# RELATIONSHIP BETWEEN ISOMETRIC AND ISOKINETIC ARM STRENGTH IN DIVISION I COLLEGIATE BASEBALL PITCHERS


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## INTRODUCTION

Isokinetic testing is often used to evaluate the effect of different types of interventions and levels of readiness for physical activity (6). However, between the size, immobility, and cost of many isokinetic dynamometers, coaches and practitioners are not able to utilize its benefits for strength testing. Isometric dynamometers, on the other hand, are portable, convenient to use, and cost effective. Despite previous studies indicating isokinetic testing benefits in a clinical setting, in a sports performance setting, a lack of research exploring the relationship between isometric and isokinetic dynamometers exists (7).

In baseball, pitchers endure repetitive high intensity valgus torque on the medial side of the elbow and rotational torque of the shoulder when delivering the baseball (1,3,5). Exposure to high forces makes pitchers prime candidates for isokinetic testing to determine muscular contributions in handling peak torque in the forearm, upper arm, and shoulder in the delivery (3,4,5). Further, how these strength values compare to pitcher performance and pitch metrics are unknown.

Isokinetic dynamometry has been considered the gold standard for strength assessment and can be used to assess a baseball pitcher's shoulder and elbow joint (2). Readily available strength measure to record the condition of the throwing arm before taking the mound could be invaluable in detecting muscle weakness, deficits, and imbalances that could potentially lead to injury. Connected to this belief, the present study will observe potential correlations between isometric and isokinetic dynamometers that could reveal practical use case for strength testing beyond clinical evaluations. In relation to performance, ball flight and seasonal statistics will be explored for both dynamometry approaches.

It was hypothesized that isometric shoulder internal, external rotation, and scaption strength will relate to isokinetic shoulder peak torque strength. Additionally, it was hypothesized that isometric grip strength will relate to isokinetic forearm supination/pronation and wrist extension/flexion peak torque strength. Therefore, the purpose of this study was to determine the relationship between isometric and isokinetic arm strength in collegiate baseball pitchers.

## METHODS

Seventeen Division I (DI) collegiate baseball pitchers (age = 20.0 ± 1.62 yr; height = 185.4 ± 6.4 cm; body mass = 92.9 ± 10.5 kg; lean body mass = 77.5 ± 6.1 kg; body fat percentage = 16.3 ± 4.0) participated in this study during the offseason. Isometric shoulder internal rotation (IR) (Figures 1 & 2), external rotation (ER) (Figure 3), scaption (S) (Figure 4), and grip (G) strength (Figure 5) as well as total arm (TA) strength (combined IR, ER, S, and G) and arm score (TA strength/body mass) for the throwing arm were acquired before and after throwing bullpens and intrasquad games using the ArmCare dynamometer. Additionally, each isometric arm strength score was divided by the pitcher's body mass and lean body mass to provide relative strength values. Table 1 displays isometric arm strength data. Prior to testing, all pitchers completed a standardized warm-up using a UBE for 5 minutes at 300 kpm at 50 rpm and 50 W. Isokinetic arm strength was tested by using the Biodex System 3 isokinetic dynamometer in the seated position, including: throwing arm shoulder diagonal abduction/adduction (Figure 6) and shoulder 90° external/internal rotation (Figure 7) at 180, 300, and 450°·sec$^{-1}$, forearm supination/pronation (Figure 8) at 120, 180, and 240°·sec$^{-1}$, and wrist extension/flexion (Figure 9) at 120 and 180° ·sec$^{-1}$.

## METHODS

Additionally, individual isokinetic values were combined and divided by the number of speed settings to create an average score. Table 2 displays isokinetic arm strength metrics.

Correlation values (Table 3) were classified by significance using Pearson's product-moment critical *r* value for alpha levels α = 0.05 (*r* (11) = 0.553, $p < 0.05$) and α = 0.01 (*r* (11) = 0.684, $p < 0.01$) and color-coded by strength of correlation: moderate (green: 0.553 - 0.599), moderately high (0.600 – 0.799), and high (0.800 – 1.0).

## RESULTS

**Table 1.** Isometric strength (mean and ±SD) metrics (N = 17).

| ArmCare Isometric Metrics | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arm Score | Arm Score LM | Total Strength | IRTARM Strength | IRTARM RS | IRTARM LMRS | ERTARM Strength | ERTARM RS | ERTARM LMRS | STARM Strength | STARM RS | STARM LMRS | FBG Strength | FBG RS | FBG LMRS | Shoulder Balance |
| 85.41 | 100.91 | 172.38 | 52.49 | 0.257 | 0.308 | 46.93 | 0.227 | 0.275 | 36.71 | 0.177 | 0.215 | 36.40 | 0.174 | 0.212 | 0.901 |
| 6.77 | 13.78 | 27.24 | 8.24 | 0.033 | 0.046 | 7.72 | 0.024 | 0.041 | 6.50 | 0.021 | 0.034 | 9.93 | 0.030 | 0.049 | 0.129 |

Arm Score LM = Total Strength divided by lean body mass; Total Strength = summation of IR, ER, S, and FBG; IRTARM = internal rotation throwing arm; RS = relative strength; LMRS = lean body mass relative strength; ERTARM = external rotation throwing arm; STARM = scaption throwing arm; FBG = fastball grip.

**Table 2.** Isokinetic arm strength (mean and ±SD) metrics for wrist, forearm, and shoulder at various speeds (N = 17).

| Seated Wrist Extension Flexion | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wrist Extension Flexion @120° /s | | Wrist Extension Flexion @180° /s | | Average Wrist Extension Flexion | | | | | | | |
| DPTE 120 | DPTF 120 | DPTE 180 | DPTF 180 | AVG DPTE | AVG DPTF | ADPTE RS | ADPTF RS | ADPTE LMRS | ADPTF LMRS | | |
| 7.61 | 13.89 | 7.10 | 13.76 | 7.36 | 13.82 | 0.036 | 0.068 | 0.043 | 0.081 | | |
| 1.47 | 3.01 | 1.52 | 3.17 | 1.46 | 3.05 | 0.01 | 0.02 | 0.01 | 0.02 | | |
| Seated Forearm Supination Pronation | | | | | | | | | | | |
| Forearm Sup/Pro @120° /s | | Forearm Sup/Pro @180° /s | | Forearm Sup/Pro @240° /s | | Average Forearm Supination Pronation | | | | | |
| DPTS 120 | DPTP 120 | DPTS 180 | DPTP 180 | DPTS 240 | DPTP 240 | AVG DPTS | AVG DPTP | ADPTS RS | ADPTP RS | ADPTS LMRS | ADPTP LMRS |
| 7.73 | 9.50 | 7.27 | 9.26 | 7.32 | 8.95 | 7.44 | 9.24 | 0.037 | 0.046 | 0.044 | 0.054 |
| 1.30 | 2.17 | 1.23 | 2.06 | 1.17 | 1.86 | 1.08 | 1.86 | 0.01 | 0.01 | 0.01 | 0.01 |
| Seated Shoulder Diagonal Away (Abduction) and Towards (Adduction) | | | | | | | | | | | |
| Diagonal Away Towards @180° /s | | Diagonal Away Towards @300° /s | | Diagonal Away Towards @450° /s | | Average Shoulder Diagonal Away (Abduction) Towards (Adduction) | | | | | |
| DPTA 180 | DPTT 180 | DPTA 300 | DPTT 300 | DPTA 450 | DPTT 450 | AVG DPTA | AVG DPTT | ADPTA RS | ADPTT RS | ADPTA LMRS | ADPTT RS |
| 56.02 | 76.28 | 43.42 | 72.21 | 25.06 | 44.51 | 41.50 | 64.33 | 0.203 | 0.316 | 0.243 | 0.376 |
| 15.07 | 13.87 | 12.68 | 15.19 | 10.73 | 11.18 | 12.11 | 12.69 | 0.06 | 0.06 | 0.07 | 0.07 |
| Seated Shoulder External and Internal Rotation at 90° | | | | | | | | | | | |
| ER and IR at 90° @180° /s | | ER and IR at 90° @300° /s | | ER and IR at 90° @450° /s | | Average Shoulder External and Internal Rotation at 90° | | | | | |
| DPTER 180 | DPTIR 180 | DPTER 300 | DPTIR 300 | DPTER 450 | DPTIR 450 | AVG DPTER | AVG DPTIR | ADPTER RS | ADPTIR RS | ADPTER LMRS | ADPTIR LMRS |
| 40.46 | 49.92 | 37.79 | 46.92 | 30.60 | 41.76 | 36.28 | 46.20 | 0.179 | 0.228 | 0.213 | 0.271 |
| 7.08 | 12.37 | 6.64 | 11.65 | 5.64 | 11.00 | 6.24 | 11.38 | 0.04 | 0.06 | 0.04 | 0.06 |

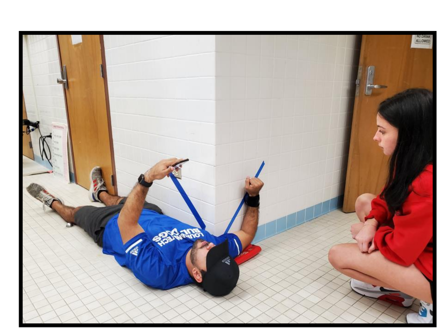

**Figure 1.** Isometric internal rotation.


**Figure 2.** Internal rotation score.

**Figure 3.** Isometric external rotation.

**Figure 4.** Isometric scaption.

**Figure 5.** Isometric grip.

**Table 3.** Pearson product-moment correlations between isometric and isokinetic arm strength.

| *Variables* | Arm Score LM | Total Strength | IRTARM LMRS | ERTARM Strength | ERTARM RS | ERTARM LMRS | Grip Strength |
|---|---|---|---|---|---|---|---|
| **ADPTF LMRS** | -0.026 | **0.518*** | -0.215 | 0.449 | -0.227 | -0.067 | **0.508*** |
| **DPTS 180** | -0.398 | -0.032 | -0.474 | -0.156 | -0.410 | **-0.492*** | 0.161 |
| **DPTS 240** | -0.389 | -0.054 | -0.458 | -0.230 | **-0.496*** | **-0.540*** | 0.222 |
| **DPTP 240** | -0.387 | -0.269 | **-0.522*** | -0.222 | -0.100 | -0.325 | -0.133 |
| **ADPTS** | -0.426 | -0.040 | -0.469 | -0.160 | -0.394 | **-0.515*** | 0.144 |
| **ADPTS RS** | **-0.576*** | **-0.528*** | -0.454 | **-0.563*** | -0.248 | **-0.591*** | -0.350 |
| **ADPTS LMRS** | **-0.510*** | -0.394 | -0.441 | **-0.495*** | -0.329 | **-0.589*** | -0.162 |
| **DPTA 180** | 0.132 | 0.326 | 0.076 | 0.069 | -0.249 | -0.111 | **0.491*** |
| **DPTT 450** | 0.234 | 0.399 | 0.004 | 0.270 | 0.004 | 0.114 | **0.509*** |

*p* < 0.05*

Arm Score LM = Total Strength divided by lean body mass; Total Strength = summation of IR, ER, S, and FBG; IRTARM = internal rotation throwing arm; RS = relative strength; LMRS = lean body mass relative strength; ERTARM = external rotation throwing arm; STARM = scaption throwing arm; FBG = fastball grip. ADPTF = average dominant peak torque wrist flexion, DPTS = dominant peak torque forearm supination, ADPTS = average dominant peak torque forearm supination, DPTA = dominant peak torque shoulder abduction (away), DPTT = dominant peak torque shoulder adduction (toward), numbers = degrees/sec.

**Figure 6.** Isokinetic shoulder away (abduction) and toward (adduction).

**Figure 7.** Isokinetic shoulder external and internal rotation 90° .

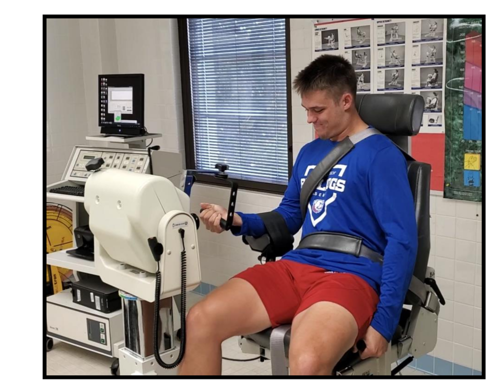

**Figure 8.** Isokinetic forearm supination and pronation.

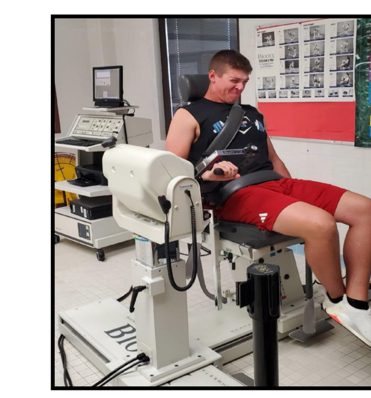

**Figure 9.** Isokinetic wrist extension and flexion.

## CONCLUSIONS

Meaningful significant relationships existed between isokinetic average throwing arm peak torque wrist flexion relative to lean body mass and isometric grip strength and isometric throwing arm strength (Table 3).

Isometric grip strength did significantly relate to isokinetic shoulder diagonal abduction (away) at 180 °·sec$^{-1}$ and isokinetic shoulder diagonal adduction (toward) at 450 °·sec$^{-1}$. Twelve significant relationships were identified as negative; however, these positive and negative relationships do not seem to be meaningful to the pitcher.

## PRACTICAL APPLICATIONS

Isokinetic wrist flexion strength relates to isometric grip strength and throwing arm strength of DI baseball pitchers. Other testing variables do not significantly relate to one another. Though both devices produce valuable information to identify strength deficiencies, imbalances, and inhibited recovery, they provide little data that relates to one another. It is important to understand that the isometric device provides values at specific joint angles without movement while the isokinetic device provides values throughout an entire range of motion at specific speeds.

## REFERENCES


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