Countermovement Jump Metrics and Injury Risk: Individualized Screening for Performance Optimization and Injury Reduction

Michael Toczko, Megan Sax van der Weyden, Yosef Shaul, Travis Lipscomb, Joel Martin
Sports Medicine Assessment Research & Testing (SMART) Laboratory, George Mason University, Manassas, VA

Introduction

Team sports (TS), require high levels of physiological adaptations to anaerobic and aerobic pathways for peak performance. The high physiological workloads associated with TS can lead to increased injury risks (IR). Thus, screening and monitoring athletes is common practice. The countermovement jump (CMJ) is widely used to assess performance and neuromuscular fatigue (NMF) as changes in the eccentric (EP), concentric (CP), and landing (LP) phases of the CMJ are sensitive to NMF. However, the influence of aerobic fitness (AF) and body composition (BC) in mitigating the impact of maximal aerobic exercise (MAE) on CMJ phases remains poorly understood.

Purpose

To determine the effect of maximal aerobic exercise on CMJ phase metrics and control for aerobic fitness and body composition factors.

Methods

Sample: 13 healthy adults (males=7, females=6) age=30.61±6.8yr, Ht=170.9±7.3cm, Mass=73.0±15.4kg.

1. Body composition analysis via Bodpod.

2. Pre-fatigue CMJ; 2 jumps with 15-seconds rest between.

3. Complete Wellness Fitness Initiative VO_{2max} protocol.

4. Post-fatigue CMJ; 2 jumps with 15-seconds rest between.

Statistical Analysis

Multiple ANCOVAs with Tukey post hoc tests compared non-fatigued (NFC) and fatigued (FC) conditions on EP, CP, and LP CMJ metrics, controlling for age, MAE, FM, FFM, heart rate at ventilatory threshold (HRVT), and percent VO2 at ventilatory threshold (PVT). Peak force (PF), rate of force development (RFD), peak power (PP), and impulse (IMP) were computed relative to body mass. Alpha was set to <0.05.

Results

- A significant main effect was observed for LP IMP (FC>NFC), no covariates were significant.
- No main effects were identified for PF, RFD, and PP across all CMJ phases.
- EP: significant covariate effects of MAE, FM, FFM, HRVT, and PVT on PF. MAE was a significant covariate for RFD, while FFM and PVT were significant covariates for PP. For IMP, FFM and PVT were significant covariates.
- CP: significant covariates including age and MAE on PF, PVT on RFD, and MAE on PP. CP IMP had no significant covariates.
- LP: FFM was a significant covariate for PP, and both MAE and FFM were significant covariates for RFD. Age, MAE, and FFM were significant covariates for PP.

Key Findings

1. Aerobic fitness and body composition were significant covariate on all phases of the CMJ.

2. Significant individual-level factors indicate the importance of screening individual responses to maximal exercise to identify those at greater injury risk during team sports based on CMJ metrics associated with injury.

Conclusion

Group-level changes post-MAE was evident only in LP IMP, with significant covariate effects observed on all phases of the CMJ for both AF and BC. The findings exhibit the challenges of detecting group level NMF changes, as few significant changes were observed. However, the significant individual-level factors indicate the importance of screening individual responses to maximal exercise to identify those at greater IR during TS involving MAE. Screening protocols that incorporate the measurement of pre- and post-fatigue biomechanical measures may provide insight to individual's risk of injury.

Figure 1. Distribution of CMJ Phases