RELATIONSHIP BETWEEN ISOMETRIC ARM STRENGTH TO PITCHING METRICS AND GAME PERFORMANCE IN DIVISION I COLLEGIATE BASEBALL PITCHERS

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INTRODUCTION

Previous baseball pitching research has evaluated the relationship between grip and pinch strength to pitch types (7) and wrist, grip, and finger strength to ball spin rate (8) using isometric dynamometers. However, isokinetic dynamometry testing has not been frequently used with baseball pitchers.

Isokinetic testing is often used to evaluate the effect of different types of strength interventions and levels of readiness for physical activity (5). However, between the size, immobility, and cost of many isokinetic dynamometers, many 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 (6), in a sports performance setting, the isometric dynamometer would provide ease of use and immediate feedback with strength values. isokinetic dynamometers exists.

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 (1,2,4). Exposure to high forces makes pitchers prime candidates for isometric testing to determine muscular contributions in handling forces on the forearm and shoulder in the delivery (2,3,4). Further, how these strength values compare to pitch metrics and pitcher game performance are unknown.

The isometric dynamometer in this study is a relatively new device used to assess a baseball pitcher's shoulder and grip strength. Readily available strength measure to record the condition of the throwing arm before and after throwing a bullpen or pitching in a game could be invaluable in detecting muscle weakness, deficits, and imbalances that could potentially lead to injury.

It was hypothesized that isometric shoulder internal rotation, external rotation, and scaption strength, as well as fastball grip strength would relate to pitching metrics, such as fastball velocity and ball spin, and game pitching performance (seasonal statistics). Therefore, the purpose of this study was to evaluate the relationship between isometric arm strength to pitching metrics and game performance in Division I collegiate baseball pitchers.

METHODS

Thirteen Division I pitchers (age = 20.5 ± 1.5 yr; height = 185.8 ± 6.5 cm; body mass = 93.5 ± 11.6 kg; lean body mass (LBM) = 77.6 ± 6.8 kg; body fat percentage = 16.6 ± 4.4%) participated in this study. Isometric data for shoulder internal rotation (IR) (Figure 1), external rotation (ER) (Figure 2), scaption (S) (Figure 3), and fastball grip (FBG) (Figure 4) strength for the throwing arm as well as a total arm (TA) strength value (combined IR, ER, S, and G) and arm score (TA strength value/body mass) were acquired before and after competitive games using the ArmCare dynamometer according to the manufacturer's directions. Table 1 shows mean ArmCare isometric strength metrics for pitchers. Additionally, each isometric arm strength score was divided by pitcher's body mass and LBM to provide relative strength values. Pitching metrics were recorded using Rapsodo In-Stadium unit during the competitive baseball season and included velocity (V), top spin (TS), side spin, total spin, true spin, spin efficiency, horizontal break, and vertical break recorded for three pitch types: fastball (FB), breaking ball (BB), and change-up (CH). Table 2 shows mean Rapsodo pitching metric data.

METHODS

Game performance data (wins, losses, earned-run average, innings pitched, hits, hits per inning, hits per nine innings, runs, earned runs, walks, walks per inning, walks per nine innings, strikeouts, strikeouts per inning, strikeouts per nine innings, walks plus hits per inning pitched, walks plus hits per nine innings, and opponents' batting average) were acquired after the competitive season through the official university athletics website.

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

RESULTS

Table 1. ArmCare isometric strength (mean and ±SD) metrics (N =13).

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
86.17	102.15	174.46	53.05	0.258	0.311	47.35	0.229	0.278	36.51	0.176	0.214	37.73	0.180	0.220	0.896
6.91	15.38	30.49	8.97	0.027	0.047	8.54	0.027	0.047	6.84	0.022	0.037	10.29	0.029	0.050	0.108

Arm Score LM = Total Strength divided by lean body mass; Total Strength = summation of IR, ER, S, 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. Mean and ±SD Rapsodo game pitching metrics and game pitching performance statistics (N = 13).

Rapsodo Pitching Metrics																	
Fastball						Breaking Ball						Chane-up					
FB V	FB TS	FB SS	FB TOS	FB HB	FB VB	BB V	BB TS	BB SS	BB TOS	BB HB	BB VB	CH V	CH TS	CH SS	CH TOS	CH HB	CH VB
88.8	933.83	400.48	1809.66	6.55	13.58	79.72	-157.2	67.11	1962.16	-2.23	-0.9	82.72	638.3	447	1651.22	7.29	8.13
1.72	257.6	710.92	129.28	11.1	3.89	2.55	336.5	154.74	207.34	5.81	4.5	2.26	290.3	718	181.1	11.3	4.14

Season Game Pitching Performance Statistics																	
ERA	Wins	Losses	Innings Pitched (IP)	Hits (H)	H/IP	H/9IP	Runs	Earned Runs	Walks (W)	W/IP	W/9IP	Strike Outs (SO)	SO/IP	SO/9IP	WHIP	WHIP/9 IP	Opp B/AVG
7.73	1.69	2.23	34.66	43.23	1.3	11.7	27.08	25	14.92	0.65	5.839	28.23	0.782	7.04	1.949	17.5	0.31
4.74	2.43	1.96	25.11	31.35	0.35	3.15	17.26	16.71	6.82	0.41	3.647	23.81	0.276	2.488	0.633	5.7	0.07

FB = fastball, V = velocity, TS = top spin (back spin), SS = side spin, TOS = total spin, HB = horizontal break, VB = vertical break, BB = breaking ball, CH = change-up, WHIP = wins plus hits per inning, Opp = opponent, B/AVG = batting average.

Table 3. Pearson product-moment correlations between isometric strength values and pitching metrics and game pitching performance.

Metric	Arm Score LM	Total Strength	IRTARM Strength	STARM Strength	FBG Strength	FBG RS	FBG LMRS
Fastball Top Spin	0.302	0.405	0.474	0.204	0.645*	0.673*	0.630*
Breaking Ball Velocity	-0.451	-0.472	-0.458	-0.290	-0.586*	-0.385	-0.615*
Change-up Top Spin	0.340	0.493	0.544	0.273	0.638*	0.526	0.593*
Wins	0.535	0.666*	0.681*	0.544	0.734**	0.657*	0.674*
Losses	0.424	0.526	0.400	0.581*	0.419	0.214	0.382
Innings Pitched (IP)	0.507	0.645*	0.549	0.563*	0.710**	0.565*	0.664*
Hits	0.478	0.664*	0.532	0.578*	0.736**	0.567*	0.672*
Runs	0.455	0.702**	0.589*	0.640*	0.716**	0.489	0.616*
Earn Runs	0.432	0.683*	0.563*	0.627*	0.692**	0.462	0.589*
Walks/IP	-0.595*	-0.534	-0.428	-0.495	-0.564*	-0.537	-0.648*
Walks/9IP	-0.595*	-0.534	-0.428	-0.495	-0.564*	-0.537	-0.648*
Strike Outs	0.539	0.627*	0.535	0.548	0.680*	0.581*	0.644*

* = $p < 0.05$*, ** = $p < 0.01$

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

Figure 1. Isometric shoulder internal rotation test.

Figure 2. Isometric shoulder external rotation test.

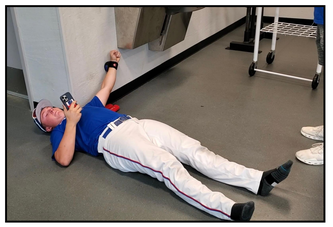

Figure 3. Isometric shoulder scaption test.

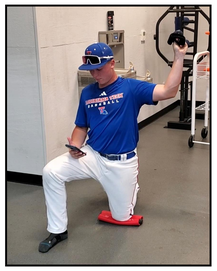

Figure 4. Isometric fastball grip test.

CONCLUSIONS

Meaningful significant relationships existed between isometric FBG strength, relative strength, and relative LBM strength and FB top spin, BB velocity, and CH top spin. Pitchers with greater arm score relative to LBM, TA strength, IR strength, FBG strength had more wins, innings pitched, strike outs, and less walks per inning pitched and walks per 9 innings pitched.

PRACTICAL APPLICATIONS

An isometrically stronger arm relates to better pitching metrics and game performance, which could improve team success. Strength and skill coaches should make a conscientious effort to promote the importance of data-led and individualized throwing arm strength programming beyond injury prevention, as lower arm strength could translate to poor game pitching performance and lack of team success.

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