Novel Translation of Countermovement Jump Force-Time Characteristics: Dynamic Force, Power, and Velocity Ratios

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PURPOSE

The purpose of this study was to develop and examine the relationship between a novel method for evaluating stretch shortening cycle efficiency during the countermovement vertical jump (CMJ) and impulse ratio (IR).

METHODS

- 78 NCAA Division-II athletes participated in this study as part of normal performance testing. Athletes from the university's American football, men's basketball, women's basketball, women's golf, women's soccer, and women's volleyball teams' CMJ data were analyzed.
- Following a standardized dynamic warm-up, athletes performed 2-4 CMJs without an arm swing. Data was collected at 1,000 Hz using a Hawkin Dynamics uniaxial dual force plate system (Westbrook, ME, USE).
- Descriptive statistics and Pearson's r correlation coefficients were calculated to determine the relationship between dynamic force (avg. propulsive force/avg. braking force; DFR; Newtons), power (avg. propulsive power/avg. braking power; DPR; watts), and velocity (avg. propulsive velocity/avg. braking velocity; DVR; meters/second) ratios, CMJ kinematic and kinetic variables, as well as the impulse ratio (propulsive net impulse/braking net impulse; IR). The a priori alpha level was set at 0.05 for all analyses.

RESULTS

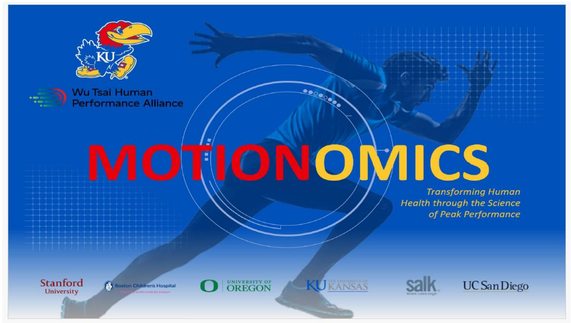
- Moderate to strong significant correlations were observed between DFR and IR (r=0.374, p<0.001), DPR and IR (r=-0.956, p<0.001), and DVR and IR (r=-0.943, p<0.001).
- Further significant relationships were observed between DFR (r=-0.395-0.506, p<0.001), DPR (r=-0.643-0.485, p<0.001), and DVR and CMJ kinematic variables (r=-0.665-0.809, p<0.001).
- However, no significant relationships were observed between DFR, DPR, DVR, or IR and CMJ height (r= -0.183 – 0.133, p = 0.435-0.250).

CONCLUSIONS

- Findings from this study provide evidence of a potential alternative to the IR that can be utilized to measure SSC efficiency, and translated into appropriate units for measures of force, power, and velocity.

PRACTICAL APPLICATIONS

- When athletic performance is considered, understanding how one portion of a movement directly transfers to another can provide practitioners with insight into movement efficiency and can support training approaches to optimize athletic preparation and performance.



The countermovement vertical jump is a criterion assessment of ***lower-body neuromuscular performance and fatigue*** within athletic populations. However, a ***translatable metric*** which assesses the efficiency of the stretch shortening cycle (where a muscle first lengthens and then immediately shortens to produce power) during a single dynamic plyometric task such as the CMJ is not currently available to the field. ***Dynamic ratios*** which evaluate propulsive (concentric) and braking (eccentric) characteristics during a single plyometric task could be ***utilized with others such as jump height, reactive strength index, and modified reactive strength index to more precisely evaluate performance*** and ***to more effectively compare athletes*** across competitive levels and sports.

Table 1. Descriptive statistics for jump height and jump strategy.

Group	JH (cm)	IR (au)	DFR (N)	DPR (W)	DVR (m/s)
American Football	55.2±10.0	2.4:-1.0	1.2:-1.0	2.5:-1.0	1.8:-1.0
Men's Basketball	41.4±5.0*	2.2:-1.0	1.1:-1.0	2.4:-1.0	2.1:-1.0
Women's Basketball	31.7±5.5*	2.4:-1.0	1.2:-1.0	2.5:-1.0	2.1:-1.0
Women's Golf	25.1±3.7*	6.5:-1.0	1.2:-1.0	1.7:-1.0	1.1:-1.0
Women's Soccer	33.2±5.1*	2.3:-1.0	1.2:-1.0	2.4:-1.0	1.9:-1.0
Women's Volleyball	30.3±4.5*	6.5:-1.0	1.2:-1.0	2.4:-1.0	1.7:-1.0

Note: JH = countermovement jump height; IR = impulse ratio; DFR = dynamic force ratio; DPR = dynamic power ratio; DVR = dynamic velocity ratio; * = significantly different when compared to American football ($p < 0.05$).

Table 2. Dynamic force, power, and velocity ratios among elementary school, middle school, high school, collegiate volleyball, and professional athletes originally calculated as braking metric/propulsive metric.

Athlete Classification	Dynamic Force Ratio (N)	Dynamic Power Ratio (W)	Dynamic Velocity Ratio (m/s)
Elementary	-1:1.1	-1:1.6	-1:1.5
Middle School	-1:1.2	-1:1.6	-1:1.5
High School	-1:1.2	-1:1.7	-1:1.5
NCAA Division-II Female Volleyball	-1:1.1	-1:1.6	-1:1.5
Professional Female Volleyball	-1:1.6	-1:1.8	-1:1.5
Professional Male Basketball	-1:1.6	-1:1.8	-1:1.6

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