RELATIONSHIP BETWEEN BODY COMPOSITION, AGILITY, SPEED, AND ABSOLUTE AND RELATIVE POWER TO CURVILINEAR ABILITY AMONGST COLLEGIATE BASEBALL PLAYERS

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INTRODUCTION

The emphasis of most strength and conditioning programs for athletes is to enhance strength, power, speed, change of direction ability, and body composition (8). Part of most strength coaches periodized plan is to increase strength and power so that speed and agility times will improve (8). The ability to start, stop, and change directions quickly and efficiently in the game of baseball is essential. This is especially true for playing defense and running bases. Mangine et al. (5) indicated that lean body mass (LBM), vertical jump (VJ) power, and agility may predict defensive fielding performance. Hoffman et al. (4) demonstrated that speed, agility, and mean VJ power related to stolen bases in professional baseball players. Furthermore, this research indicated that LBM, strength, speed, and power related to total bases (4).

From an offensive standpoint, when a runner has to advance from 1st base to 3rd base, go back to a base to tag up, or gets in a run-down, for example, they perform various linear and curvilinear change of directions on the base path. The ability to run the bases well is critical to the outcome of the game. Research by Baumer (1) indicated that those professional teams with the best nine baserunners could gain as many as 70 runs per season due to baserunning, which could ultimately decide which team wins a game.

Based on previous research, change of direction ability can positively impact baseball defensive and offensive performance. However, agility has been traditionally assessed in the sport of baseball via the 5-10-5 pro agility (PA) test. Because baseball players run bases in a curvilinear manner and the PA test is only performed in a linear change of direction fashion, a new agility test has been developed to assess curvilinear ability that mimics running bases and change of direction similar to tagging up or being a run-down (7). Therefore, the purpose of this investigation was to determine which lab and field tests correlate to curvilinear ability for collegiate baseball players.

METHODS

Twenty-seven Division I college baseball players (age = 20.2 ± 1.4 years, height = 181.2 ± 5.2 cm, body mass = 86.0 ± 9.7 kg, lean body mass = 75.0 ± 6.2 kg, BMI = 26.1± 2.2 kg·m^{-2}, percent body fat = 12.5 ± 3.7%) volunteered for this study. Tests included height measured with a stadiometer, body mass and body composition recorded with the InBody 770, as well as absolute and relative bilateral and unilateral power measured with Bertec force plates. The PA was used to test linear agility. Speed was evaluated by hand-held stop watches while players bunted and hit a baseball and sprinted to first base. Absolute power tests included standing long jump (SLJ) and estimation of SLJ peak power (PP) using the Mann et al. (6) equation, drive (D) and stride (S) leg lateral-to-medial jump (LMJ), bilateral vertical jump (VJ), bilateral estimation of VJPP using the Sayers et al. (10) equation, actual bilateral VJPP, unilateral vertical jump (UVJ) from the D and S leg, and unilateral VJPP from the D and S legs. Curvilinear running ability, similar to running bases, was evaluated by players performing a novel curvilinear ability test (CAT) designed by Martinez-Rodriguez et al. (7). Relative values for all tests were calculated based on power values that were divided by athletes' body mass and lean body mass (LBM). All of these variables were recorded during the offseason and were correlated with one another by using a correlation matrix from raw data scores. Interpretation of correlation coefficient is based on the suggestion of Safrit and Wood (9). Correlations were listed as high (± 0.800 - 1.00), moderately high (± 0.600 - 0.799), moderate (± 0.400 - 0.599), or low (± 0.381 – 0.399). The critical *r* value for Pearson product-moment correlation coefficient was 0.381 with an alpha level of 0.05.

RESULTS

Table 1. Physiologic variables and evaluation parameters from 27 Division I position players.*

Variables	Mean	SD	Min	Max	CV (%)
Height (cm)	181.20	5.20	170.20	188.00	2.87
Weight (kg)	86.00	9.70	71.40	112.60	11.28
Percent body fat (%)	12.50	3.70	6.10	23.90	29.60
Lean body mass (kg)	75.00	6.20	65.80	85.70	8.27
Body mass index (kg/m^2)	26.10	2.20	21.30	32.70	8.43
Curvilinear ability test (s)	7.05	0.22	6.64	7.63	3.12
Pro agility right (s)	4.48	0.23	4.02	4.96	5.13
Pro agility left (s)	4.45	0.20	4.15	4.95	4.49
Speed: Bunt Home to 1st base (s)	3.93	0.19	3.61	4.26	4.83
Speed: Swing Home to 1st base (s)	4.34	0.17	3.99	4.63	3.92
Standing long jump (cm)	274.96	15.25	248.90	297.20	5.55
Standing long jump/BM	0.58	0.08	0.40	0.75	13.79
Standing long jump/LBM	0.66	0.08	0.52	0.80	12.12
Standing long jump estimated peak power (W)	4739.63	446.68	4095.45	5442.91	9.42
Drive leg lateral-to-medial jump (cm)	214.79	14.97	190.50	243.80	6.97
Drive leg lateral-to-medial jump/BM	0.45	0.07	0.31	0.63	15.56
Drive leg lateral-to-medial jump/LBM	0.52	0.07	0.41	0.67	13.46
Stride leg lateral-to-medial jump (cm)	215.08	14.85	186.70	243.80	6.90
Stride leg lateral-to-medial jump/BM	0.45	0.07	0.30	0.60	15.56
Stride leg lateral-to-medial jump/LBM	0.52	0.07	0.40	0.65	13.46
Bilateral vertical jump (cm)	71.73	6.74	55.88	85.09	9.40
Bilateral vertical jump/BM	0.15	0.03	0.10	0.22	20.00
Bilateral vertical jump/LBM	0.17	0.03	0.12	0.23	17.65
Bilateral estimated vertical jump peak power (W)	5922.50	447.98	4890.32	6802.99	7.56
Bilateral estimated vertical jump peak power/BM	69.29	5.61	58.34	83.70	8.10
Bilateral estimated vertical jump peak power/LBM	79.17	5.02	66.70	89.08	6.34
Bilateral actual vertical jump peak power (W)	6284.36	695.34	5221.70	7569.99	11.06
Bilateral actual vertical jump peak power/BM	73.75	7.77	61.42	92.32	10.54
Bilateral actual vertical jump peak power/LBM	84.12	8.00	69.46	102.11	9.51
Drive leg unilateral vertical jump (cm)	49.53	2.94	33.02	66.04	5.94
Drive leg unilateral vertical jump/BM	0.11	0.02	0.07	0.17	18.18
Drive leg unilateral vertical jump/LBM	0.12	0.02	0.08	0.15	16.67
Stride leg unilateral vertical jump (cm)	52.50	3.00	36.83	71.12	5.71
Stride leg unilateral vertical jump/BM	0.11	0.02	0.08	0.18	18.18
Stride leg unilateral vertical jump/LBM	0.13	0.02	0.09	0.20	15.38
Drive leg unilateral vertical jump peak power (W)	3680.96	370.40	3041.30	4522.03	10.06
Drive leg unilateral vertical jump peak power/BM	43.29	5.00	34.88	56.06	11.55
Drive leg unilateral vertical jump peak power/LBM	49.35	4.93	42.26	62.02	9.99
Stride leg unilateral vertical jump peak power (W)	4026.86	498.52	3211.31	5238.53	12.38
Stride leg unilateral vertical jump peak power/BM	47.38	6.43	32.84	62.46	13.57
Stride leg unilateral vertical jump peak power/LBM	53.96	6.27	40.41	69.59	11.62

* CV % = coefficient of variation percentage.

Table 2. Positive correlations between curvilinear ability test (CAT) and numerous physiologic tests and variables.

Variables	PAR	PAL	BHF	%BF	BM	BMI	HT	SHF	LBM	EstVJPP
CAT	0.828	0.808	0.760	0.700	0.658	0.551	0.510	0.504	0.492	0.388

PAR = pro agility right, PAL = pro agility left, BHF = bunt home to first base, %BF = percent body fat, BMI = body mass index, HT = height, SHF = swing home to first base, LBM = lean body mass, EstVJPP = estimated vertical jump peak power.

Table 3. Negative correlations between curvilinear ability test (CAT) and numerous physiologic tests.

Variables	*SLJ/BM*	SLJ	LMJS/BM	SLJ/LBM	LMJD/BM	DUVJPP	LMJS/LBM	VJ/BM	LMJD/LBM	*LMJS*
CAT	-0.731	-0.722	-0.679	-0.674	-0.647	-0.627	-0.612	-0.587	-0.575	-0.567

Variables	*SUVJPP/BM*	LMJD	*EstBVJPP*	*VJ/LBM*	SUVJPP/LBM	*DUVJPP/LBM*	*BVJPP/BM*	*VJ*
CAT	-0.563	-0.529	-0.526	-0.515	-0.429	-0.422	-0.420	-0.395

SLJ/BM = standing long jump to body mass ratio, SLJ = standing long jump, LMJS/BM = lateral to medial jump stride leg to body mass ratio, SLJ/LBM = standing long jump to lean body mass ratio, LMJD/BM = lateral to medial jump drive leg to body mass ratio, DUVJPP = drive leg unilateral vertical jump peak power, LMJS/LBM = lateral to medial jump stride leg to lean body mass ratio, VJ/ BM = vertical jump to body mass ratio, LMJD/LBM = lateral to medial jump drive leg to lean body mass ratio, LMJS = lateral to medial jump stride leg distance, SUVJPP/BM = stride leg unilateral vertical jump peak power to body mass ratio, LMJD = lateral to medial jump drive leg, EstBVJPP = estimated bilateral vertical jump peak power, VJ/LBM = vertical jump to lean body mass ratio, SUVJPP/LBM = stride leg unilateral vertical jump peak power to lean body mass ratio, DUVJPP/LBM = drive leg unilateral vertical jump peak power to lean body mass ratio, BVJPP/BM = bilateral vertical jump peak power to body mass ratio, VJ = vertical jump.

0.800-1.00	High	0.400-0.599	Moderate
0.600-0.799	Moderately High	0.381-0.399	Low

Figures 1 & 2. Height & Body composition.

Figure 3. Pro agility test.

Figure 6. Standing long jump test.

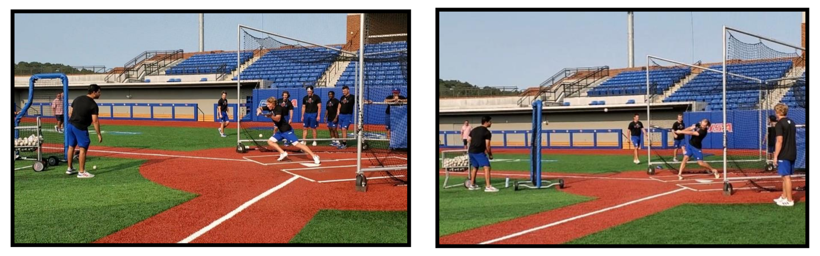

Figure 4 & 5. Bunting & hitting with sprint to first base tests.

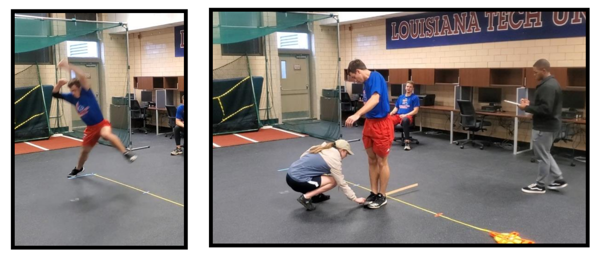

Figure 7. Lateral-to-medial jump test.

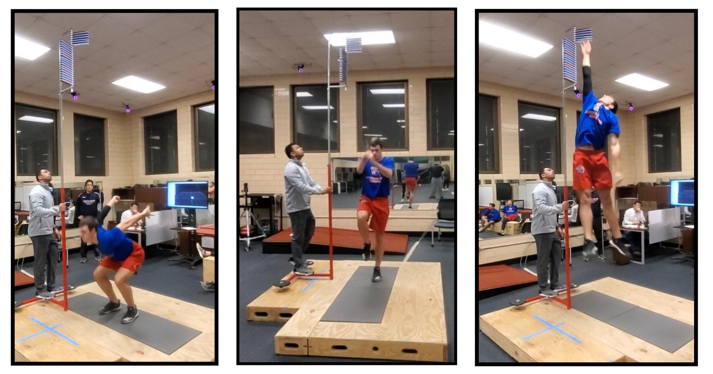

Figure 8. Bilateral & unilateral vertical jump tests.

Figure 9. Curvilinear ability test.

CONCLUSIONS

These data suggest that significant relationships do exist between body composition, agility, speed, and power to the CAT, but one cannot interpret this to mean a cause-and-effect relationship. Because the CAT is a preplanned change of direction test and mimics the actions of running bases, which is generally a pre-planned movement, the athlete performing the test can better adjust their footwork and body positioning to optimize the technique of change of direction leading force production (3). Therefore, the athlete's strength, power, and speed will impact the CAT performance outcome (2).

PRACTICAL APPLICATION

This investigation provides insight for the sports scientist and strength and conditioning coach about relationships that exist between various variables and curvilinear ability. It is recommended that strength and conditioning coaches should use the CAT when assessing running ability of baseball players as it highly relates to the traditional, linear PA test and speed of running to first base. Training programs to develop absolute and relative multi-directional power that are bilateral and unilateral, as well as LBM should be implemented as these improvements could improve baseball-specific running ability.

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