RELATING THE COUNTERMOVEMENT JUMP, BROAD JUMP, AND FLYING-10 SPRINT TO FASTBALL VELOCITIES OF NCAA DIII PITCHERS

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ABSTRACT

Throwing velocity in pitchers across all levels continues to increase with the advancements in training techniques and training methods for pitchers. It is useful to conduct field tests that do not require the same exertion of throwing a pitch at maximal intent, but to quantify athleticism and collect data that could predict pitching performance. A variety of field tests, such as the countermovement jump (CMJ), the broad jump (BJ), and the flying 10-yard sprint (F10) are commonly used to assess athleticism. **PURPOSE:** The purpose of this study was to determine if both kinematics and kinetics of the BJ, CMJ, and sprint performance were effective predictors of average pitching velocity and peak pitching velocity in baseball pitchers. **METHODS:** 14 NCAA DIII pitchers (age: 20.2 ± 1.1 yr, body mass: 82.2 ± 6.9 kg, height: 184.5 ± 7.6 cm) performed three maximal CMJ and three maximal BJ on a force plate. (Hawkin Dynamics; Westbrook, Maine). They also completed two trials of a F10 sprint using timing gates (Microgate, Bolzano, Italy), and pitched during live game action. The specific metrics collected from the CMJ were jump height (JH), braking rate of force development (BRFD), average relative propulsive force (ARPF), relative propulsive impulse (RPI), peak power output (PPO), jump momentum (MO), and countermovement depth (CD). The specific metrics collected from the BJ were jump distance (JD), horizontal force (Fx), and vertical force (Fz). Sprints were collected as time (seconds). CMJ, BJ, and F10 metrics were then correlated to each pitcher's average fastball velocity and peak fastball velocity during the game. A correlation coefficient was used to examine any relationships between the metrics and pitching, as well as linear regressions to investigate predictive qualities between the metrics and pitching. **RESULTS:** No correlations were deemed as moderate-to-high relationships across any of the metrics and pitching. No significant linear regression analyses were reported to be predictor qualities of pitching. **CONCLUSIONS:** The field tests chosen in this study had no relationship or predictive qualities to game performances in NCAA DIII pitchers. In addition, the metrics from this study were not able to discriminate performance within this specific population. **PRACTICAL APPLICATIONS:** While metrics from jumping and sprinting still have importance in quantifying athleticism and monitoring training programs, they could not be used to predict game performance in this population. There are many other factors that go into pitching effectively in games. Breaking down both the physical and cognitive side of pitching and continuing to quantify those aspects could uncover the deeper layers of what is considered top pitching. Finally, future directions would be to investigate if the data from this study could be beneficial to separate pitchers across different levels of competitive play (i.e. pros, DI, DII, DIII, high school, etc.)

INTRODUCTION

As the fastball velocity of baseball pitchers continues to climb across all levels of the sport (2), there is a growing need to develop reliable and non-intrusive methods for predicting this crucial skill without necessitating actual pitching. This approach would offer a safe and efficient means of evaluating baseball pitchers (4). With advancements in training techniques and methods, it has become valuable to utilize field tests that assess athleticism and gather data that can potentially forecast pitching performance (1). Commonly employed tests like the countermovement jump (CMJ), broad jump (BJ), and flying 10-yard sprint (F10) serve this purpose effectively.

PURPOSE & HYPOTHESIS

The objective of this research was to investigate whether the kinematics and kinetics of the BJ, CMJ, and F10 could reliably predict the average pitching velocity and peak pitching velocity in baseball pitchers. It was hypothesized that CMJ, BJ, and F10 would be efficient predictors of FB velocity in baseball pitchers.

METHODS

Subjects

- 14 NCAA Division III baseball pitchers
  - age: 20.2 ± 1.1 yr, body mass: 82.2 ± 6.9 kg, height: 184.5 ± 7.6 cm
- Read and signed an informed consent approved by institution IRB prior to participation
- Approval of utilizing humans as subjects was approved by the IRB prior to any data collection

Instruments

- Bertec Triaxial Force Plate (Columbus, OH; Figure 1)
- Hawkin Dynamics software (Westbrook, MN; Figure 2)
- Witty Timer (Micrograte, Bolzano, Italy)

Pitching Data Collection

- At least 15 fastballs thrown during game-like situations (scrimmage)
- Average velocity and peak velocity were recorded (Stalker Pro 2 radar gun, Richardson, TX)

Data Analyses

- CMJ metrics collected were jump height (JH), braking rate of force development (BRFD), average relative propulsive force (ARPF), relative propulsive impulse (RPI), peak power output (PPO), jump momentum (MO), and countermovement depth (CD).
- BJ metrics collected were were jump distance (JD), horizontal force (Fx), and vertical force (Fz).
- Sprints were collected as time (seconds)
- Linear regressions were utilized to calculate predictive quality of jumping metrics and sprint times on fastball velocity.

Warm-Up

- 5 minutes in length.
- Standardized dynamic movements including jogging, back pedaling, high knees, glute kicks, quad stretch, hamstring stretch, walking lunges, and side lunges.

Athletic Testing Procedures

- Three maximal countermovement jumps (CMJ)
  - Hands on hips during entire duration of jump
  - Verbally instructed to squat down as fast and as far as needed to jump as high as they possibly can
  - Knees were required to stay extended, and feet directly under hips while airborne
- Three maximal broad jumps (BJ)
  - Athletes were allowed to utilize an arm swing
  - Verbally instructed to squat down as fast and as far as needed to jump as far anteriorly as they possibly could
  - Required to stick the landing without falling
- Three flying 10-yard (F10) sprint with a 20-yard roll in
  - Time spent to sprint the last 10 yards were recorded

Figure 1: Broad jump metrics were collected by jumping off a Bertec triaxial force plate, connected to Hawkin Dynamics software.

Figure 2: Countermovement jumps were collected through Hawkin Dynamics dual force plate system.

Figure 3: Average and peak pitching velocities were recorded during game-like situations, such as inter- and intra-squad scrimmages

RESULTS

PERFORMANCE METRICS	AVERAGE	STD. DEV.
AVERAGE FASTBALL SPEED (m/s)	37.39	1.31
PEAK FASTBALL SPEED (m/s)	38.19	1.28
COUNTERMOVEMENT JUMP HEIGHT (cm)	39.40	5.33
BROAD JUMP DISTANCE (m)	2.48	0.171
BROAD JUMP HORIZONTAL FORCE (N)	408.14	42.24
BRAKING RFD (N/s)	8047.86	2680.38
AVERAGE RELATIVE PROPULSIVE FORCE (%)	199.64	10.99
RELATIVE PROPULSIVE IMPULSE (N.s/kg)	5.61	0.33
CMJ PEAK POWER OUTPUT (W)	4582.71	680.18
FLYING-10 YARD SPRINTS (sec)	1.15	0.03

Table 1: Descriptive stats of variables collected

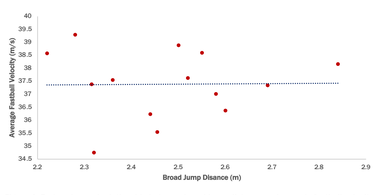

Figure 4: Regression and relationship between broad jump distance and average fastball velocity. $R^2 = 0.0002$, $p > 0.05$

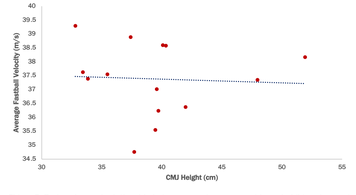

Figure 5: Regression and relationship between countermovement jump height and average fastball velocity. $R^2 = 0.003$, $p > 0.05$

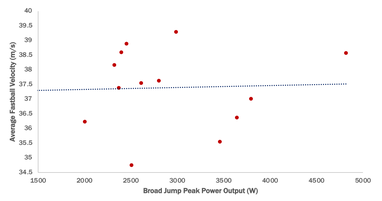

Figure 6: Regression and relationship between Broad Jump Peak Power Output and average fastball velocity. $R^2 = 0.02$, $p > 0.05$

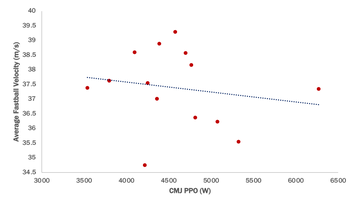

Figure 7: Regression and relationship between Countermovement Jump Peak Power Output and average fastball velocity. $R^2 = 0.0312$, $p > 0.05$

CONCLUSIONS & PRACTICAL APPLICATIONS

The selected field tests in this study exhibited no correlation or predictive capabilities concerning the game performances of NCAA DIII pitchers. Moreover, the metrics employed in this study failed to differentiate performance within this population.

While metrics related to jumping and sprinting still hold significance in quantifying athleticism and monitoring training programs (4), their utility in predicting game performance among this group is limited. Pitching effectively in games involves various other factors. Analyzing both the physical and cognitive aspects of pitching and consistently quantifying those elements could unveil the underlying factors contributing to elite pitching. Lastly, future investigations could explore whether the findings of this study can be advantageous in distinguishing pitchers across different competitive levels (e.g., professionals, DI, DII, DIII, high school, etc.).

REFERENCES

1. Huang, J. H., Chen, S. H., & Chiu, C. H. (2022). Correlation of pitching velocity with anthropometric measurements for adult male baseball pitchers in tryout settings. *Plos one*, *17*(3), e0265525.
2. Caldwell, J. M. E., Alexander, F. J., & Ahmad, C. S. (2019). Weighted-ball velocity enhancement programs for baseball pitchers: a systematic review. *Orthopaedic Journal of Sports Medicine*, *7*(2), 2325967118825469.
3. Lis, R. (2021). *Relationship Between Jump Tests and Their Influence on Multidirectional Ground-reaction Forces in Baseball Pitchers* (Doctoral dissertation, Louisiana Tech University).
4. Sakurai, M., Szymanski, D. J., Qiao, M., & Crotin, R. L. (2023). Combined Countermovement Jump Testing and Motion Analysis as the Future of Performance Assessment for Baseball Pitchers: A Narrative Review. *Journal of Strength and Conditioning Research*, *37*(6), 1327-1338