using SPSS (version 11.0; SPSS, Inc., Chicago, IL) with level of significance set at $p \leq 0.05$.

## RESULTS

The hypothesis of the study was not supported as there were no differences over time in isokinetic internal or external concentric rotational strength (Wilks' $\lambda = 0.883$; $F[2,7] = 0.462$; $p = 0.648$; $\eta^2 = 0.117$; $1 - \beta = 0.099$). However, as expected, the mean peak torque was lower at 450 than at $300°\cdot s^{-1}$ (Wilks' $\lambda = 0.128$; $F[1,8] = 54.523$; $p = 0.000$; $\eta^2 = 0.872$; $1 - \beta = 1.000$). Internal mean peak torque rotational strength was greater than external mean peak torque rotational strength (Wilks' $\lambda = 0.025$; $F[1,8] = 306.639$; $p = 0.000$; $\eta^2 = 0.975$; $1 - \beta = 1.000$). Comparisons of the internal mean peak torque rotational strength at the 3 time points examined are presented in Figure 1. Comparisons of the external mean peak torque rotational strength at the 3 time points examined are presented in Figure 2.

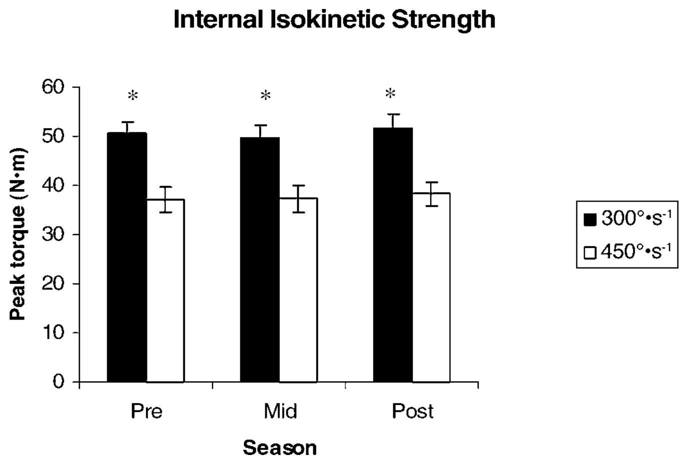


**FIGURE 1.** Comparison of internal mean peak torque rotational strength at 2 speeds preseason, midseason, and postseason. * $p = 0.05$.

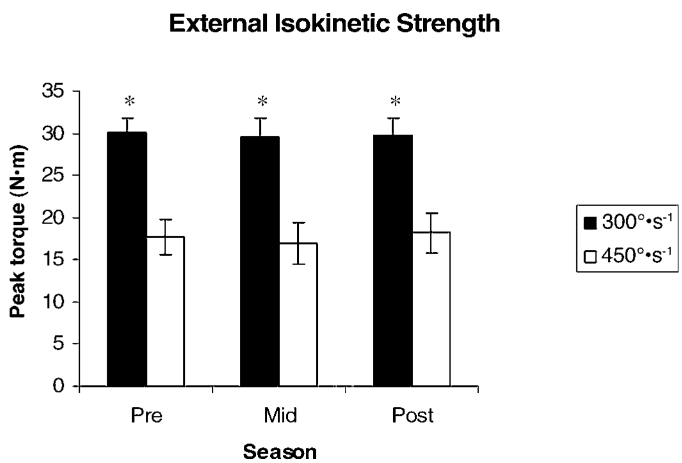


**FIGURE 2.** Comparison of external mean peak torque rotational strength at 2 speeds preseason, midseason, and postseason. * $p = 0.05$.

## DISCUSSION

The results of this study do not support the hypothesis. However, the results of this study are similar to the pilot work of Whitley and Terrio (10). Whitley and Terrio examined the isokinetic arm-shoulder strength of high school pitchers preseason and postseason. The 5 pitchers in the Whitley and Terrio study did show a significant loss in adduction arm-shoulder strength for both throwing and nonthrowing shoulders at $180°\cdot s^{-1}$. However, there was no change in isokinetic strength at $300°\cdot s^{-1}$, similar to the findings of the current study. While differ-

**Table 2.** Off-season hypertrophy/endurance phase (volume × intensity).*

| Activity | Weeks 1–2 | Weeks 3–4 | Weeks 5–8 | Week 9 | Weeks 10–12 |
|---|---|---|---|---|---|
| Bench press, squat, stiff leg deadlifts, leg press (rehabilitation) | | | | | |
| Core lifts | 48 × 65% (4 sets × 12 reps) | 40 × 70% (4 sets × 10 reps) | 32 × 75% (4 sets × 8 reps) | 30 × 70% (4 sets × 10 reps) | 24 × 80% (4 sets × 6 reps) |
| Triceps press-down, biceps curl, wrist curls, calf press, lat pull-downs, seated row, dumbbell row, lunge, shoulder series, wrist rolls | | | | | |
| Auxiliary lifts | 48 × LW (4 sets × 12 reps) | 40 × MW (4 sets × 10 reps) | 32 × MHW (4 sets × 8 reps) | 30 × MW (4 sets × 10 reps) | 24 × HW (4 sets × 6 reps) |

* LW = light weight; MW = moderate weight; MHW = moderate heavy weight; HW = heavy weight.

**Table 3.** Prepractice conditioning.

| |
|---|
| Weight training (3 times/wk 3 sets of 10 repetitions) |
| Bench press or dumbbell press, squats (not an option), deadlift, curls, lat pulls, triceps extension, adductor/abductor or equivalent, shoulder (Jobes; pitchers should do these daily), sit-ups × 200, back extensions |
| Running |
| 3 times/wk sprint work/1½ miles on lift days; distance work = 1½ mile run on lift days under 11:00 min; sprint work = ½ mile jog and 4 × 200 yards full on nonlift days |
| Long toss |
| Begin throwing 3 times/wk firm long toss with proper arm angle; do not change arm angle if you need to skip ball (one hop) |
| Hitting |
| Begin swinging but with a purpose (25 off tee, soft toss, life cage, and bat handling drills); front side closed, pivot on back foot, little movement, opposite field |

ences at 180°·s$^{-1}$ may exist, the current study only tested strength at 300 and 450°·s$^{-1}$. The Whitley and Terrio work did not report any mean peak torque values in their publication. The expectation would be that the NCAA Division II collegiate pitchers should have greater isokinetic internal and external mean peak torque values due to maturation and improved biomechanics.

In addition, the pitchers in this study utilized a series of strengthening exercises throughout the season to assist with the maintenance of rotational strength. These shoulder and arm exercises for athletes who throw were developed by Frank W. Jobe, M.D. (7). The recommended exercises include a series of stretches. The stretches include posterior shoulder, wrist flexor and extensor, elbow extensor, and shoulder blade. The strengthening exercises include shoulder flexion, extension, abduction, and elevation, military press, horizontal abduction, ulnar and radial deviation, external rotation, internal rotation, horizontal adduction, push-ups, rowing, elbow flexion, elbow extension, forearm supination and pronation, and wrist flexion and extension. This series of exercises may have contributed to the ability of the pitchers in the current study to maintain the strength of their shoulders throughout the season.

The isokinetic internal and external peak torques of the shoulder at 300°·s$^{-1}$ were similar to the results of the Codine et al. (2) work that examined the influence of sports discipline on shoulder rotator cuff balance. Our peak torque values were similar to the baseball players in this study. Codine et al. mean internal peak torque at 300°·s$^{-1}$ was 58 ± 8.25 N·m (mean ± *SD*). The current study mean internal peak torque at 300°·s$^{-1}$ was 50.66 ± 6.81 N·m preseason, 49.70 ± 7.61 N·m midseason, and 51.7 ± 8.80 N·m postseason. Codine et al. mean external peak torque at 300°·s$^{-1}$ was 33.4 ± 7.87 N·m. The current study mean external peak torque at 300°·s$^{-1}$ was 30.16 ± 5.08 N·m preseason, 29.50 ± 6.67 N·m midseason, and 29.79 ± 6.25 N·m postseason. Codine et al. did not examine isokinetic strength at 450°·s$^{-1}$.

However, our results were not similar to those found by Mikesky et al. (8). Their work examined eccentric and concentric strength of the shoulder and arm musculature in collegiate baseball pitchers before the season began. This work included Division I, II, and III pitchers. The internal isokinetic strength at 300°·s$^{-1}$ in the Mikesky et al. work was 84.0 ± 7.7 N·m (mean ± *SEM*), while the current study's internal isokinetic strength at 300°·s$^{-1}$ was 50.6 ± 2.27 N·m preseason, 49.70 ± 2.54 N·m midseason, and 51.7 ± 2.94 N·m postseason. The external isokinetic strength at 300°·s$^{-1}$ in the Mikesky et al. work was 53.2 ± 2.8 N·m, while the current study's external isokinetic strength at 300°·s$^{-1}$ was 30.16 ± 1.96 N·m preseason, 29.50 ± 2.22 N·m midseason, and 29.79 ± 2.08 N·m postseason. The Mikesky et al. group did not examine isokinetic strength at 450°·s$^{-1}$. In the discussion section of this paper, they suggested that their results were higher than those previously reported and suggested that the differences may be due to equipment and testing position and not subject sample. The isokinetic dynamometer used in the Mikesky et al. work was a KIN-COM III and our work utilized a Biodex dynamometer.

Due to the reported stresses to the shoulder musculature during the pitching motion, we expected to find a decrease in isokinetic internal and external rotational strength of the shoulder of NCAA Division II collegiate pitchers throughout the season. Our results do not support this hypothesis. There were no differences in shoulder internal and external rotational strength from preseason to midseason to postseason for uninjured NCAA Division II collegiate pitchers. This may suggest that the strengthening work prescribed by the coaching staff throughout the season is adequate to sustain rotational strength.

Future work in this area might include testing of the eccentric isokinetic internal and external strength of the shoulder muscles. In addition, examination of pitching performance including number of pitches thrown and number of days pitching throughout the season may also be an indication of shoulder strength.

## Practical Applications

This study suggests that NCAA Division II baseball pitchers that avoid musculoskeletal injuries and perform regular stretching and strengthening exercises do not lose internal and external rotational strength of their shoulder.

Tables 2 and 3 outline the strength training program suggested by the baseball coaches for both preseason and in-season training. This information should be helpful to coaches as they plan strengthening programs throughout the season. It would seem that NCAA Division II pitchers who avoid injury throughout the season and follow an appropriate strengthening and stretching program should be able to maintain their rotational strength from the beginning to the end of the typical 4-month season.

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