

**NSCA**

# COACHES

**CONFERENCE 2023**

**JANUARY 4 – 6, 2023**

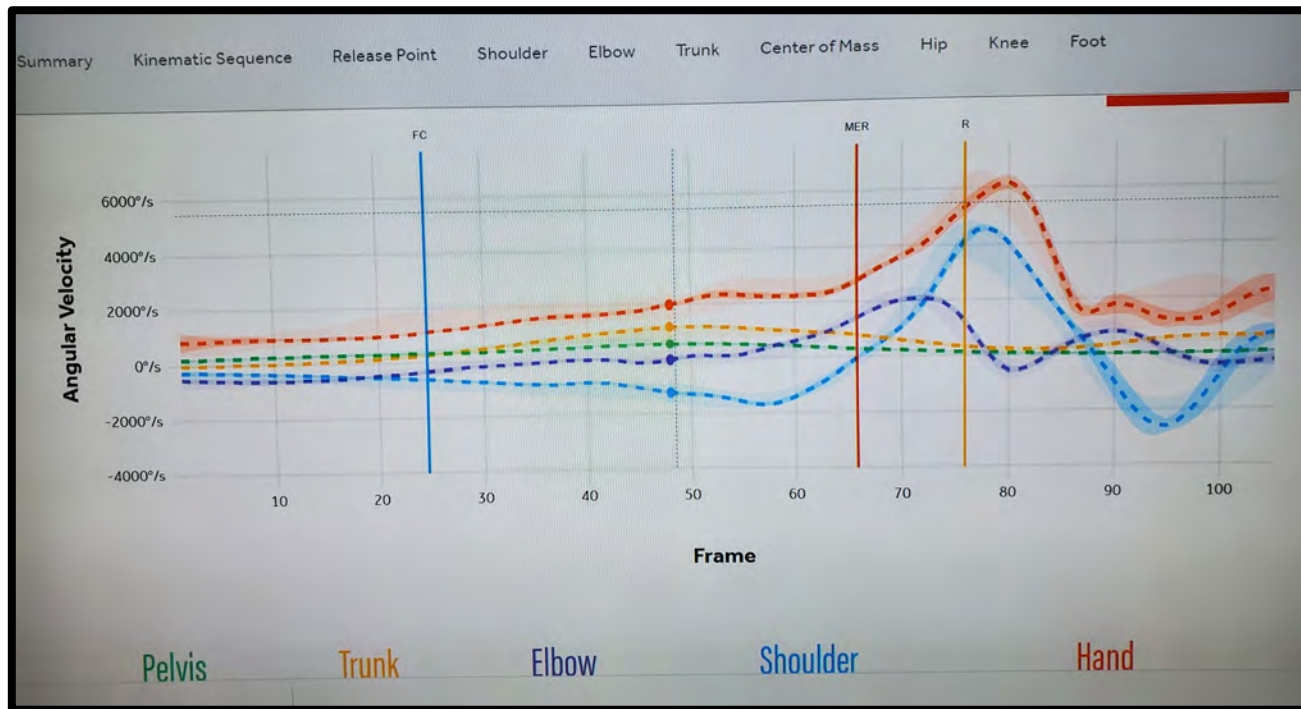
Charlotte, NC & Online | 2.0 CEUs

#NSCACoaches23

# ***CONFLICT OF INTEREST STATEMENT***

I have no actual or potential conflict of interest in relation to this presentation.

# BASEBALL PERFORMANCE TESTING & ASSESSMENT



# WHY TEST?

1. Provides objective evaluation of player's baseline physical capabilities & baseball performance
  - Identifies strengths & weaknesses
2. Provides descriptive data about your athletes and allows them to be ranked
3. Allows coach to assign appropriate weight for strength training loads
4. Provides objective evaluation of the effectiveness of your strength & conditioning program
5. Provides information about player's development & injury risk reduction strategies
6. Identifies an athlete's ability to return to practice or play after an injury



Szymanski & Vazquez, 2022

# WHEN TO TEST?

- **Beginning of off-season**

- High School
  - August
- College
  - August or September
- Professional
  - Beginning of Spring Training

- **End of off-season**

- High School
  - December
- College
  - December
- Professional
  - Individual team decision

# WHICH TESTS TO USE?

## Depends on:

- Available equipment, surfaces, & facilities
- Which tests are valued
- Which tests are most appropriate for sport
- Number of trained personnel
- Time available
- Safety considerations
- Familiarity with test
- Athlete's experience & training status
  - Beginner, intermediate, or advanced
- Validity and reliability of tests
- Time of the year
  - Off-, pre, in-, or postseason

McGuigan, 2016



# HOW TO ORDER TESTS?

- **Non-fatiguing Tests**
  - Anthropometry
  - Body composition
  - Mobility
- **High-skill Tests**
  - Agility
  - Power
  - Sprints
- **Strength Tests**
  - Lower body
  - Upper body
- **Metabolic Energy Systems (Aerobic Capacity)**
  - Estimated or actual  $VO_2$ max
- **Biomechanical Movement Pattern Specificity**
  - Pitching
  - Hitting
  - Baserunning

McGuigan, 2016

# TESTING & ASSESSMENT

## General Testing Guidelines

- Follow manufacturer's setup & calibration guidelines for all equipment
- Keep a log of the tests performed
- Standardize the testing environment & protocols
- Maintain consistency in the testing sequence

## Testing Considerations

- Health & safety
- Selection & training of testers
- Recording forms
- Test format
- Testing batteries & multiple testing trials
- Sequence of testing
- Preparing athletes for testing

McGuigan, 2016

# TESTING & ASSESSMENT OUTLINE

- Performance Testing

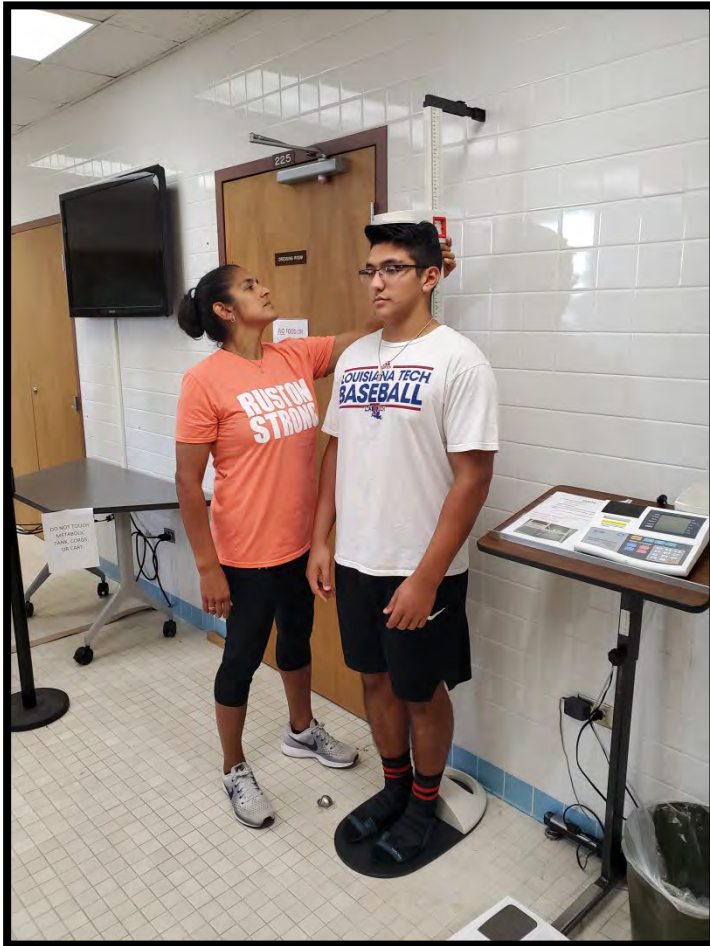
- Anthropometry
- Body Composition & Hydration
- Mobility
- Strength
- Arm Isokinetic Strength
- Arm ROM
- Arm Isometric Strength
- Power
- Speed
- Agility
- Aerobic Capacity

- Baseball Performance Testing

- Pitching
  - Throwing Velocity & Pitching Metrics
  - Power
  - 3D & 2D Motion Capture
  - Oxygen Consumption
  - Blood Lactate
- Hitting
  - Bat & Batted-Ball Exit Velocity
  - Power
  - Various Hitting Metrics
  - 3D & 2D Motion Capture
- Baseball-Specific Speed
  - Home to 1<sup>st</sup> Base

# ANTHROPOMETRY

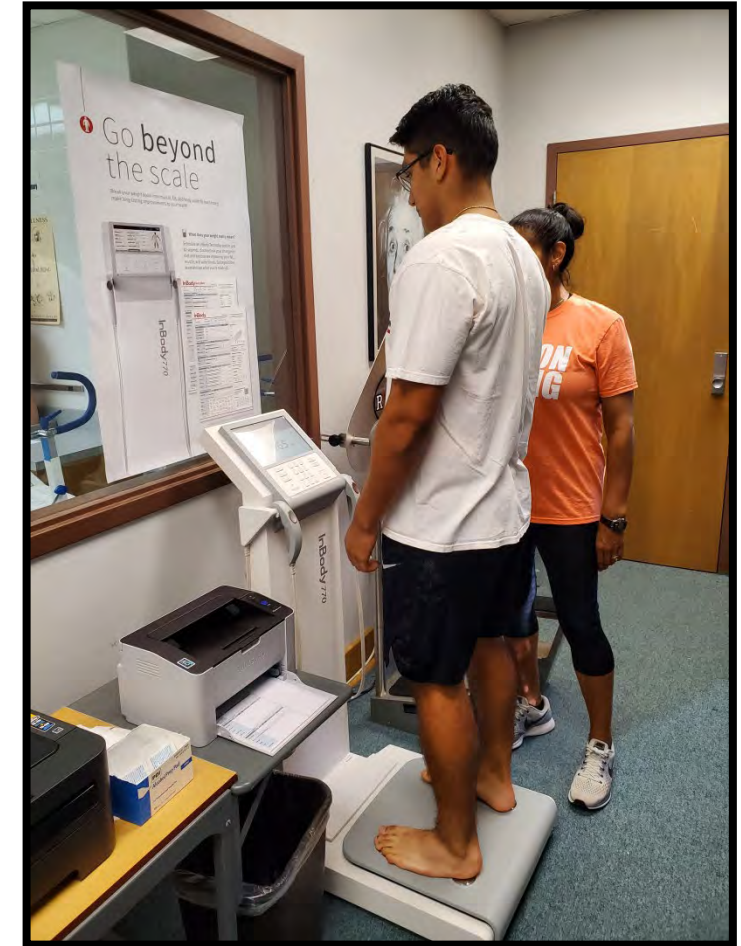
## Height



### Reasons for tests

- Identifies stature & weight of athlete
- Identifies growth or changes of athlete
- Identifies relationship to pitching & hitting metrics

## Body Mass



# ANTHROPOMETRY

## Upper Arm Length



### Reasons for tests

- Identifies growth of those that are not physically mature
- Identifies limb length
- Identifies relationship to pitching & hitting metrics

## Forearm Length



# ANTHROPOMETRY

## Index Finger Length



## Middle Finger Length



## Thumb Length



## Reasons for tests

- Identifies relationship to pitching metrics (e.g., FBV & spin rate)

# ANTHROPOMETRY

## Upper Arm Circumference



## Elbow Circumference



## Forearm Circumference



### Reasons for tests

Identifies girth of various parts of the throwing arm; identifies patterns of change, such as growth in LBM, body fat distribution, & inflammation; relates to pitching metrics

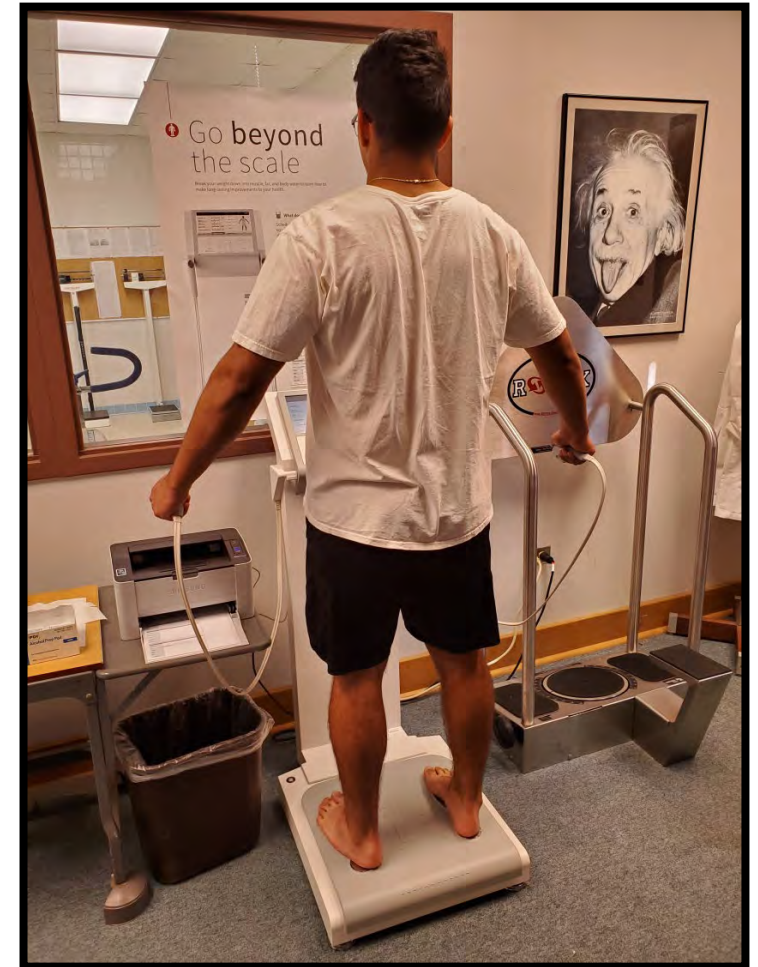
# BODY COMPOSITION & HYDRATION ANALYSIS



## Reasons for tests

- Identifies LBM & %BF
- Identifies hydration status, especially for starting pitchers
- Identifies relationship to pitching & hitting metrics

**Takes 60 sec to analyze**



- Intracellular Water
- Extracellular Water
- Dry Lean (Body) Mass
- Body Fat Mass
- Weight
- Skeletal Muscle Mass
- Body Fat Mass
- Body Mass Index
- Percent Body Fat
- Segmental Lean Analysis
- ECW/Total Body Water (TBW)
- Body Composition History
- Visceral Fat Area
- Basal Metabolic Rate
- Leg Lean Mass
- TBW/Lean Body Mass
- Skeletal Muscle Index



ID	Height	Age	Gender	Test Date / Time
cmg056	6ft. 01.5in	24	Male	04.20.2022 13:21

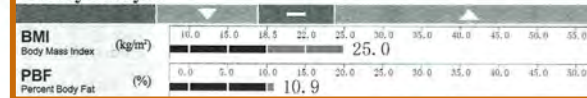
### Body Composition Analysis

	Values	Total Body Water	Lean Body Mass	Weight
Intracellular Water (lbs)	78.9	125.4	171.5	192.4
Extracellular Water (lbs)	46.5			
Dry Lean Mass (lbs)	46.1			
Body Fat Mass (lbs)	20.9			

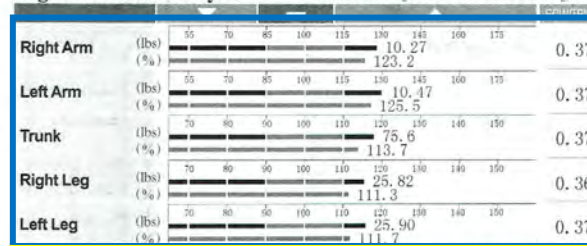
### Muscle-Fat Analysis



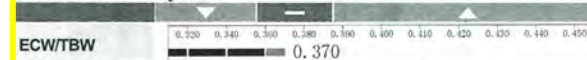
### Obesity Analysis



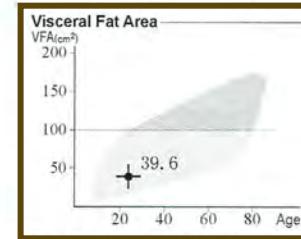
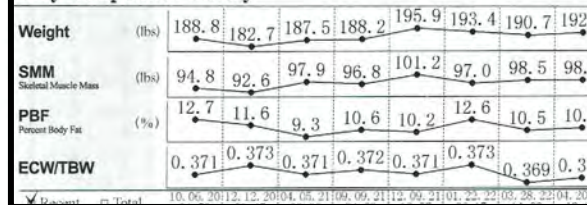
### Segmental Lean Analysis



### ECW/TBW Analysis



### Body Composition History



### Body Fat - Lean Body Mass Control

Body Fat Mass 0.0 lbs  
Lean Body Mass 0.0 lbs  
(+) means to gain fat/lean (-) means to lose fat/lean

### Segmental Fat Analysis

Right Arm (0.41lbs) 31.9%  
Left Arm (0.41lbs) 26.2%  
Trunk (11.21lbs) 105.9%  
Right Leg (3.11lbs) 69.3%  
Left Leg (3.11lbs) 69.2%

### Basal Metabolic Rate

Basal Metabolic Rate 2050 kcal  
Leg Lean Mass 51.7 lbs  
TBW/LBM 73.2%  
SMI 9.4 kg/m²

### Results Interpretation QR Code

Scan the QR Code to see results interpretation in more detail.

### Whole Body Phase Angle

Whole Body Phase Angle 6.9°  
φ (°) 50 kHz: RA 6.7, LA 6.7, TR 11.7, RL 6.8, LL 6.9  
Impedance

Z(Ω)	RA	LA	TR	RL	LL
1 kHz	297.2	291.8	25.0	273.5	267.6
5 kHz	288.9	282.9	23.9	265.8	260.2
50 kHz	247.4	241.9	19.0	226.8	222.6
250 kHz	218.8	213.5	14.8	202.1	198.4
500 kHz	210.4	205.4	13.4	196.9	192.9
1000 kHz	205.2	200.5	12.3	192.9	188.8

## Preparation Guidelines

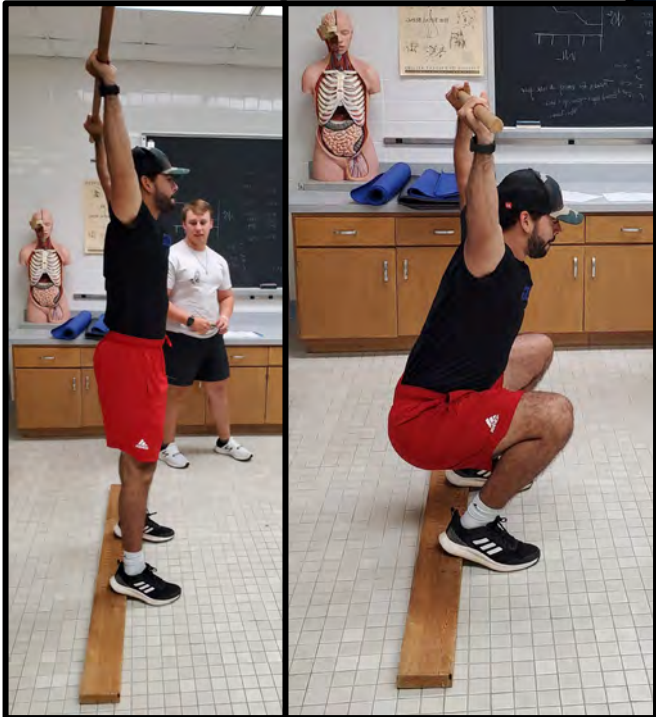
- Do not eat for 3-4 hr before testing
- Do not exercise for 6-12 hr before testing
- Do not drink caffeine on the day of testing & be well hydrated
- Do not shower or sauna immediately before test
- Avoid putting lotion on hands and feet before testing
- For women, avoid testing if you are pregnant or menstruating
- Those with pacemaker or other electronic device do not use InBody

Table 1 Percentile Values of Body Mass, Percent Body Fat, Fat Mass, and Lean Body Mass from NCAA Division I College Baseball Players

Percentile Rank	Body mass		Percent body fat	Fat mass		Lean body mass	
	lb	kg	%	lb	kg	lb	kg
90-100	226.0-265	102.5-120.5	8.0-4.0	14.2-6.0	6.4-2.7	190.2-231.6	86.5-105.3
80-89.9	216.4-225.9	98.4-102.4	9.4-8.1	16.7-14.3	7.5-6.5	181.7-190.1	82.6-86.4
70-79.9	207.5-216.3	94.3-98.3	10.2-9.5	18.9-16.8	8.5-7.6	176.7-181.6	80.3-82.5
60-69.9	201.0-207.4	91.0-94.2	11.4-10.3	21.2-19.0	9.6-8.6	172.6-176.6	78.4-80.2
50-59.9	194.6-200.9	88.5-90.9	12.7-11.5	24.6-21.3	11.2-9.7	168.6-172.5	76.6-78.3
40-49.9	189.1-194.5	86.0-88.4	13.7-12.8	27.8-24.7	12.6-11.3	165.5-168.5	75.2-76.5
30-39.9	183.0-189	83.0-85.9	15.1-13.8	30.6-27.9	13.9-12.7	162.0-165.4	73.6-75.1
20-29.9	176.1-182.9	80.1-82.9	16.3-15.2	35.0-30.7	15.9-14.0	156.3-161.9	71.0-73.5
10-19.9	168.1-176.0	76.4-80.0	18.6-16.4	40.2-35.1	18.2-16	149.8-156.2	68.1-70.9
<10	130.0-168.0	59.0-76.3	26.9-18.9	68.4-40.3	31.1-18.3	122.5-149.7	55.5-68.0
<b>Average</b>	<b>195.9</b>	<b>89.0</b>	<b>13.0</b>	<b>26.0</b>	<b>11.8</b>	<b>169.8</b>	<b>77.2</b>
<b>SD</b>	<b>23.1</b>	<b>10.5</b>	<b>4.1</b>	<b>10.5</b>	<b>4.8</b>	<b>16.0</b>	<b>7.3</b>
<b>N</b>	<b>440</b>						

Szymanski & Vazquez, 2022

# MOBILITY TESTS: IDENTIFIES POTENTIAL MOBILITY ISSUES, ASYMMETRIES, & PAIN



**Deep Squat**



**Hurdle Step**



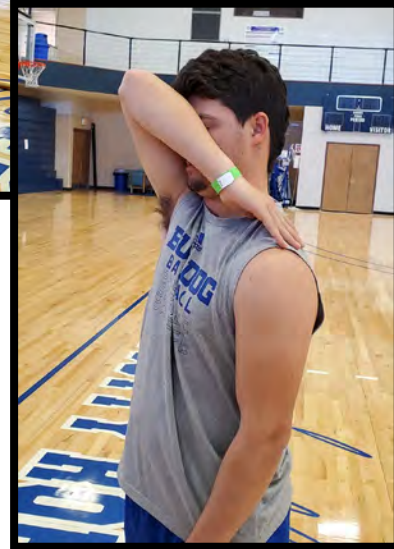
**In-Line Lunge**



**Straight Leg Raise**



**Shoulder Mobility & Impingement**



Functional Movement Screen

Descriptive Data				
Name:	Date:	Varsity Level:		
Age:	Height (in):	Hand Dominance: L R	Throws: L R	
Position:	Weight (lb):	Leg Dominance: L R	Bats: L R S	
Test	Score	Comments		Needs
Deep Squat	3 2 1 0	Ankle: Left-	Ankle: Right-	
		Knee: Left-	Knee: Right-	
		Hip: Left-	Hip: Right-	
		Low Back:		
		Thoracic:		
		Shoulder:		
Hurdle Step	3 2 1 0	Ankle: Left-	Ankle: Right-	
		Knee: Left-	Knee: Right-	
		Right Hip:		
		Left Hip:		
		RT Leg Stability:		
		LT Leg Stability:		
In-Line Lunge Left	3 2 1 0	Ankle: Left-	Ankle: Right-	
In-Line Lunge Right	3 2 1 0	Knee: Left-	Knee: Right-	
		Right Hip:		
		Left Hip:		
		RT Leg Stability:		
		LT Leg Stability:		
		Shoulder Mobility	3 2 1 0	
Shoulder Impingement	3 2 1 0	RT Over:		
		LT Over:		
		Right:		
Straight Leg Raise Left	3 2 1 0	Left:		
Straight Leg Raise Right	3 2 1 0			
Trunk Stability Push-up	3 2 1 0			
Rotational Stability Left	3 2 1 0			
Rotational Stability Right	3 2 1 0			
TOTAL SCORE				
Previous Injuries:				

Cook et al., 2014



David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNSCA  
Baseball Performance Testing & Assessment



# STRENGTH TESTING

## 1RM or Submaximal (2- to 10RM)

### Strength

- Back Squat
- BB or DB Bench Press
- Landmine or DB Row

## Reasons for tests

- Relate to other performance variables and baseball-specific performance variables
- Use 1RM data to assign percentages for training phases
- Use 1RM data to estimate other strength exercise's maximum value



Table 2 Percentile Values of the 1RM Back Squat and Barbell Bench Press from NCAA Division I College Baseball Players

Percentile rank	1 RM Back Squat		1RM Barbell Bench Press	
	lb	kg	lb	kg
90-100	435-535	197.7-243.2	290-385	131.8-175.0
80-89.9	405-434	184.1-197.6	280-289	127.3-131.7
70-79.9	390-404	177.3-184.0	270-279	122.7-127.2
60-69.9	370-389	168.2-177.2	265-269	120.5-122.6
50-59.9	350-369	159.1-168.1	255-264	115.9-120.4
40-49.9	340-349	154.5-159.0	250-254	113.6-115.8
30-39.9	320-339	145.5-154.4	240-249	109.1-113.5
20-29.9	310-319	140.9-145.4	230-239	104.5-109.0
10-19.9	280-309	127.3-140.8	215-229	97.7-104.4
<10	225-279	102.3-127.2	185-214	84.1-97.6
<b>Average</b>	<b>352.1</b>	<b>160.0</b>	<b>251.6</b>	<b>114.4</b>
<b>SD</b>	<b>58.0</b>	<b>26.4</b>	<b>31.9</b>	<b>14.5</b>
<b>N</b>	<b>375</b>		<b>212</b>	

Table 3.4 Percentile Values of the 1RM Dumbbell Bench Press and 1-Arm Dumbbell Row from NCAA Division I College Baseball Players

Percentile rank	1 RM Dumbbell Bench Press		1-Arm Dumbbell Row	
	lb	kg	lb	kg
90-100	120-145	54.5-65.9	155-170	70.5-77.3
80-89.9	115-119	52.3-54.4	145-154	65.9-70.4
70-79.9	110-114	50.0-52.2	140-144	63.6-65.8
60-69.9	105-109	47.7-49.9	135-139	61.4-63.5
50-59.9	100-104	45.5-47.6	130-134	59.1-61.3
40-49.9	95-99	43.2-45.4	125-129	56.8-59.0
30-39.9	90-94	40.9-43.1	120-124	54.5-56.7
20-29.9	85-89	38.6-40.8	115-119	52.3-54.4
10-19.9	80-84	36.4-38.5	110-114	50.0-52.2
<10	60-79	27.3-36.3	80-109	36.4-49.9
<b>Average</b>	<b>96.6</b>	<b>43.9</b>	<b>127.4</b>	<b>57.9</b>
<b>SD</b>	<b>15.1</b>	<b>6.9</b>	<b>16.5</b>	<b>7.5</b>
<b>N</b>	<b>126</b>		<b>382</b>	

Szymanski & Vazquez, 2022



# STRENGTH TESTING

## Grip Strength

### Reasons for tests

- Identify if there is a relationship to pitching metrics (e.g., FBV & spin rate)
- Identify if there is a relationship to hitting metrics (e.g., BV & BEV)
- Identify if there is a relationship to upper body strength

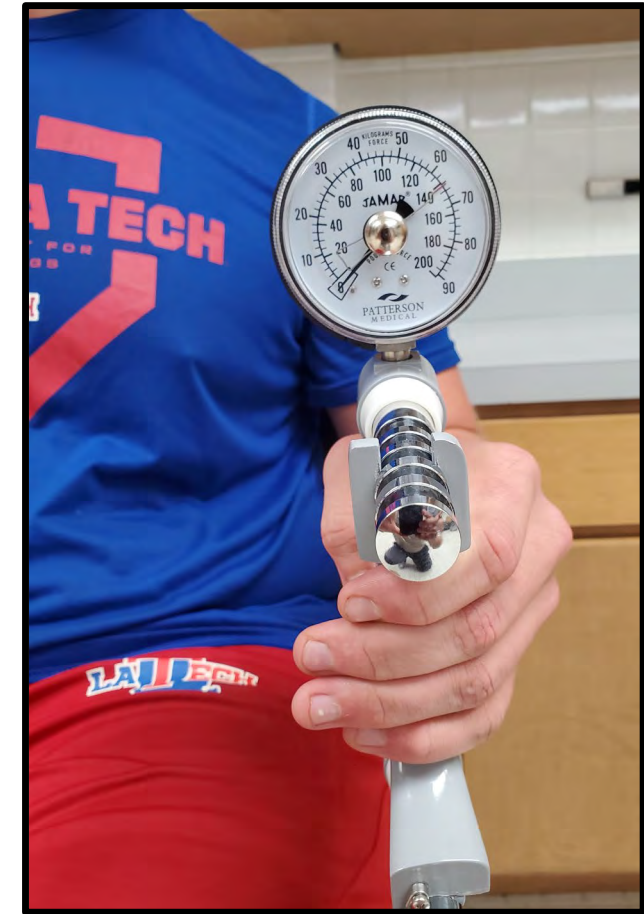
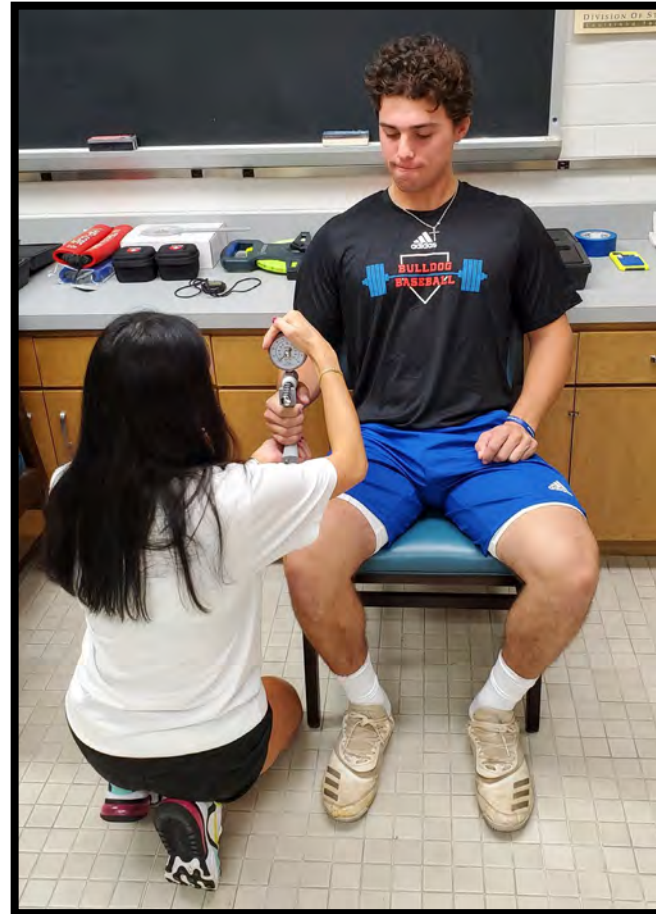


Table 4 Percentile Values of Total Grip Strength, Dominant Grip Strength, and Non-dominant Grip Strength from NCAA Division I College Baseball Players

Percentile rank	Total Grip Strength		Dominant Grip Strength		Non-Dominant Grip Strength	
	lb	kg	lb	kg	lb	kg
90-100	349.8-400.4	159-182	178.2-200.2	81-91	173.8-200.2	79-91
80-89.9	323.4-347.6	147-158	165.0-176.0	75-80	160.6-171.6	73-78
70-79.9	310.2-321.2	141-146	160.6-162.8	73-74	156.2-158.4	71-72
60-69.9	303.6-308.0	138-140	156.2-158.4	71-72	151.8-154.0	69-70
50-59.9	294.8-301.4	134-137	151.8-154.0	69-70	147.4-149.6	67-68
40-49.9	286.0-292.6	130-133	147.4-149.6	67-68	140.8-145.2	64-66
30-39.9	277.2-283.8	126-129	143.0-145.2	65-66	136.4-138.6	62-63
20-29.9	266.2-275.0	121-125	136.4-140.8	62-64	132.0-134.2	60-61
10-19.9	248.6-264.0	113-120	127.6-134.2	58-61	125.4-129.8	57-59
<10	140.8-246.4	64-112	92.4-125.4	42-57	88.0-123.2	40-56
<b>Average</b>	<b>294.4</b>	<b>133.8</b>	<b>149.8</b>	<b>68.1</b>	<b>145.0</b>	<b>65.9</b>
<b>SD</b>	<b>39.2</b>	<b>17.8</b>	<b>20.2</b>	<b>9.2</b>	<b>19.8</b>	<b>9.0</b>
<b>N</b>	<b>410</b>					

Szymanski & Vazquez, 2022

# STRENGTH TESTING

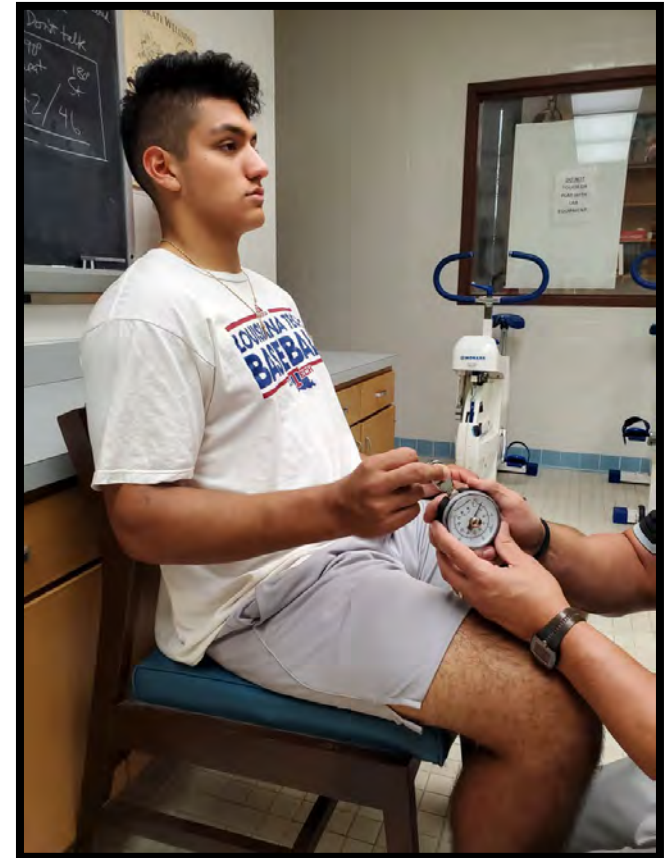
## Index Finger Pinch Strength



### Reasons for tests

- Identify if there is a relationship to pitching metrics (e.g., spin rate & FBV)

## Middle Finger Pinch Strength



# STRENGTH TESTING

## Total (Index & Middle) Finger Pinch Strength



### Reasons for tests

- Identify if there is a relationship to pitching metrics (e.g., spin rate & FBV)



Table 3.8 Percentile Values of Index Finger Pinch Strength, Middle Finger Pinch Strength, and Total Pinch Strength from NCAA Division I College Baseball Pitchers

Percentile Rank	Index Finger Pinch Strength		Middle Finger Pinch Strength		Total Pinch Strength	
	lb	kg	lb	kg	lb	kg
90-100	24.2-29.7	11-13.5	20.9-22.0	9.5-10.0	33.0-37.4	15.0-17.0
80-89.9	22.0-24.1	10-10.9	19.8-20.8	9.0-9.4	27.5-32.9	12.5-14.9
70-79.9	20.9-21.9	9.5-9.9	17.6-19.7	8.0-8.9	26.4-27.4	12.0-12.4
60-69.9	19.8-20.8	9.0-9.4	16.5-17.5	7.5-7.9	25.3-26.3	11.5-11.9
50-59.9	18.7-19.7	8.5-8.9	15.4-16.4	7.0-7.4	24.2-25.2	11.0-11.4
40-49.9	17.6-18.6	8.0-8.4	14.3-15.3	6.5-6.9	20.9-24.1	9.5-10.9
30-39.9	16.5-17.5	7.5-7.9	13.2-14.2	6.0-6.4	19.8-20.8	9.0-9.4
20-29.9	14.3-16.4	6.5-7.4	12.1-13.1	5.5-5.9	18.7-19.7	8.5-8.9
10-19.9	13.2-14.2	6.0-6.4	11.0-12.0	5.0-5.4	17.6-18.6	8.0-8.4
<10	9.9-13.1	4.5-5.9	9.9-10.9	4.5-4.9	16.5-17.5	7.5-7.9
Average	18.3	8.3	16.3	7.4	23.3	10.6
SD	4.8	2.2	2.6	1.2	5.3	2.4
N	36					

Szymanski et al., 2021

# ARM ISOKINETIC STRENGTH TESTING

## Warm-up



## Seated Shoulder External/Internal Rotation @ 90°



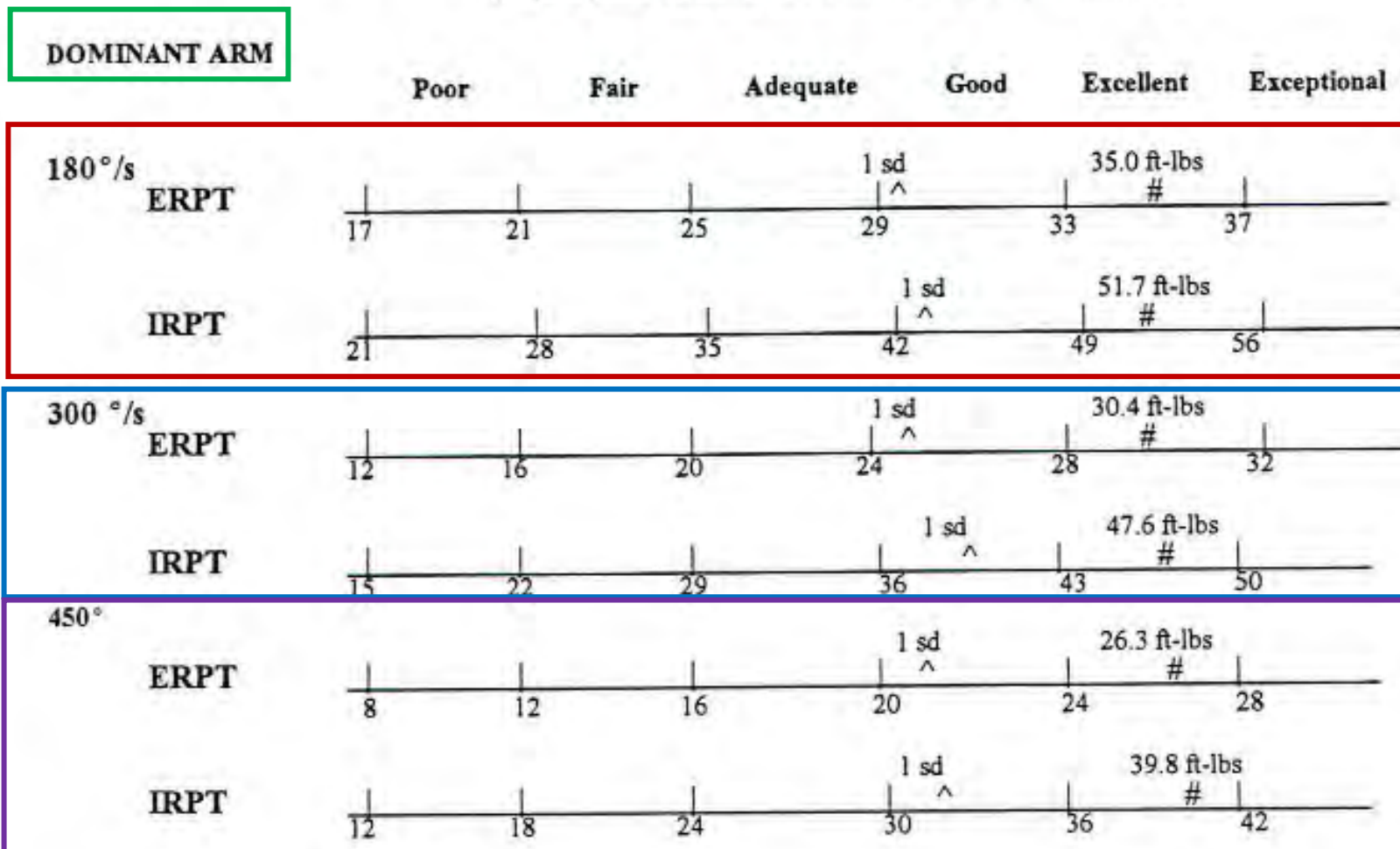
## Seated Shoulder Diagonal Abduction/Adduction



### Reasons to test

- Identify if there is a relationship to pitching performance & pitching metrics
- Identify strength & weakness to offset potential injuries

**SHOULDER EXTERNAL-INTERNAL ROTATION ISOKINETIC PERFORMANCE EVALUATION**  
 (Sagittal plane with arm abducted 90° and elbow flexed 90°)



Newsham et al., 1998

TABLE 4. Isokinetic performance evaluation of internal-external rotation in the dominant arm.

	$180^{\circ}\cdot\text{s}^{-1}$		$300^{\circ}\cdot\text{s}^{-1}$		$450^{\circ}\cdot\text{s}^{-1}$	
	ER	IR	ER	IR	ER	IR
<b>Torque/body weight</b>						
Exceptional	>20%	>30%	>16%	>28%	>15%	>22%
Excellent	19–13%	29–24%	16–13%	28–24%	15–12%	22–17%
Good	13–10%	24–29%	13–10%	24–20%	12–9%	17–12%
Adequate	10–7%	19–14%	10–7%	20–16%	9–6%	12–8%
Fair	7–4%	14–9%	7–4%	16–12%	6–3%	10–6%
Poor	<4%	<9%	<4%	<12%	<3%	<3%
<b>Average power</b>						
Exceptional	>85	>150	>90	>195	>85	>200
Excellent	84–70	150–120	90–75	195–155	85–66	200–156
Good	70–55	120–90	75–58	150–115	66–48	156–112
Adequate	55–40	90–60	58–42	115–75	48–30	112–69
Fair	40–25	60–30	42–25	75–35	30–12	69–25
Poor	<25	<30	<25	<35	<12	<25

Dominant arm tq/bw values are not significantly different than nondominant arm values.

Dominant arm average power is significantly greater than nondominant for internal rotation.

Newsham et al., 1998

TABLE 3. Isokinetic profile for intercollegiate baseball pitchers external/internal rotation.

	Peak Torque (ft-lb)	Torque @ 0.2 s (ft-lb)	Tq/Body Weight (%)	Work/Body Wt (%)	Average Power (W)	Pk Tq Ratio Er/Ir
<b>180°·s<sup>-1</sup></b>						
Dominant						
ER	35.0 ± 6.85*		18.7 ± 3.97*	32.6 ± 11.9*	90.7 ± 18.8*	0.67
IR	51.7 ± 8.04*	46.1 ± 6.39*	28.3 ± 4.09*	49.8 ± 8.51*	148.1 ± 29.5*	
Nondominant						
ER	34.5 ± 6.29*		18.6 ± 3.58*	34.5 ± 8.82*	89.7 ± 22.9*	0.73
IR	46.9 ± 6.73*	42.2 ± 7.44*	25.4 ± 3.99*	48.3 ± 7.92*	133.1 ± 25.5*	
<b>300°·s<sup>-1</sup></b>						
Dominant						
ER	30.4 ± 5.80*		16.3 ± 2.63*	24.7 ± 6.98*	90.7 ± 18.8*	0.64
IR	47.6 ± 8.49*	42.3 ± 9.33*	25.6 ± 4.30*	44.0 ± 9.76*	194.7 ± 49.9*	
Nondominant						
ER	29.4 ± 6.61*		15.9 ± 3.82*	26.8 ± 6.99*	89.7 ± 22.9*	0.67
IR	44.0 ± 10.0*	38.5 ± 5.99*	23.3 ± 4.61*	41.9 ± 6.36*	165.0 ± 34.5*	
<b>450°·s<sup>-1</sup></b>						
Dominant						
ER	26.3 ± 4.71*		14.2 ± 2.68*	21.2 ± 5.40*	90.1 ± 21.3*	0.66
IR	39.8 ± 7.97*	34.6 ± 6.22 (P=0.041)	21.5 ± 4.35*	36.2 ± 8.78*	199.0 ± 57.8*	
Nondominant						
ER	24.6 ± 5.37*		13.3 ± 2.84*	21.6 ± 5.93*	82.6 ± 20.5*	0.67
IR	36.4 ± 11.04*	28.5 ± 6.84 (P=0.041)	19.5 ± 4.16*	32.5 ± 5.91*	167.5 ± 41.5*	

\*Difference between dominant and nondominant is not significant ( $P < 0.05$ ); difference between IR and ER is significant ( $P < 0.0001$ ).

Newsham et al., 1998

# ARM ISOKINETIC STRENGTH TESTING

## Wrist Extension/Flexion



### Reasons for tests

- Identify if there is a relationship to pitching performance & pitching metrics
- Identify strength & weakness to offset potential injuries

## Forearm Supination/Pronation

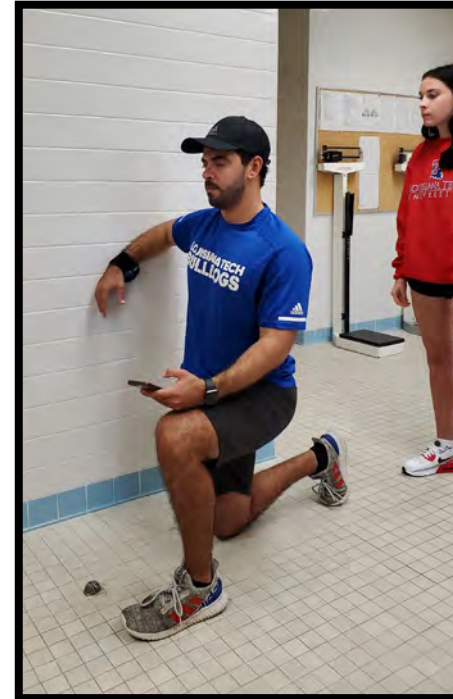


# ARM RANGE OF MOTION (ROM) TESTING

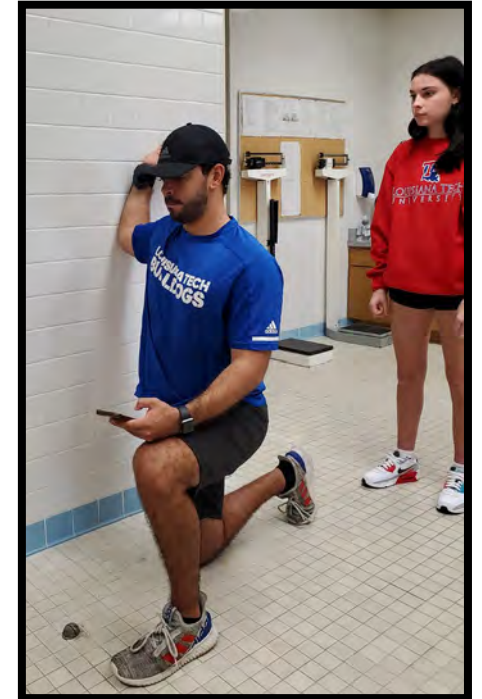
## Shoulder Flexion ROM



## Internal Rotation ROM



## External Rotation ROM



### Reasons for tests

- Assess ROM of shoulder
- Monitor strength & weakness before and after pitching
- Help to make pitching & training decisions

# ARM ISOMETRIC STRENGTH TESTING

## Shoulder Internal Rotation Strength



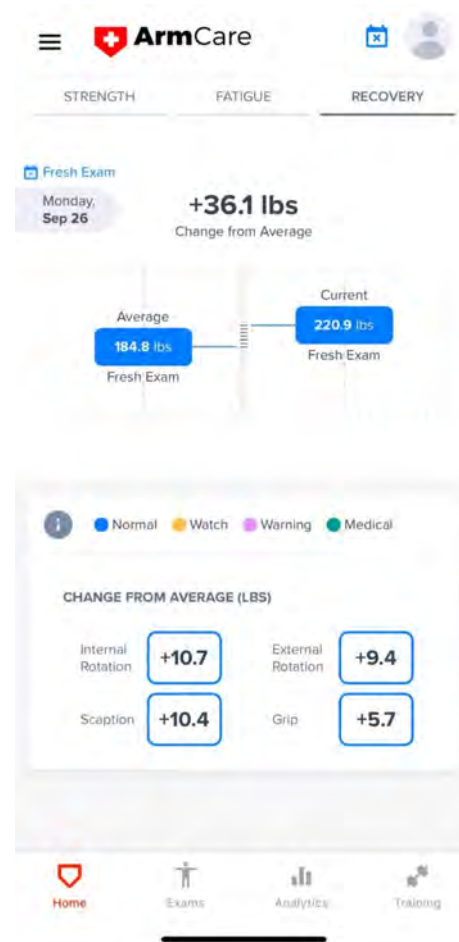
Armcare.com

## Shoulder External Rotation Strength



# ARM ISOMETRIC STRENGTH TESTING

## Shoulder Scaption Strength



## Grip Strength



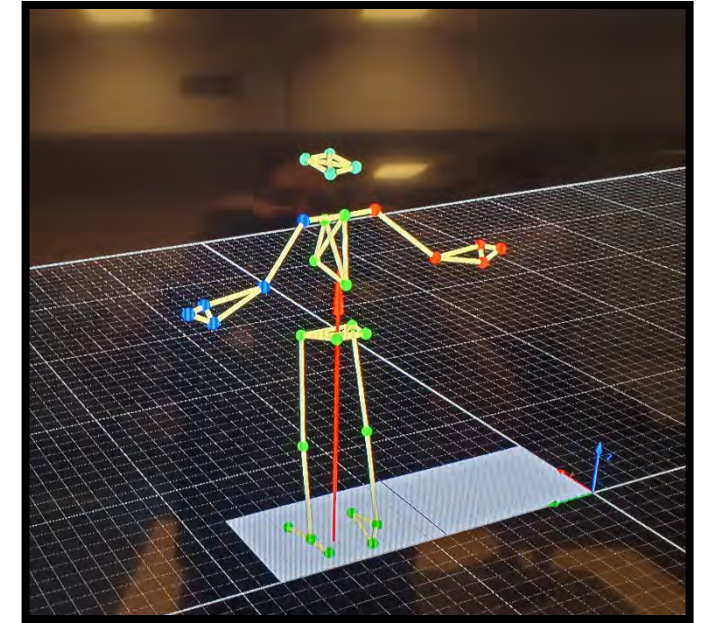
Armcare.com

# POWER TESTING

**Bilateral (2-Leg) Vertical Jump Height**  
**Peak Power**  
**Estimation of Peak Power (Sayers et. al, 1999)**



**Force Plate Data: Peak Power, EccRFD,  
Concentric Vertical Impulse, Take Off Velocity,  
Contraction Time, RSI modified**



## **Reasons for tests**

- Relate to forces while pitching & pitching metrics
- Relate to forces while hitting & hitting metrics
- Identify neurologic fatigue prior to training
- Identify potential elbow injury risk (Mayberry et al., 2020)

Table 3.10 Percentile Values of Vertical Jump and Estimated Peak Power (PP) from NCAA Division I (DI) College Baseball Players, and Actual Peak Power from DI College Pitchers

Percentile Rank	Vertical Jump		Estimated PP (Sayers) *	Corrected Estimated PP (Harman) +	Actual Peak power
	in.	cm	W	W	W
90-100	31.0-35.5	78.7-90.2	6522.8-7280.0	6272.1-6970.0	6875.6-8500.0
80-89.9	29.5-30.5	74.9-77.5	6304.3-6522.7	6010.6-6272.0	605.2-6875.5
70-79.9	28.5-29.0	72.4-73.7	6113.5-6304.2	5830.0-6010.5	6137.9-6405.1
60-69.9	27.5-28.0	69.9-71.2	5947.9-6113.4	5696.2-5829.9	5888.3-6137.8
50-59.9	26.5-27.0	67.3-68.6	5810.9-5947.8	5539.1-5696.1	5549.8-5888.2
40-49.9	26.0	66.0	5668.6-5810.8	5368.6-5539.0	5311.4-5549.7
30-39.9	25.0-25.5	63.5-64.8	5495.0-5668.5	5178.3-5368.5	5153.9-5311.3
20-29.9	24.0-24.5	61.0-62.2	5281.0-5494.9	5026.5-5178.2	4781.8-5153.8
10-19.9	22.5-23.5	57.2-59.7	5114.8-5280.9	4805.1-5026.4	4369.1-4781.7
<10	18.5-22.0	47.0-55.9	4008.3-5114.7	3870.2-4805.0	3032.0-4369.0
Average	26.4	67.1	5818.2	5527.4	5628.2
SD	3.2	8.1	567.1	545.2	1178.8
N	420		420		38

\*Sayers = estimation of peak power from reference 7.

+Harman = estimation of peak power from reference 2.

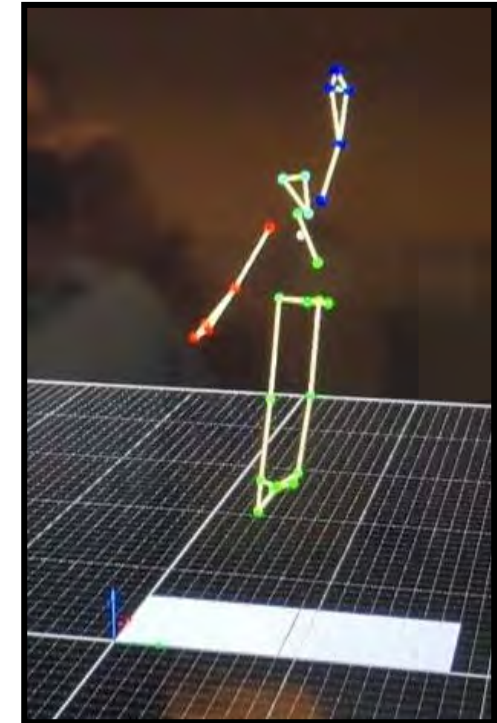
Szymanski & Vazquez, 2022

# POWER TESTING

**Unilateral (1-Leg) Vertical Jump Height: drive & stride leg  
Peak Power**



**Force Plate Data: Peak Power, EccRFD,  
Concentric Vertical Impulse, Take Off  
Velocity, Contraction Time, RSI modified**



## Reasons for tests

Relate to forces while pitching & hitting, Identify leg dominance, Identify single-leg power, Relate to pitching & hitting metrics, and Use to identify neurologic fatigue prior to training

# POWER TESTING

## Standing Long (Broad) Jump



## Estimation of Peak Power (Mann et al., 2021)



### Reasons for tests

- Identifies horizontal jumping power
- Identifies if there is a relationship to pitching & hitting metrics & other performance variables

# POWER TESTING

## Lateral-to-Medial Jump



### Reasons to test

- Measures unilateral lower body horizontal plane jumping power
- Identifies if there is a relationship to pitching & hitting metrics & other performance variables

Table 7 Percentile Values of Lateral to Medial Jump and Standing Long Jump from NCAA Division I College Baseball players

Percentile Rank	Lateral to Medial Jump Right		Lateral to Medial Jump Left		Standing Long Jump	
	in.	cm	in.	cm	in.	cm
90-100	89.5-93.0	227-236	90.0-94.5	228-240	113.0-122.0	287.0-310.0
80-89.9	85.5-89.4	217-226.9	86.5-89.9	219.0-227.9	110.0-112.9	279.4-286.9
70-79.9	82.5-85.4	209-216.9	84.5-86.4	214.0-218.9	107.0-109.9	271.8-279.3
60-69.9	81.0-82.4	205-208.9	83.0-84.4	210.0-213.9	104.5-106.9	265.4-271.7
50-59.9	79.5-80.9	201-204.9	80.5-82.9	204.0-209.9	101.5-104.4	257.8-265.3
40-49.9	77.5-79.4	196-200.9	80.0-80.4	203.0-203.9	99.5-101.4	252.7-257.7
30-39.9	76.5-77.4	194-195.9	77.0-79.9	195.5-202.9	97.5-99.4	247.7-252.6
20-29.9	75.5-76.4	191-193.9	76.5-76.9	194.0-195.4	94.5-97.4	240.0-247.6
10-19.9	73.0-75.4	185-190.9	75.5-76.4	191.0-193.9	91.0-94.4	231.1-239.9
<10	67.0-72.9	170-184.9	70.0-75.4	177.5-190.9	74.0-90.9	188.0-230.0
<b>Average</b>	<b>79.5</b>	<b>202.0</b>	<b>81.1</b>	<b>206.0</b>	<b>101.7</b>	<b>258.3</b>
<b>SD</b>	<b>6.3</b>	<b>16.0</b>	<b>5.5</b>	<b>14.1</b>	<b>8.4</b>	<b>21.3</b>
<b>N</b>	<b>55</b>				<b>294</b>	

5 ft = 60 in  
 6 ft = 72 in  
 7 ft = 84 in  
 8 ft = 96 in  
 9 ft = 108 in  
 10 ft = 120 in  
 11 ft = 132 in

Szymanski & Vazquez, 2022

# POWER TESTING

## Overhead 4 LB Medicine Ball Throw – Radar gun records velocity



### Reasons for tests

- Relates to fastball/throwing velocity

Table 8 Percentile Values of Overhead Medicine Ball Throw for NCAA Division I College Baseball Pitchers

Percentile Rank	Overhead Medicine Ball Throw	
	mph	m/s
90-100	33.0-33.5	14.8-15.0
80-89.9	32.1-32.9	14.3-14.7
70-79.9	31.0-32.0	13.9-14.2
60-69.9	30.5-30.9	13.6-13.8
50-59.9	29.8-30.4	13.3-13.5
40-49.9	29.5-29.7	13.1-13.2
30-39.9	28.5-29.4	12.7-13.0
20-29.9	27.8-28.4	12.4-12.6
10-19.9	27.3-27.7	12.2-12.3
<10	26.0-27.4	11.6-12.2
<b>Average</b>	<b>30.0</b>	<b>13.4</b>
<b>SD</b>	<b>2.2</b>	<b>1.0</b>
<b>N</b>	<b>19</b>	

Szymanski & Vazquez, 2022

# POWER TESTING

## 2 LB Medicine Ball Hitter's Throw – Radar gun records velocity



### Reasons for tests

- Relates to bat velocity & exit velocity
- Identifies if there is a relationship to offensive performance (e.g., HR, OBP, SLG%, OPS, XBH, RBI, WAR, BABIP, ISO power)

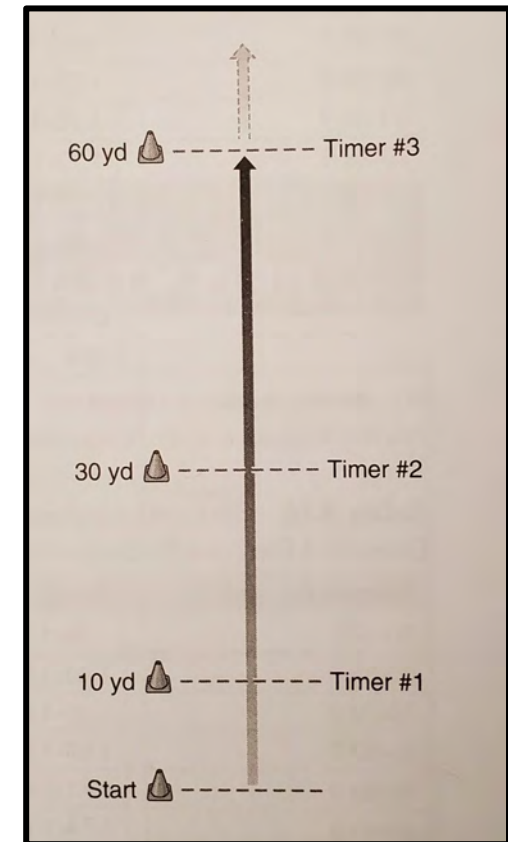
# SPEED TESTING

## 10-30-60 yd Sprint



### Reasons for tests

- Relate 10, 30, 60 yd times to baserunning speed, such as time to:
  - 1<sup>st</sup> base
  - Home to 2<sup>nd</sup> base
  - 2<sup>nd</sup> base to home



Szymanski & Vazquez, 2022

Table 3.16 Percentile Values of 10-30-60-yd (9.1-27.4-54.9 m) Sprint Times NCAA Division I Baseball Position Players (in Seconds)

Percentile Rank	Sprints		
	10-yd	30-yd	60-yd
90-100	1.53-1.36	3.68-3.29	6.67-6.29
80-89.9	1.59-1.54	3.72-3.67	6.81-6.68
70-79.9	1.61-1.60	3.79-3.73	6.92-6.80
60-69.9	1.63-1.62	3.84-3.80	7.00-6.93
50-59.9	1.65-1.64	3.91-3.85	7.10-7.01
40-49.9	1.67-1.66	3.98-3.92	7.16-7.11
30-39.9	1.70-1.68	4.04-3.99	7.32-7.17
20-29.9	1.73-1.71	4.10-4.05	7.44-7.33
10-19.9	1.78-1.74	4.16-4.11	7.57-7.45
<10	1.97-1.79	4.74-4.17	8.36-7.58
Average	1.66	3.92	7.13
SD	0.10	0.21	0.36
N	184		

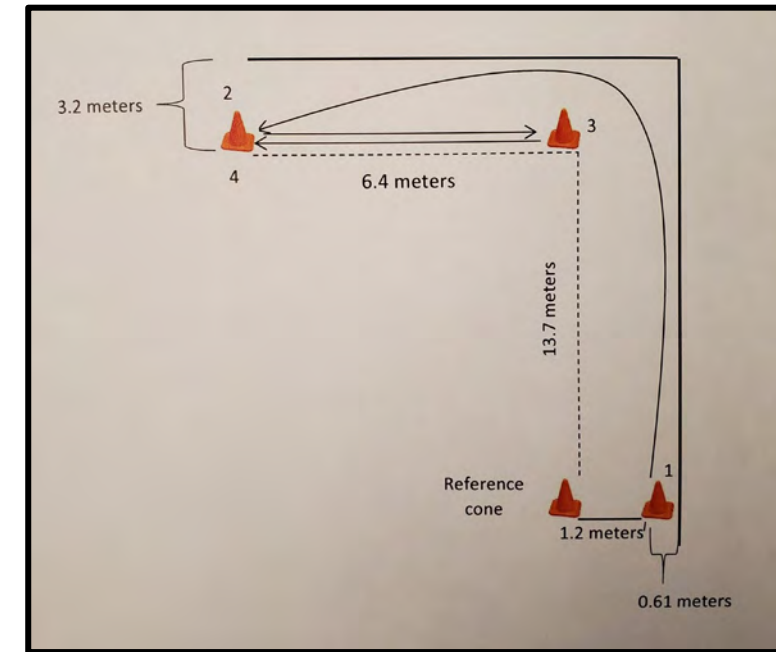
Szymanski & Vazquez, 2022

# AGILITY TESTING

## 5-10-5 (Pro) Agility Test



## Curvilinear Ability Test (CAT)



### Reasons for tests

- Relate to ability to move on the field
- Identify strength & weaknesses of COD ability
- Relate to stolen bases & total bases

Martinez-Rodriguez et al., 2021

Table 3.19 Percentile Values of 5-10-5 Agility Test for NCAA Division I Baseball Position Players and Pitchers (in Seconds)

Percentile Rank	Position Players	Pitchers
90-100	4.21-4.04	4.37-4.17
80-89.9	4.29-4.22	4.45-4.38
70-79.9	4.34-4.30	4.52-4.46
60-69.9	4.41-4.35	4.56-4.53
50-59.9	4.45-4.42	4.62-4.57
40-49.9	4.51-4.46	4.69-4.63
30-39.9	4.57-4.52	4.74-4.70
20-29.9	4.63-4.58	4.78-4.75
10-19.9	4.79-4.64	4.89-4.79
<10	5.09-4.80	5.50-4.90
Average	4.48	4.64
SD	0.21	0.24
N	278	158

Szymanski & Vazquez, 2022

# AEROBIC CAPACITY TESTING – PITCHERS

## 1.5 Mile Run Test - Estimate $VO_2$ max



## $VO_2$ max Test



ACSM, 2014

TABLE 4.9. Fitness Categories for Maximal Aerobic Power for Men and Women

%	Fitness Category	Age 20-29			
		Balke Treadmill (time)	Max $VO_2$ (mL/kg/min)	12-Min Run (miles)	1.5-Mi Run (time)
99	Superior	31:30	60.5	2.00	8:29
95		28:05	55.5	1.86	9:17
90	Excellent	27:00	54.0	1.81	9:34
85		25:30	51.8	1.75	10:00
80	Good	25:00	51.1	1.73	10:09
75		23:13	48.5	1.66	10:43
70	Fair	22:30	47.5	1.63	10:59
65		22:00	46.8	1.61	11:10
60	Fair	21:10	45.6	1.58	11:29
55		21:40	44.8	1.56	11:41
50	Fair	20:00	43.9	1.53	11:58
45		19:08	42.6	1.50	12:20
40	Poor	18:30	41.7	1.47	12:38
35		18:00	41.0	1.45	12:53
30	Poor	17:17	39.9	1.42	13:15
25		16:38	39.0	1.40	13:36
20	Very poor	15:56	38.0	1.37	14:00
15		15:00	36.7	1.33	14:34
10	Very poor	13:37	34.7	1.28	15:30
5		11:38	31.8	1.20	17:04
1		8:00	26.5	1.05	20:58

Total n = 15,058

### Reasons for tests

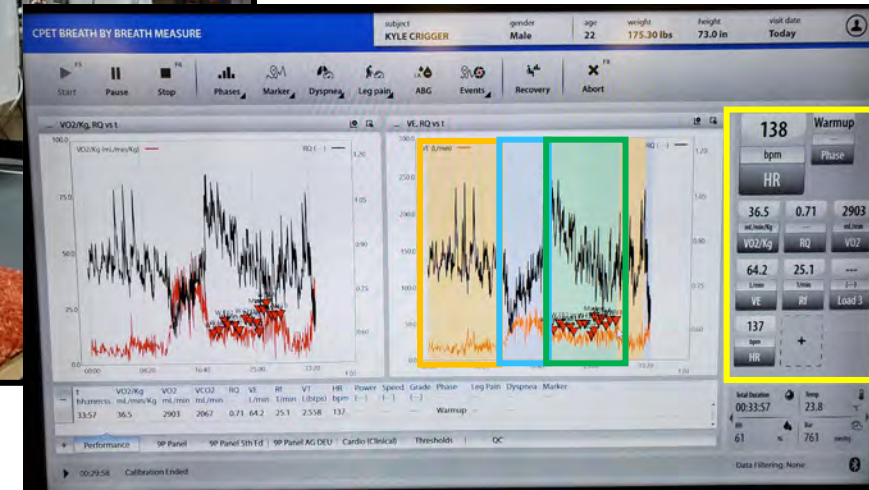
Relate CV fitness to ability to pitch long inning & ability to recover between innings. For starting pitcher, a greater CV fitness level can help with the ability to pitch more innings. Greater CV fitness will allow pitchers to physiologically handle heat & humidity better.

# PITCHING PERFORMANCE TESTING

Throwing Velocity, 3D Marker-based Motion Capture, Power,  $VO_2$ , RQ, HR,  $V_E$  while pitching

## Reasons for tests

- Relate pitching  $VO_2$  (intensity) to  $VO_{2max}$
- Identify intensity of pitching
- Use to make decisions about training intensity

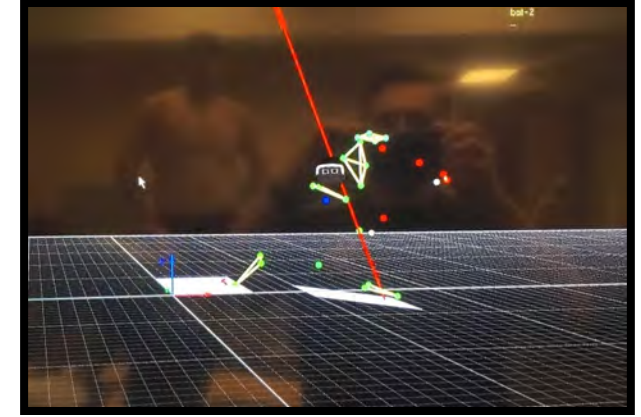
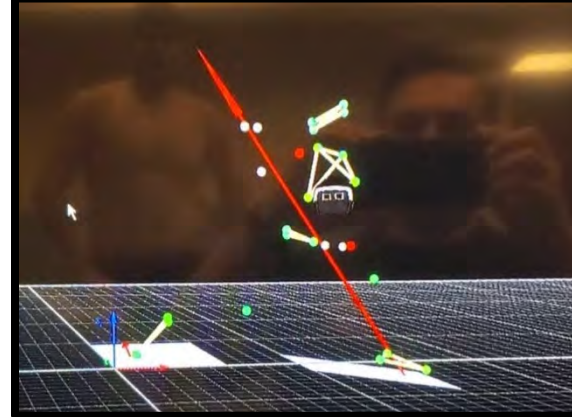
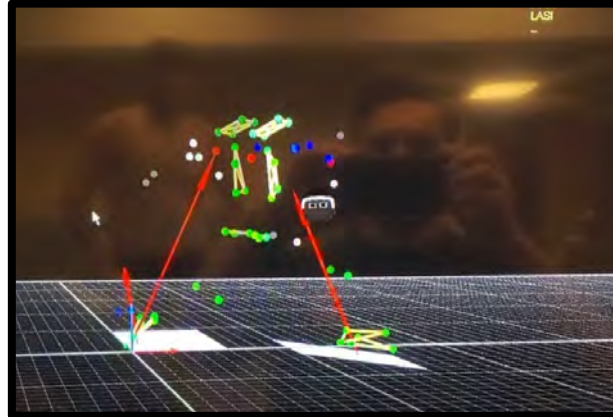
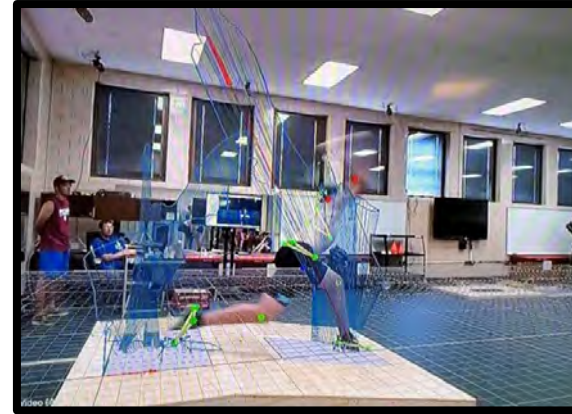
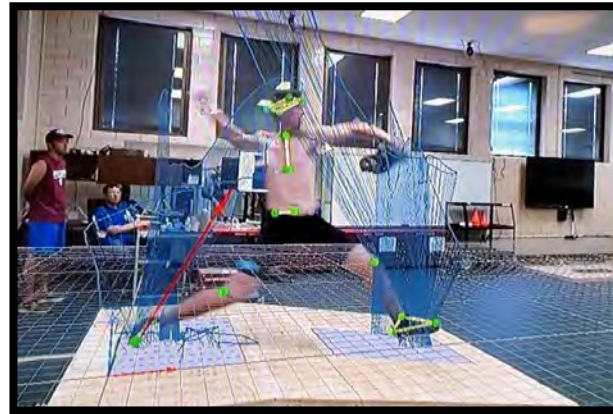


# PITCHING PERFORMANCE TESTING

## 2D & 3D Marker-based Motion Capture System with Force Plate data (Power)

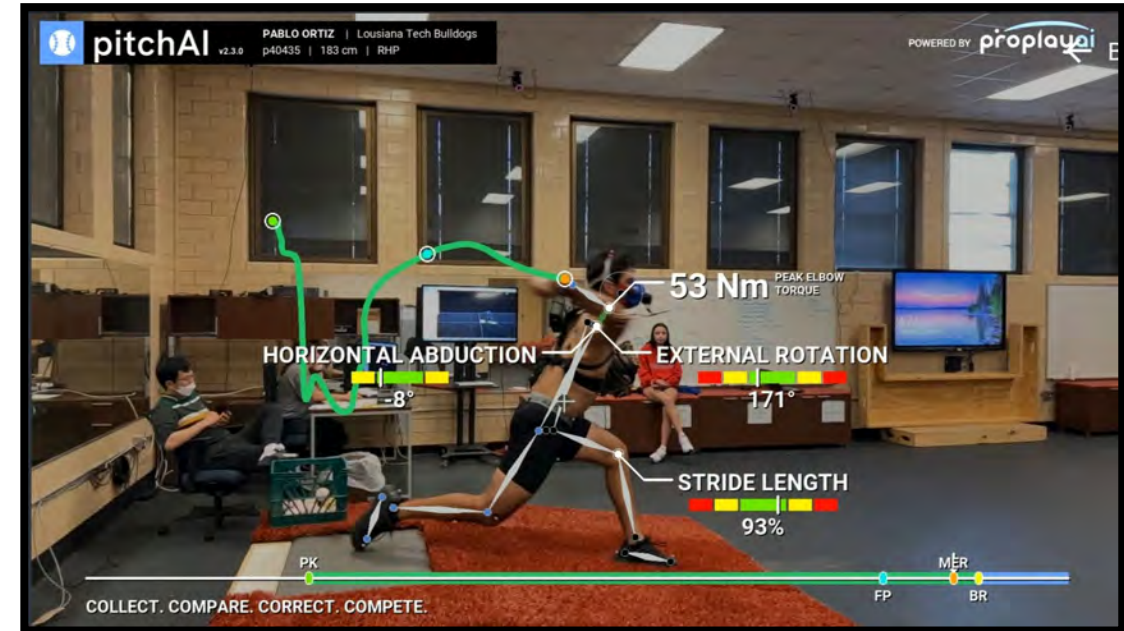
### Reasons to test

- Relate to pitching metrics (e.g., velocity, spin rate, vertical & horizontal break, etc)
- Relate to pitching mechanics (e.g., hip shoulder separation or time difference of max pelvis rotation velocity & max trunk rotation velocity)
- Relate to unilateral lower body training (e.g., plyometric & resistance exercises)



# PITCHING PERFORMANCE TESTING

## 3D & 2D Markerless Motion Capture System data with Force Plate data (Power)



### Reasons for tests

- Relate to pitching performance (e.g., MER, stride length, & arm speed to FBV), potential injuries, & mechanics
- Identify various variables of interest (e.g., max lead & rear leg GRF residual)
- Use information to make decisions about possibly changing pitching mechanics or to support good mechanics
- Relate to various jumping tests

# PITCHING PERFORMANCE TESTING

## Pitching Sensor Metrics



### Pitching Metrics

Velocity  
Strike zone analysis  
Spin rate & efficiency  
True spin rate  
Pitch break  
Spin Axis

3D trajectory  
Release angle  
Release side

Release height  
Release extension  
Horizontal angle

Rapsodo.com



David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNCSA  
Baseball Performance Testing & Assessment

NSCA **COACHES**  
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Table 3.25 Percentile Values of Throwing Velocity from High School and NCAA Division I (DI) Baseball Players from a Two-Step Approach on Flat Ground, and Pitching Velocity from NCAA DI Pitchers from a Wind-up and Stretch (Slide Step) from Intrasquad Games

Percentile Rank	High School Throwing Velocity		DI Throwing Velocity		DI Pitching Velocity: Wind-up		DI Pitching Velocity: Stretch	
	mph	m/s	mph	m/s	mph	m/s	mph	m/s
90-100	77.3-80.3	34.6-35.9	88.5-92.2	39.6-41.2	91.5-93.5	40.9-41.8	91.0-93.4	40.7-41.8
80-89.9	75.0-77.2	33.5-34.5	86.4-88.4	38.6-39.5	91.0-91.4	40.7-40.8	88.9-90.9	39.7-40.6
70-79.9	72.3-74.9	32.3-33.4	85.2-86.3	38.1-38.5	90.0-90.9	40.2-40.6	88.2-88.8	39.4-39.6
60-69.9	71.5-72.2	32.0-32.2	84.3-85.1	37.7-38.0	89.0-89.9	39.8-40.1	87.9-88.1	39.2-39.3
50-59.9	70.2-71.4	31.4-31.9	83.2-84.2	37.2-37.6	87.6-88.9	39.2-39.7	87.0-87.8	38.9-39.1
40-49.9	68.3-70.1	30.5-31.3	82.1-83.1	36.7-37.1	87.0-87.5	38.9-39.1	86.5-86.9	38.7-38.8
30-39.9	65.8-68.2	29.4-30.4	80.7-82.0	36.1-36.6	86.7-86.9	38.7-38.8	85.9-86.4	38.4-38.6
20-29.9	65.0-65.7	29.1-29.3	79.3-80.6	35.5-36.0	85.5-86.6	38.2-38.6	85.0-85.8	38.0-38.3
10-19.9	62.2-64.9	27.8-29.0	77.8-79.2	34.8-35.4	85.0-85.4	38.0-38.1	84.0-84.9	37.6-37.9
<10	53.7-62.1	24.0-27.7	70.6-77.7	31.6-34.7	80.0-84.9	35.8-37.9	79.7-84.9	35.6-37.5
Average	69.3	31.0	82.9	37.1	87.9	39.3	87.2	39.0
SD	6.2	2.8	4.0	1.8	3.2	1.4	3.3	1.5
N	102		305		98			

Adapted from Szymanski and colleagues

# PITCHING PERFORMANCE TESTING

## Blood Lactate

### Reasons for tests

- Indication of pitching intensity, fatigue, & recovery ability
- Use for training intensity along with HR data
- Relate fatigue to impact on FBV
- Relate fatigue to impact on pitching mechanics and forces & torques on medial elbow, for example



Warren et al., 2015

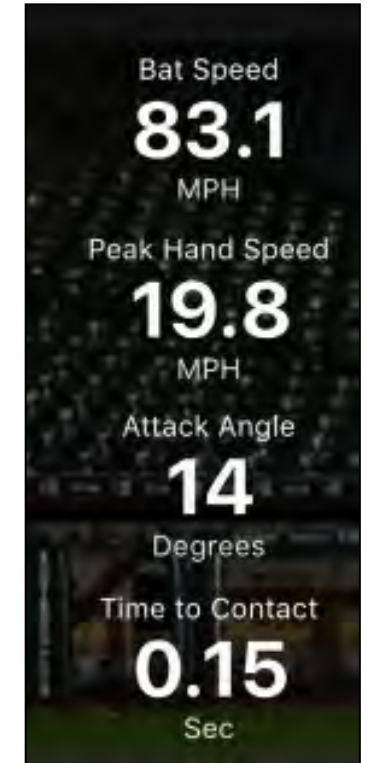
# HITTING PERFORMANCE TESTING

## Bat Sensor – Bat Velocity

## Radar Gun – Exit Velocity

## Reasons to test

- Relate to offensive hitting performance (e.g., HR, OBP, SLG%, OPS, XBH, RBI, WAR, BABIP, ISO power) & hitting sensor metrics



Blastmotion.com



David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNCSA  
Baseball Performance Testing & Assessment



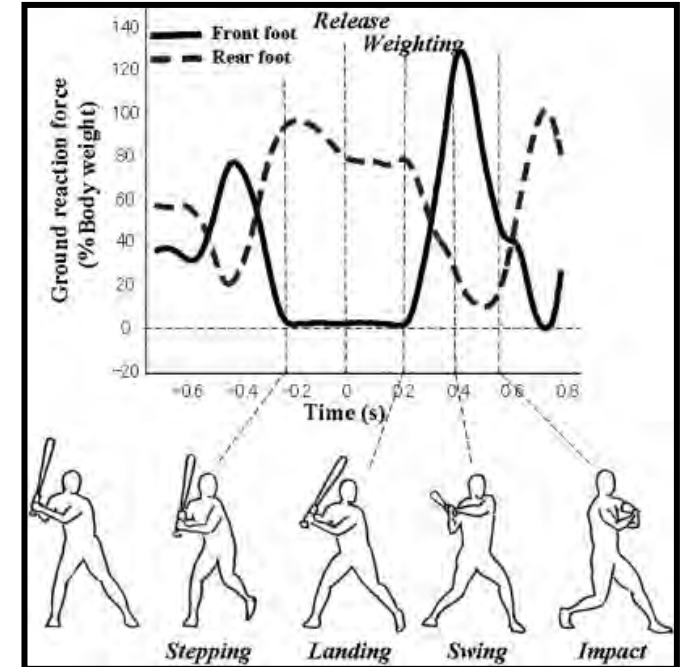
Table 3.24 Percentile Values of Bat Swing Velocity and Batted-ball Exit Velocity for High School and NCAA Division I (DI) Baseball Players

Percentile Rank	High School Bat Swing Velocity		High School Batted-ball Exit Velocity		DI Bat Swing Velocity		DI Batted-ball Exit Velocity	
	mph	m/s	mph	m/s	mph	m/s	mph	m/s
90-100	80.2-90.0	35.9-40.2	80.6-86.5	36.0-38.7	97.4-108.0	43.5-48.3	93.7-100.6	41.9-45.0
80-89.9	77.0-80.1	34.4-35.8	76.7-80.5	34.3-35.9	95.8-97.3	42.8-43.4	92.0-93.6	41.1-41.8
70-79.9	74.0-76.9	33.1-34.3	75.7-76.6	33.8-34.2	94.7-95.7	42.3-42.7	90.8-91.9	40.6-41.0
60-69.9	71.9-73.9	32.1-33.0	73.2-75.6	32.7-33.7	93.3-94.6	41.7-42.2	89.6-90.7	40.1-40.5
50-59.9	70.3-71.8	31.4-32.0	72.0-73.1	32.1-32.6	92.1-93.2	41.2-41.6	88.8-89.5	39.7-40.0
40-49.9	68.4-70.2	30.6-31.3	70.2-71.9	31.4-32.0	90.8-92.0	40.6-41.1	87.7-88.7	39.2-39.6
30-39.9	66.8-68.3	29.9-30.5	69.0-70.1	30.8-31.3	89.4-90.7	40.0-40.5	86.6-87.6	38.7-39.1
20-29.9	64.1-66.7	28.7-29.8	67.2-68.9	30.0-30.7	87.6-89.3	39.2-39.9	85.3-86.5	38.1-38.6
10-19.9	61.1-64.0	27.3-28.6	64.4-67.1	28.8-29.9	85.0-87.5	38.0-39.1	83.0-85.2	37.1-38.0
<10	52.1-61.0	23.3-27.2	53.2-64.3	23.8-28.7	75.0-84.9	33.5-37.9	74.3-82.9	33.2-37.0
Average	71.0	31.7	71.9	32.1	91.6	40.9	88.3	39.5
SD	7.8	3.5	6.4	2.9	5.3	2.4	4.6	2.1
N	310		126		275			

Adapted from Szymanski and colleagues

# HITTING PERFORMANCE TESTING

**Force Plate data: Peak Power, GRF, Center of Pressure for Feet, EccRFD, Concentric Impulse, Contraction Time, RSI modified, Rate of Unloading**



Katsumata, 2007

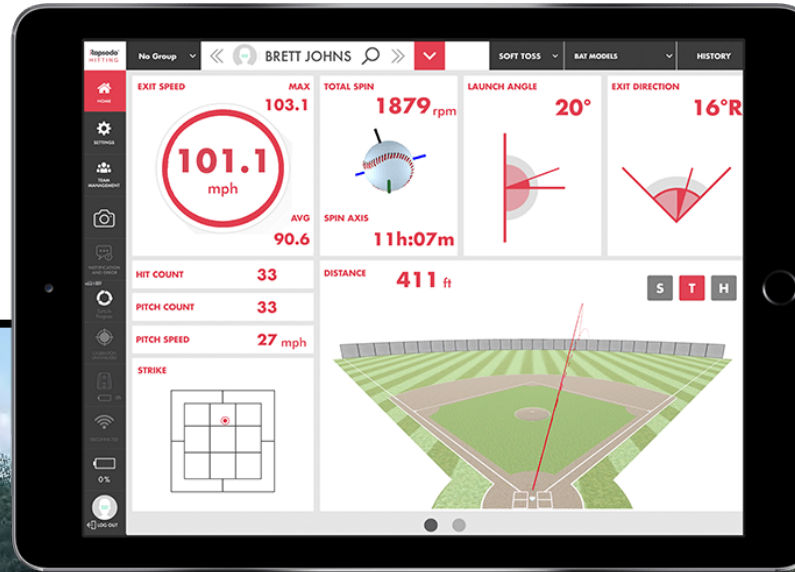
## Reasons for tests

- Relate to bat velocity & batted-ball exit velocity
- Relate to offensive hitting performance (e.g., HR, OBP, SLG%, OPS, XBH, RBI, WAR, BABIP, ISO power) & hitting sensor metrics

# HITTING PERFORMANCE TESTING

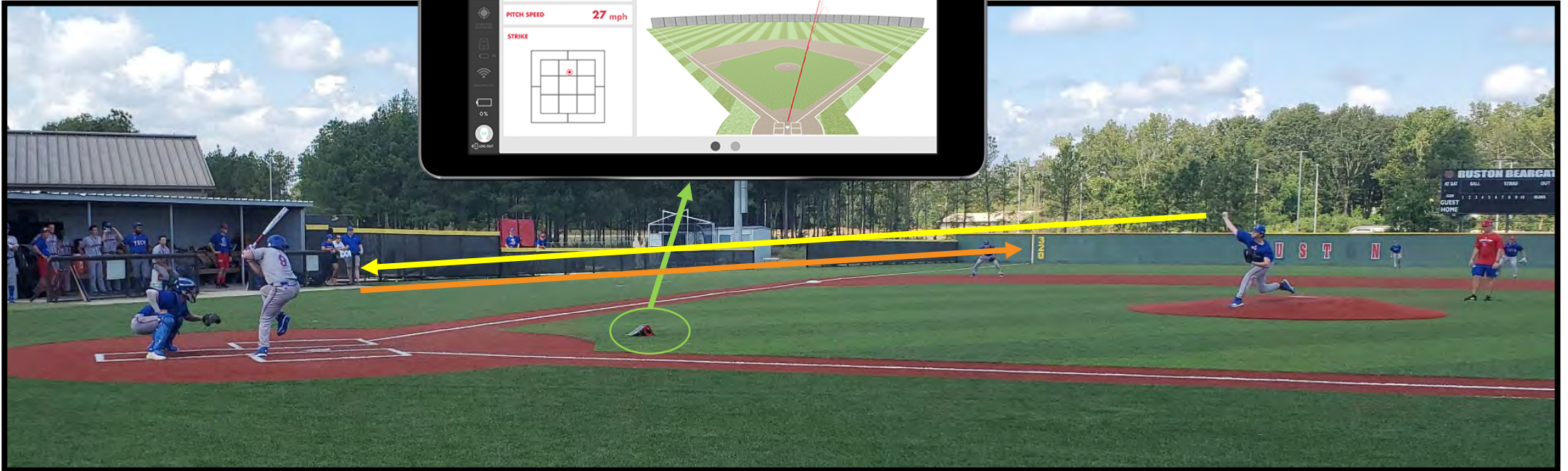
## Hitting Sensor Metrics

Rapsodo.com



## Reasons to test

- Relate to offensive hitting performance (e.g., HR, OBP, SLG%, OPS, XBH, RBI, WAR, BABIP, ISO power)



# Hitting Sensor Metrics

## Rapsodo HITTING

### 1 RAPSODO HITTING METRICS: MEDIANS BY AGE GROUP

Live/BP

AGE GROUP	EXIT VELO	LAUNCH ANGLE	SPIN (RPM)	DISTANCE (FEET)
MLB	90.5	14.8	1898	210.4
COLLEGE	81.0	15.6	2013	165.8
18U	78.7	16.1	1913	159.6
16U	72.2	15.4	1856	140.5
14U	66.3	15.9	1998	126.0
12U	57.0	16.3	1963	100.7

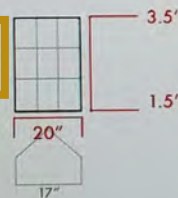
Soft Toss

AGE GROUP	EXIT VELO	LAUNCH ANGLE	SPIN (RPM)	DISTANCE (FEET)
MLB	90.3	14.2	1555	210.3
COLLEGE	83.8	15.6	1580	180.1
18U	77.7	17.4	1451	182.7
16U	72.8	16.9	1430	158.0
14U	64.5	16.4	1665	131.9
12U	53.3	17.1	1581	100.2

Tee

AGE GROUP	EXIT VELO	LAUNCH ANGLE	SPIN (RPM)	DISTANCE (FEET)
MLB	83.4	9.4	1280	137.3
COLLEGE	73.7	11.3	1194	118.7
18U	71.3	10.7	1203	115.9
16U	68.6	12.3	1242	115.2
14U	62.2	11.8	1238	98.4
12U	51.2	15.6	1180	89.5

### 7 STRIKE ZONE



### 2 RECORD VIDEO

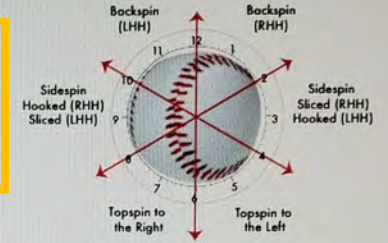
Point and shoot slow-mo video directly from the Rapsodo iPad application, including data overlay and auto-cropping.

### 3 3D SPINNING BALL



### 4 SPIN DIRECTION

Rotation of the ball shown on clock representation (Hour:Minute)



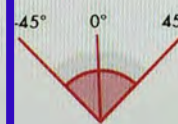
### 5 SPIN RATE (RPM)

SPIN RATE	RESULT
<700	Ball was squared up resulting in a knuckleball-type ball flight
<1500	Squared up, little spin induced effect to the ball flight
1500-2500	Ideal amount of backspin to create distance as balls will generally still carry a high exit velocity
1500-3500	Typically see a dip in exit velocity at this spin rate because too much of the hit went to the spin and not the exit velocity. Not impossible to create distance, but likely to reduce exit velocity so balls will not travel as far, even with the extra spin induced carry.
>3500	Miss hit creating too much back spin resulting in lower exit velocity and carry.



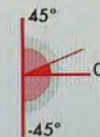
### 9 EXIT DIRECTION

Ball path shown by exit direction degree. The right side of the field is positive and the left side of the field is negative.



### 10 LAUNCH ANGLE

The degree of angle the ball leaves the bat. Positive represents elevated balls and negative represents a ball hit towards the ground.



### 8 3D BALL FLIGHT

Dashed line shows ball path with no spin related movement. Solid line is actual ball path.

### 6 SESSION TYPE

Inbound velocity classifications

HIT PLACEMENT	INBOUND VELOCITY (MPH)
Tee	0
Soft Toss	<30
Live/BP	30+

Rapsodo.com

RAPSODO.COM



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# 3D MOTION CAPTURE

## 3D Markerless Motion Capture System data



Kinatrax.com

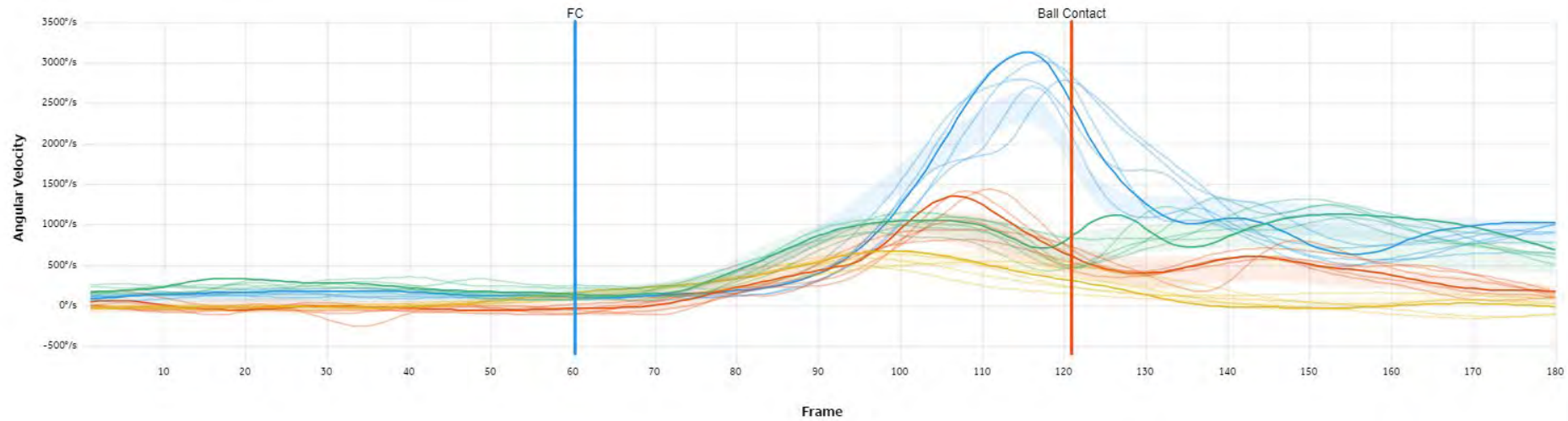


### Reasons to test

- Relate to offensive hitting performance (e.g., HR, OBP, SLG%, OPS, XBH, RBI, WAR, BABIP, ISO power) & hitting sensor metrics
- Use information to make decisions about possibly changing hitting mechanics or to support good mechanics



Kinematic Sequence



Pelvis		Trunk		Front Arm		Bat		
Peak	Timing (FC to Max Pelvis)	Peak	Timing (Max Pelvis to Trunk)	Peak	Timing (Max Trunk to Front Arm)	Peak	Timing (Max Arm to Bat)	Timing (Max Bat to BC)
682 °/s	103 ms	1354 °/s	27 ms	1058 °/s	-13 ms	3129 °/s	40 ms	20 ms



3D Playback

Camera 1



1 2 3 4 5 6 7 8

Camera 2



1 2 3 4 5 6 7 8

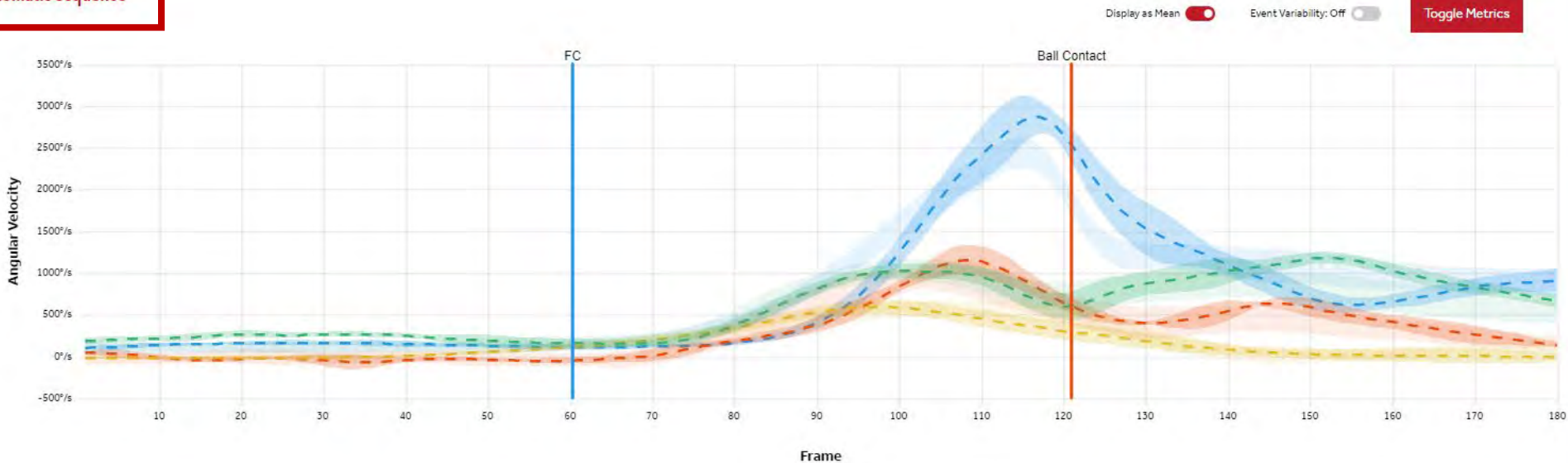
Kinatrax.com

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KINEMATIC SEQUENCE

Kinematic Sequence



Pelvis		Trunk		Front Arm		Bat		
Average Peak	Average Timing (FC to Max Pelvis)	Average Peak	Average Timing (Max Pelvis to Trunk)	Average Peak	Average Timing (Max Trunk to Front Arm)	Average Peak	Average Timing (Max Arm to Bat)	Average Timing (Max Bat to BC)
610°/s	127 ms	1173°/s	32 ms	1052°/s	-24 ms	2931°/s	52 ms	15 ms

3D Playback

Camera 1

Camera 2

1 2 3 4 5 6 7 8

1 2 3 4 5 6 7 8

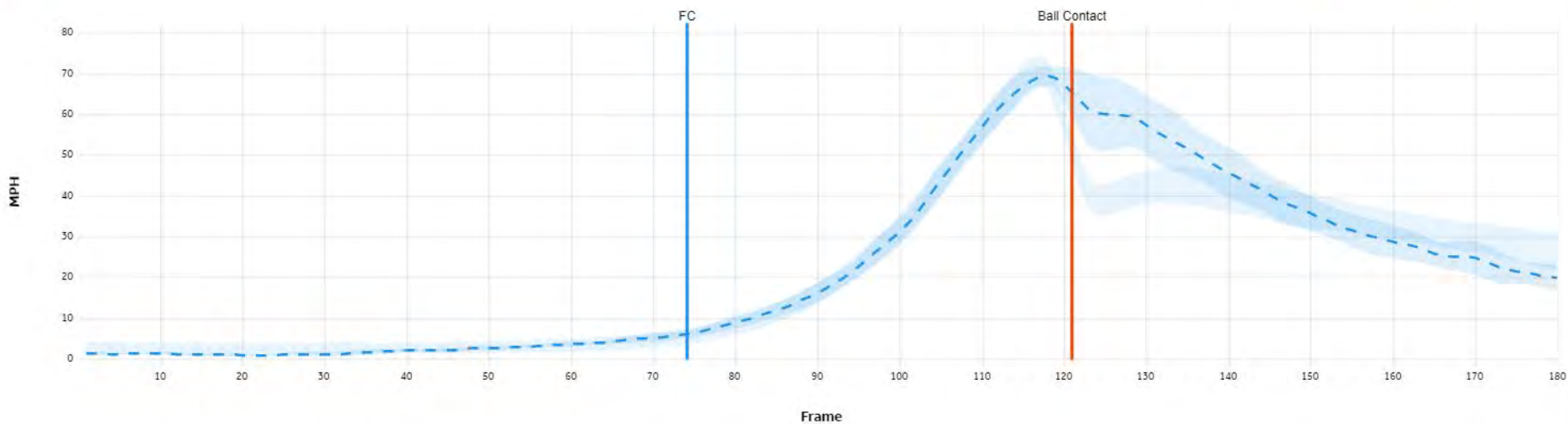
Kinatrax.com



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Bat Speed



DISCRETE METRICS ^

	Control Data Mean (SD)	Mean
Max Bat Speed (mph)	70.9 (3.5)	70.3
Timing - Max Bat Speed to BC (ms)	20.9 (4.8)	18.3

1/16 1/8 1/4 1/2 1

3D Playback

Camera 1

1 2 3 4 5 6 7 8

Camera 2

1 2 3 4 5 6 7 8

Kinatrax.com

# 2D MOTION CAPTURE

## PLANE • CONNECTION • ROTATION

SWING METRICS: IDEAL RANGES

On Plane Efficiency %	Rotational Acceleration	Early Connection	Connection at Impact
70% or Higher Range: 65% - 85%	Score above 50 for your level of play	90° (Perpendicular) Range: 80° - 105°	90° (Perpendicular) Range: 80° - 95°



### Connection Notes

- Ideal for Early Connection and Connection at Impact to be relatively the same. Up to a 15° difference between the two is acceptable, however generally the closer the better.
- It is generally ok for hitters to not be exactly 90°, especially if both of their connection metrics are the same.

## PLANE • CONNECTION • ROTATION

IMPACT METRICS: IDEAL RANGES

Level	Pro	MLB	College	High School Varsity	High School JV	Middle School	Youth
Bat Speed	66 - 78 MPH	63 - 75 MPH	66 - 75 MPH	60 - 70 MPH	53 - 67 MPH	46 - 62 MPH	40 - 56 MPH
Attack Angle	5° to 15°	3° to 15°	2° to 15°	2° to 13°	0° to 15°	0° to 15°	0° to 15°
Vertical Bat Angle *	-10° to -40°	-10° to -40°	-10° to -40°	-10° to -40°	-10° to -40°	-10° to -40°	-10° to -40°
Time to Contact	0.13 - 0.17 seconds	0.13 - 0.17 seconds	0.14 - 0.16 seconds	0.15 - 0.18 seconds	0.15 - 0.20 seconds	0.16 - 0.21 seconds	0.17 - 0.23 seconds
Peak Hand Speed	23 - 29 MPH	22 - 28 MPH	21 - 24 MPH	19 - 22 MPH	19 - 25 MPH	18 - 24 MPH	17 - 23 MPH
Power kW	3.65 - 5.65 kilowatts	3.20 - 5.20 kilowatts	3.83 - 5.08 kilowatts	2.81 - 4.09 kilowatts	1.75 - 3.75 kilowatts	1.40 - 3.20 kilowatts	0.90 - 2.50 kilowatts

\* Pitch location specific



### Reasons to test

- Relate to offensive hitting performance (e.g., HR, OBP, SLG%, OPS, XBH, RBI, WAR, BABIP, ISO power) & hitting sensor metrics
- Use information to make decisions about possibly changing hitting mechanics or to support good mechanics

Blastmotion.com

David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNCSA  
Baseball Performance Testing & Assessment



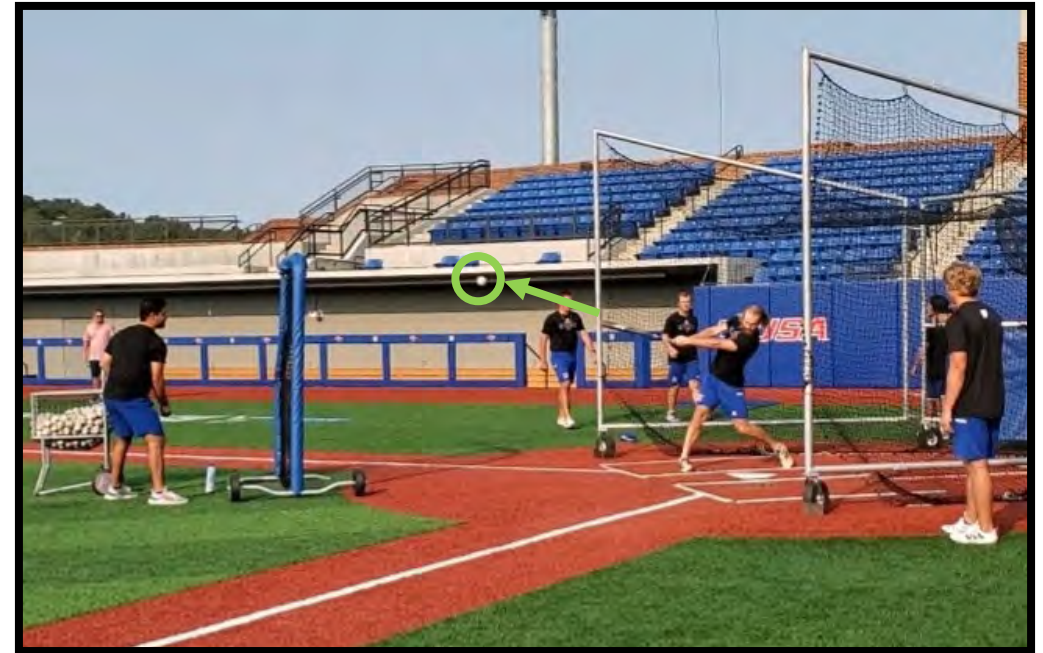
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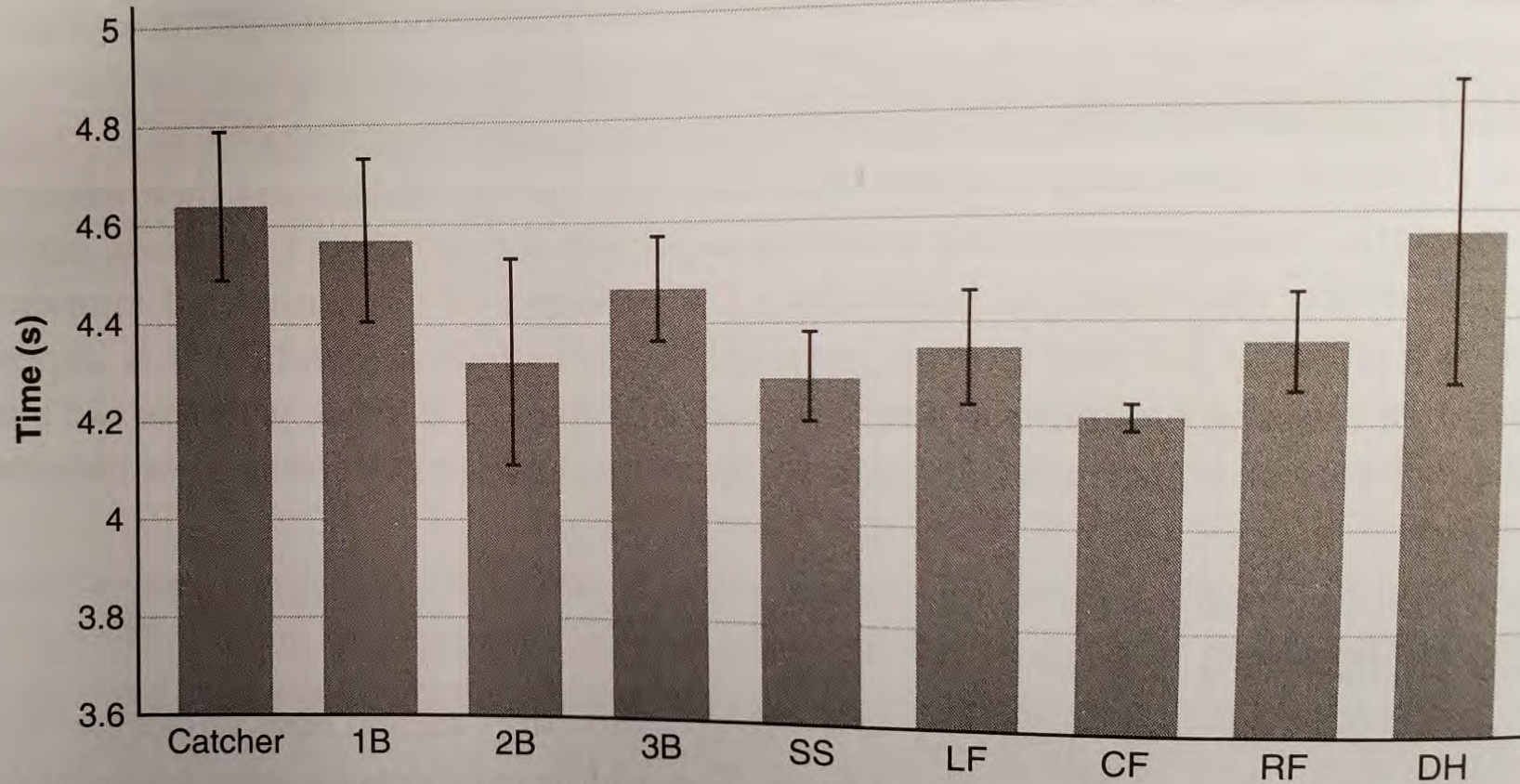
# BASEBALL-SPECIFIC SPEED TESTING

## Home to 1<sup>st</sup> Base Running Time after Bunt & Swing

### Reasons for tests

- Identifies speed to 1<sup>st</sup> base
- Relate 10, 30, 60 yd times to baserunning speed to 1<sup>st</sup> base & other bases





**Figure 2.4** Average electronic times from home plate to first base by MLB position in 2019.

Coleman & Amonette, 2022

### Cole McConnell

Height (in) 72.5  
 Weight (lb) 193  
 Body Comp. 8.9%  
 Position Outfield



### Strength Testing

1RM Squat	1RM Bench	1RM Row
390	230	125

### Upper Body Power

MB Hitter Throw	OH MB Toss	Grip Strength
33.7	33.1	72

### Lower Body Power

Vert	VJ Drive Leg	VJ Stride Leg
30	21.50	24.50
Long Jump	Lat.Jump (dr.)	Lat.Jump (str.)
111.5	87.8	87.5

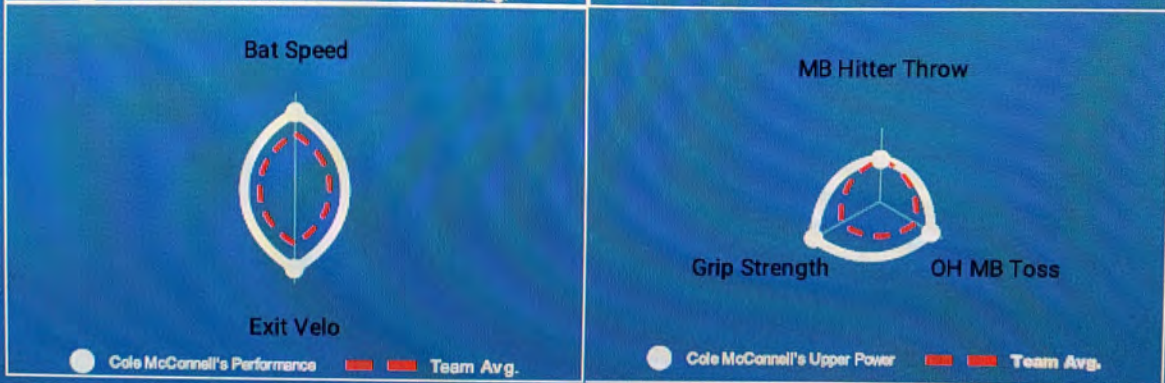
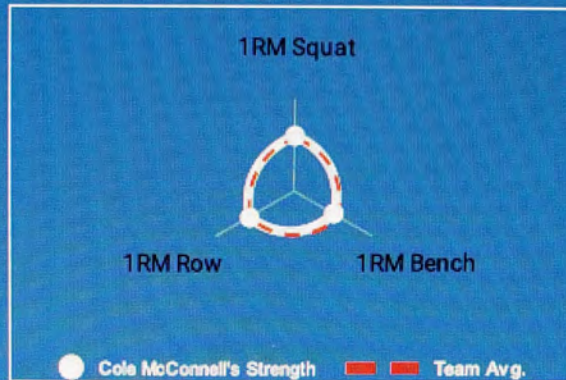
### Sprint / Agility

Home to 1st	Pro Agility	Curvilinear Ag.
4.3	4.42	7.07
	1.5 Mi Run	N/A

### Performance Data

Pitcher Velo	Bat Speed	Exit Velo
	79.7	94

## Testing Fall 2022



# BASEBALL PERFORMANCE TESTING & ASSESSMENT

## Basic Tests to Perform

1. Height & Body mass
2. Strength
  - Back squat
  - 1-Arm DB or LM row
  - BB or DB bench press
3. Arm isometric strength
4. Power
  - 2 & 1-Leg vertical jump – estimate PP
  - Standing long jump – estimate PP
  - OH MB throw
  - MB hitter's throw
5. Speed
  - 10-30-60 yd sprint
  - Home to 1<sup>st</sup> base – bunt & swing
6. Agility
  - 5-10-5
7. Aerobic Capacity
  - 1.5 mile run - pitchers

## Advanced Tests to Perform

1. Body composition & hydration status
2. Strength
  - Grip
  - Pinch
3. Arm isokinetic strength
  - Shoulder
  - Forearm
  - Wrist
4. Power
  - 2 & 1-Leg vertical jump from force plates
  - Drive & stride leg forces – pitcher
  - Back & stride leg forces – hitter
5. 2D & 3D motion capture – pitching & hitting
6. Aerobic capacity
  - VO<sub>2</sub> – while pitching
  - VO<sub>2</sub>max
7. Blood lactate – before and after pitching
8. Pitching & Hitting metrics

# CONCLUSION

- With the limited time that athletes are available
  - It is important to know which tests to select and why
- Tests presented in this presentation are some tests that you could perform
  - You can select tests based on your experience or preference
- Although various variables may be correlated with baseball performance at different levels (HS, college, or professional)
  - Research has not consistently found which tests are most important
- Just because an athlete is physically superior at performing many of the tests
  - Does not mean that the athlete will be a great baseball player
- However, if an outstanding baseball player performs some or all tests well
  - They may have the appropriate performance & baseball skills to become a professional player

# CONCLUSION

- **Recommendations**: Perform the most common tests for baseball players
  - Lower and upper body strength
  - Lower body power
  - Speed
  - Agility
- These tests will provide a foundation from which to:
  - Build a resistance training & conditioning program
  - Objectively evaluate your players
- Generally, the tests should be:
  - Practical
  - Easy to perform
  - Meaningful to coach, players, and organizations
- Selection of players should not be made solely on test results
  - Test results do not predict baseball success

# BASEBALL PERFORMANCE TESTING & ASSESSMENT

## References

1. *ACSM's Guidelines for Exercise Testing and Prescription*. 9<sup>th</sup> ed. Pescatello, LS, D. Sr. Ed. Wolters Kluwer, Philadelphia, PA. 2014. pp. 60-113.
2. [Blastmotion.com/products/baseball/](https://blastmotion.com/products/baseball/)
3. Coleman, AE and Amonette, WE. Analysis of the sport and sport positions. In: *Strength Training for Baseball*. Coleman, AE and Szymanski, DJ, eds. Human Kinetics. Champaign, IL. 2022. pp. 11-30.
4. Cook, G, Burton, L, Hoogenboom, BJ, and Voight, M. Functional movement screening: The use of fundamental movements as an assessment of function – Part I. *Int J Sports Phys Ther* 9(3): 396-409, 2014.
5. Cook, G, Burton, L, Hoogenboom, BJ, and Voight, M. Functional movement screening: The use of fundamental movements as an assessment of function – Part II. *Int J Sports Phys Ther* 9(4): 549-563, 2014.
6. Harman, EA, Rosenstein, MT, Frykman, PN, Rosenstein, RM, and Kraemer, WJ. Estimation of human power output from vertical jump. *J Appl Sport Sci Res* 5(3): 116-120, 1991.
7. Katsumata, H. A functional modulation for timing a movement: A coordinative structure in baseball hitting. *Human Mov Sci* 26: 27-47, 2007.
8. [Kinatrax.com](https://kinatrax.com)
9. Mann, JB, Bird, M, Signorile, JF, Brechue, WF, and Mayhew, JL. Prediction of anaerobic power from standing long jump in NCAA Division IA football players. *J Strength Cond Res* 35(6): 1542–1546, 2021.
10. Martínez-Rodríguez, J, Ramírez-Marrero, F, Martínez-Colón, L, and Rodríguez-Torres, J. Relación entre agilidad específica y fuerza reactiva en el deporte del béisbol [Master's Thesis]. University of Puerto Rico, Rio Piedras Campus, San Juan, PR, 2021.
11. Mayberry, J, Mullen, S, and Murayama, S. What can a jump tell us about elbow injuries in professional baseball pitchers? *Amer J Sports Med* 48(5): 1220-1225, 2020.
12. McGuigan, M. Administration, scoring, and interpretation of selected tests. In: *Essentials of Strength Training and Conditioning*. 4<sup>th</sup> edition. Haff, GG & Triplett, NT, eds. Human Kinetics, Champaign, IL. 2016. pp. 259-316.
13. McGuigan, M. Principles of test selection and administration. In: *Essentials of Strength Training and Conditioning*. 4<sup>th</sup> edition. Haff, GG & Triplett, NT, eds. Human Kinetics, Champaign, IL. 2016. pp. 249-258.



# BASEBALL PERFORMANCE TESTING & ASSESSMENT

## References

14. Newsham, KR, Keith, CS, Saunders, JE, and Goffinett, AS. Isokinetic profile of baseball pitchers' internal/external rotation 180, 300, 450 degrees·s<sup>-1</sup>. *Med Sci Sport Exerc* 30 (10): 1489-1495, 1998.
15. Sayers, SP, Harackiewicz, DV, Harman, EA, Frykman, PN, and Rosenstein, MT. Cross-validation of three jump power equations. *Med Sci Sports Exerc* 31: 572–577, 1999.
16. Szymanski, DJ, Garcia, AS, and Qiao, M. Relationship of pinch and grip strengths on velocity and spin variables of different pitch types by collegiate baseball pitchers. Online Poster Presentation. National Strength and Conditioning Association's National Conference, Orlando, FL. July 8, 2021.
17. Szymanski, D, Qiao, M, Singh, V, and Szymanski, J. Correlation of power to fastball velocity of collegiate baseball pitchers. *J Strength Cond Res* 36(4): e192-193, 2021.
18. Szymanski, DJ, Qiao, M, Szymanski, JM, and Crotin, RL. Relationships between lower body power and fastball velocities amongst collegiate baseball pitchers. Poster Presentation. National Strength and Conditioning Association's National Conference, New Orleans, LA. July 8, 2022.
19. Szymanski, DJ, Szymanski, JM, Ortiz, PA, Cloud, DM, and Crotin, RL. Relationship between stature, body composition, and absolute and relative strength and power to fastball velocity among collegiate baseball pitchers. Online Poster Presentation. National Strength and Conditioning Association's National Conference, Orlando, FL. July 9, 2021.
20. Szymanski, DJ and Vazquez, J. Testing protocols and athlete assessment. In: *Strength Training for Baseball*. Coleman, AE and Szymanski, DJ, eds. Human Kinetics. Champaign, IL. 2022. pp. 31-64.
21. [Twitter.com/rapsodo/status/1141420018430877697/photo/2](https://twitter.com/rapsodo/status/1141420018430877697/photo/2)
22. Warren, CD, Szymanski, DJ, and Landers, MR. Effects of three recovery protocols on range of motion, heart rate, rating of perceived exertion, and blood lactate in baseball pitchers during a simulated game. *J Strength Cond Res* 29(11): 3016-3025, 2015.



# BASEBALL PERFORMANCE STAFF



Vishesh Singh, Jessica Szymanski, David Szymanski, Austin Reedy, Chris Watson, & Elise Bordlee

David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNSCA  
*Baseball Performance Testing & Assessment*



# STRENGTH TRAINING FOR BASEBALL



Foreword by  
**NOLAN RYAN**

**A. Eugene Coleman | David J. Szymanski**  
EDITORS



David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNSCA  
*Baseball Performance Testing & Assessment*

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[www.latechsportsscience.org](http://www.latechsportsscience.org)

<https://www.linkedin.com/in/dr-david-szymanski-42598832/>

<https://www.researchgate.net/profile/David-Szymanski-2>

David J. Szymanski, PhD, CSCS\*D, RSCC\*E, FNSCA  
*Baseball Performance Testing & Assessment*



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