RELATIONSHIP BETWEEN ABSOLUTE AND RELATIVE STRENGTH, POWER, AND LEAN BODY MASS TO BAT SWING AND EXIT VELOCITIES AMONGST COLLEGIATE BASEBALL PLAYERS

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INTRODUCTION

Baseball players are generally evaluated on five different characteristics. These include running speed, arm strength, fielding ability, hitting for average, and hitting for power. In order to hit for power, a baseball hitter must have increased bat swing and batted-ball exit velocities. Bat swing velocity (BV) is important because it provides three direct benefits to the hitter; increased decision time, decreased swing time assuming mechanics have not been changed, and increased batted-ball exit velocity (BEV) (1,10). According to Adair (1), if a hitter could swing a heavier bat at the same velocity as their standard game bat, or their standard game bat faster due to increased BV, the ball would either travel farther, be hit harder, or both because of the larger transfer of momentum imparted into the ball.

When designing a strength training program for baseball players, strength coaches generally emphasize the development of strength, power, and lean body mass (LBM) (10). Previous baseball literature has reported that greater lower body, upper body, and rotational strength, lower body and rotational power, and increased LBM relate to greater BV and BEV (2,3,7,8,9,11,12).

Based on previous research, there is an expectation that certain strength, power, and LBM variables are significantly associated with BV and BEV in collegiate baseball players. Therefore, the purpose of this investigation was to determine which lab and field tests correlate to maximum and mean BV and BEV 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 anthropometrics recorded with a stadiometer and body composition using an InBody 770 as well as absolute strength tests for dominant and non-dominant hand grip using a Jamar hand dynamometer, one repetition maximum (1RM) parallel squat, barbell bench press, and 1-arm landmine row. Absolute power tests included a 1.8 kg (4 lb) overhead medicine ball throw and 0.9 kg (2 lb) medicine ball rotational hitter's throw for velocity recorded with a Stalker radar gun, as well as standing long jump (SLJ) and estimation of SLJ peak power (PP) using the Mann et al. (4) equation, drive (D) and stride (S) leg lateral-to-medial jump, bilateral vertical jump (VJ) using a Vertec jump device, bilateral estimation of VJPP using the Sayers et al. (6) equation, actual bilateral VJPP recorded from two Bertec force plates, unilateral vertical jump from the D and S leg using a Vertec jump device, and unilateral VJPP from the D and S legs from one Bertec force plate. Relative values for all tests were calculated based on the strength and power values divided by the athlete's body mass and LBM. The maximum and mean BV was recorded from a Blast Motion sensor on the knob of the players bat and BEV was recorded with a Stalker radar gun from 10 baseballs hit from a batting tee into a catch net in a batting cage. Figures 1-13 represent all of these variables that 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 (5). 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*

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/m²)	26.10	2.20	21.30	32.70	8.43
1RM parallel squat (kg)	176.42	21.43	134.10	215.9	12.15
1RM parallel squat/BM	2.05	0.26	1.50	2.57	12.68
1RM parallel squat/LBM	2.34	0.28	1.80	2.96	11.97
1RM barbell bench press (kg)	107.58	13.82	77.30	129.50	12.85
1RM barbell bench press/BM	1.26	0.19	0.90	1.54	15.08
1RM barbell bench press/LBM	1.44	0.20	1.04	1.76	13.89
1RM 1-arm landmine row (kg)	56.40	6.88	45.50	75.00	12.20
1RM 1-arm landmine row/BM	0.66	0.10	0.50	0.89	15.15
1RM 1-arm landmine row/LBM	0.76	0.10	0.62	1.03	13.16
Dominant grip strength (kg)	61.11	7.32	48	74	11.98
Dominant grip strength/BM	0.72	0.11	0.46	0.95	15.28
Dominant grip strength/LBM	0.82	0.11	0.61	1.05	13.41
Non-dominant grip strength (kg)	61.33	7.54	44	78	12.29
Non-dominant grip strength/BM	0.72	0.09	0.50	0.90	12.50
Non-dominant grip strength/LBM	0.82	0.09	0.64	0.99	10.98
Total grip strength (kg)	122.44	14.12	92.00	150.00	11.53
Total grip strength/BM	1.44	0.19	0.96	1.85	13.19
Total grip strength/LBM	1.64	0.19	1.26	2.05	11.59
Overhead medicine ball throw (m/s)	13.64	0.76	12.11	14.75	5.57
Overhead medicine ball throw/BM	0.16	0.02	0.13	0.20	12.50
Overhead medicine ball throw/LBM	0.19	0.01	0.16	0.21	5.26
Medicine ball rotational hitter's throw (m/s)	15.10	1.33	12.70	17.93	8.81
Medicine ball rotational hitter's throw/BM	0.18	0.02	0.14	0.21	11.11
Medicine ball rotational hitter's throw/LBM	0.21	0.02	0.16	0.25	9.52
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
Maximum bat swing velocity (m/s)	34.79	2.78	30.80	40.20	7.99
Mean bat swing velocity (m/s)	33.42	2.71	29.90	39.40	8.11
Maximum batted-ball exit velocity (m/s)	40.11	1.96	36.20	43.80	4.89
Mean batted-ball exit velocity (m/s)	39.17	1.97	35.40	42.80	5.03
*CV% = coefficient of variation percentage.					

Table 2. Correlations between maximum (max) bat swing velocity (BV) and mean BV and physiologic variables.

Variables	*Mean BV*	*Mean BEV*	*Max BEV*	1RM PS/BM
Max BV	0.961	0.733	0.661	0.382
Mean BV		0.676	0.598	

1RM PS/BM = one-repetition maximum parallel squat to body mass ratio.

Table 3. Correlations between maximum (max) batted-ball exit velocity (BEV) and mean BEV and numerous physiologic variables.

Variables	*Mean BEV*	*1RM PS*	*SLJPP*	*VJ D Leg PP*	*VJPP*	*LBM*
Max BEV	0.969	0.489	0.437	0.402	0.394	0.387
Mean BEV		0.501	0.381	0.393	0.391	

1RM PS = one-repetition maximum parallel squat, SLJPP = standing long jump estimated peak power, VJ D Leg PP = vertical jump drive leg unilateral peak power, VJPP = bilateral actual vertical jump peak power, LBM = lean body mass.

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

Figures 1-13. Height, Body composition, Grip strength, Parallel squat, Barbell bench press, 1-Arm landmine row, Overhead medicine ball throw, Medicine ball rotational hitter's throw, Standing long jump, Lateral-to-medial jump, Bilateral vertical jump, Unilateral vertical jump, Bat velocity, and Batted-ball exit velocity.

CONCLUSIONS

These data suggest that significant relationships do exist between strength, power, and LBM to BV and BEV similar to previous research (2,3, 7,8,9,11,12), but one cannot interpret this to mean a cause-and-effect relationship. Even though power, strength, and LBM have significant relationships to BV and BEV, this does not mean that improvements in these variables from training directly lead to improvements in BV and BEV for college players over an offseason (12) or entire year (13).

PRACTICAL APPLICATION

It is recommended that strength and conditioning coaches should design their offseason training program to develop absolute strength, multi-directional power that is bilateral and unilateral, as well as LBM as these improvements could improve the baseball-specific hitting attributes of BV and BEV. Furthermore, in agreement with previous literature (12), the tests used in this investigation were selected because they provide information regarding overall strength, power, and LBM of collegiate baseball players and could provide valuable information to those that recruit players for college, or draft or sign players for professional baseball.

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