DIVISION III BASEBALL AND SOFTBALL PLAYERS HITTING PERFORMANCE CORRELATION WITH JUMP AND STATIC STRENGTH METRICS

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ABSTRACT

For softball and baseball batters, the ability to consistently hit the ball with high speed increases the chance of being successful, i.e. base hits and more importantly in the game, extra base hits. But what leads to high batted-ball speed, also known as “exit velocity,” is a combination of skill/technique, sensorimotor abilities, as well as neuromuscular characteristics. PURPOSE: The purpose of this study was to determine if specific metrics from the countermovement jump (CMJ) and isometric mid-thigh pull (IMTP) could be predictors to competitive baseball and softball hitting performance. METHODS: NCAA Division III baseball and softball hitters (n=31; 15 baseball players and 16 softball players) participated in this study, reporting to the lab on two non-consecutive days. On day one, each participant competed three maximal CMJ and IMTP attempts on force plates (Hawkin Dynamics, Westbrook, ME) The metrics analyzed for the CMJ were Max Jump Height (MJH), Average Jump Height (AJH), Reactive Strength Index-Modified (mRSI), Peak Propulsive Power (PPP), Braking Rate of Force Development (bRFD), and Positive Impulse (PIM). The metrics collected from the IMTP were Max Peak Force (MPF), Average Peak Force (APF), Rate of Force Development 0-50ms (RFD0-50), Impulse 0-50ms (IMP0-50), and Relative Peak Force (RPF). On day two, hitting metrics were collected during team batting practice using a radar-based technology (Trackman, Scottsdale, AZ) with the primary metrics collected being average and maximum batted-ball exit velocity (AEV and MEV), and average and maximum distance (AD and MD). Pearson product moment correlations and multiple linear regressions were utilized to examine the relationships between neuromuscular characteristics and batted-ball performance. RESULTS: Analysis displayed significant predictive values between all neuromuscular metrics and both MEV and AEV ($p < 0.001$). Out of all the metrics, the qualities that displayed the highest r2 values to MEV and AEV were PPP (0.83), MPF (0.77), and RFD0-50 (0.70). CONCLUSION: Specific kinematic and kinetic metrics from the CMJ and IMTP were significant predictors to hitting performance in collegiate softball and baseball players. It is important for sports performance professionals to train hitters to increase neuromuscular force and power, specifically rate of force production. Future research is warranted to extend the kinetic metrics examined for predicting hitting performance, as well as using data from more game-like performance, such as live scrimmages and games as successful hitting is highly cognitive and not purely technical and neuromuscular.

INTRODUCTION

Research in sports science and biomechanics have shown that hitting a baseball or softball with greater velocity significantly reduces defenders' reaction time and increases the likelihood of reaching base safely (4). The energy necessary for a powerful hit is generated through the kinetic chain, transferring energy from the ground up through the body (1). General total-body strength, specifically strength in torso rotation, achieved through the sequential recruitment of large muscles from the legs to the hips and torso, plays a crucial role in increasing bat speed velocity (2, 5). Additionally, sensory-motor skills such as hand-eye coordination and reaction time are essential for identifying pitch trajectories and making split-second adjustments (3). Hitting involves a combination of understanding of biomechanics, visual motor abilities neuromuscular characteristics of force and power, for hitters to improve bat speed, make solid contact with the ball to enhance their performance on the diamond.

PURPOSE & HYPOTHESIS

The purpose of this study was to profile softball and baseball players jump and static strength metrics, then correlate their neuromuscular performance with their batted-ball exit velocity hitting metric. It was hypothesized that specific jump and static strength metrics will be predictors of hitting performance.

The data will provide information about the physicality of athletes, to help potentially be a tool to profile baseball/softball hitters in the future.

METHODS

- 31 NCAA Division III varsity Softball and Baseball players

	Softball (n = 16)	Baseball (n = 15)
Age	20.46 ± 1.10 years	20.76 ± 1.34 years
Weight	76.68 ± 14.56 kg	86.28 ± 9.85 kg
Height	168.81 ± 6.02 cm	182.11 ± 8.08 cm

- Approval of utilizing humans as subjects approved by IRB prior to data collection
- Read and signed an informed consent form approved by institution IRB

- Uniaxial, dual force plate system (Hawkin Dynamics, Westbrook, ME; Figure 1)
- Triaxial force plate system (Bertec, Columbus, OH and Hawkin Dynamics, Westbrook, ME; Figure 2)
- Optical radar technology (Trackman, Scottsdale, AZ; Figure 3)

- Standardized dynamic warm-up.
- 3 maximum CMJ with hands on hips, with 20 seconds of rest between trials (Figure 1)
- 3 maximal IMTP, with 20 seconds of rest between trials (Figure 2)

- On a separate day, batted-ball trajectory data was collected during batting practice using Trackman (Figure 3)
- Data from 50 batted balls from each baseball and softball subject was collected (traditional front-toss/overhead pitched batting practice)

Data Analysis

CMJ Metrics:	IMTP Metrics:	Hitting Metrics:
Max Jump Height (MJH)	Max Peak Force (MPF)	Average Exit Velocity (AEV)
Average Jump Height (AJH)	Average Peak Force (APF)	Max Exit Velocity (MEV)
Reactive Strength Index-Modified (mRSI)	Rate of Force Development 0-50ms (RFD0-50)	Average Distance (AD)
Peak Propulsive Power (PPP)	Impulse 0-50ms (IMP0-50)	Max Distance (MD
Braking Rate of Force Development (bRFD)	Relative Peak Force (RPF)	
Positive Impulse (PIM)		

Table 1: Specific metrics collected. Data was analyzed using Pearson Product Moment Correlation and Multiple Linear Regression.

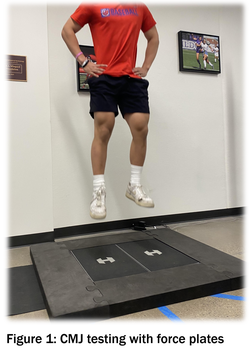

Figure 1: CMJ testing with force plates

Figure 2: IMTP testing with force plate

Figure 3: Trackman set-up during on-field batting practice

RESULTS

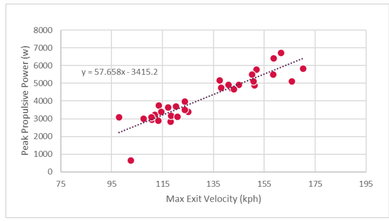

Figure 4: Max Exit Velocity (kph) and Peak Propulsive Power (W) from CMJ
$r^2 = 0.83$, $p < 0.01$

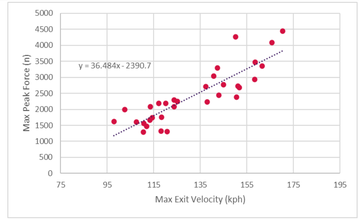

Figure 5: Max Exit Velocity (kph) and Max Peak Force (N) from IMTP
$r^2 = 0.77$, $p < 0.01$

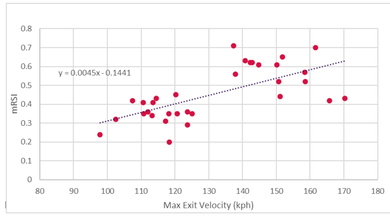

Figure 6: Max Exit Velocity (kph) and Reactive Strength Index-Modified from CMJ
r2 = 0.45, p < 0.01

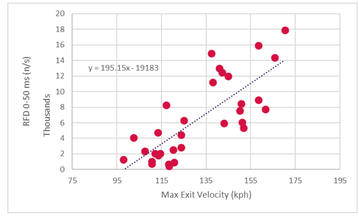

Figure 7: Max Exit Velocity (kph) and RFD 0-50 ms (N/s) from IMTP
r2 = 0.70, p < 0.01

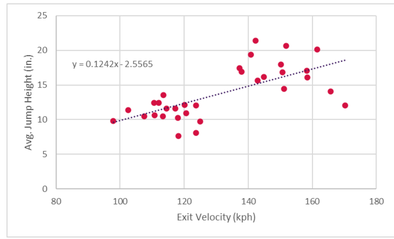

Figure 8: Average Exit Velocity (kph) and Average Jump Height from CMJ
r2 = 0.45, p < 0.01

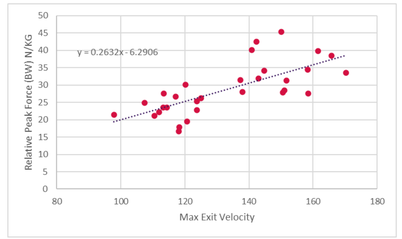

Figure 9: Max Exit Velocity (kph) and Relative Peak Force (N/kg) from IMTP
r2 = 0.51, p < 0.01

CONCLUSIONS & PRACTICAL APPLICATIONS

There are several kinematic and kinetic metrics from the CMJ and IMTP that displayed significant predictive modeling to hitting performance in collegiate softball and baseball players. Specifically, power output and rate of force development could be used to profile hitters as they strongly relate to batted-ball exit velocity.

It is important for strength and conditioning professionals to train hitters to be able to increase power more specifically rate of force development. Programming exercises that involve maximal jumping, plyometrics, static strength, and rapid force production could create neuromuscular adaptations that lead to batted balls being hit faster and harder. In addition, training to increase force production, both absolute and in respect to an athlete’s body mass, should be considered, if the ultimate goal is to maximize the exit velocity of a batted-ball.

Future research is warranted to extend to the kinetic metric to hitting performance, More specifically using data from game-like performance, such as scrimmages and games. Hitting a baseball or softball is more than technical and neuromuscular, there is a very high cognitive factor into becoming a successful hitter.

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