

LOWER EXTREMITY POWER GENERATION STRATEGIES SPECIFIC TO TASK CONSTRAINTS

Kathleen E. Costa, J.L. McNitt-Gray, W. Mathiyakom, P. Requejo, and J. Eagle

Department of Exercise Science, University of Southern California, Los Angeles, California
Email: kcosta@usc.edu

INTRODUCTION

Previous research indicates divers performing forward and backward dives (Mathiyakom et al., 1998) and gymnasts performing landings of forward and backward rotating somersaults (McNitt-Gray et al., 1995) utilize different lower extremity mechanics to generate and control total body momentum. As with divers and gymnasts, heptathletes must successfully perform multiple events that require power generation in different directions. During the unseating phase of the shot-put and the take-off phase of the hurdle, heptathletes must generate horizontal momentum while limiting vertical momentum. During the take-off phase of the hurdle horizontal momentum must be generated in the forward direction, whereas in the unseating phase of the shot-put, horizontal momentum must be generated in the backward direction. The purpose of this investigation was to test the hypothesis that multi-event athletes distribute power generation across the lower extremity in a different manner when generating horizontal momentum in forward versus backward directions. Identification of similarities and differences in power generation mechanics between events performed by multi-event athletes is necessary for improvement in designing sport specific training regimes for multi-event athletes.

PROCEDURES

Members of the USA Women's Heptathlon team (n=4) performed a series of hurdle

take-offs (H) on a track and shot-put throws (SP) in a pit under the direction of their coach as part of a training camp. Ground reaction forces (GRF) during H and SP were quantified using a force plate mounted in the track and in the shot pit (600Hz, Kistler) and sagittal plane kinematics were simultaneously videotaped (60 fps). Kinematic and reaction force data were synchronized at force plate contact during H and at force plate departure during SP, data were processed as previously described (Costa & McNitt-Gray, 1999), and kinetic variables of the support leg were determined during the propulsion phase of each task using Newtonian mechanics. The propulsion phase was defined as the time at which all joints of the support leg were extending until ground departure. Net joint moment work (NJMW) of the ankle, knee, and hip was determined by integrating the net joint moment power (NJMP), defined as the product of net joint moment (NJM) and joint angular velocity (ω_j), during the propulsion phase. Within-subject, between-task comparisons were performed to determine differences in power generation strategies used to generate horizontal momentum in the forward and backward direction.

RESULTS AND DISCUSSION

Heptathletes demonstrated significant differences in power generation strategies when generating momentum in the forward as compared to the backward direction (Figure 1a and b). Heptathletes generated more positive NJMW at the hip when

generating momentum in the backward direction as compared to the forward direction. Differences in NJMW at the hip between tasks were attributed to greater hip extensor NJM magnitudes and longer duration of propulsion phase during the SP as compared to the H (Figure 1c). No significant differences in hip angular velocity were observed between tasks during the propulsion phase, however, hip velocity was largely created by trunk motion during the SP task and by thigh motion during the H task.

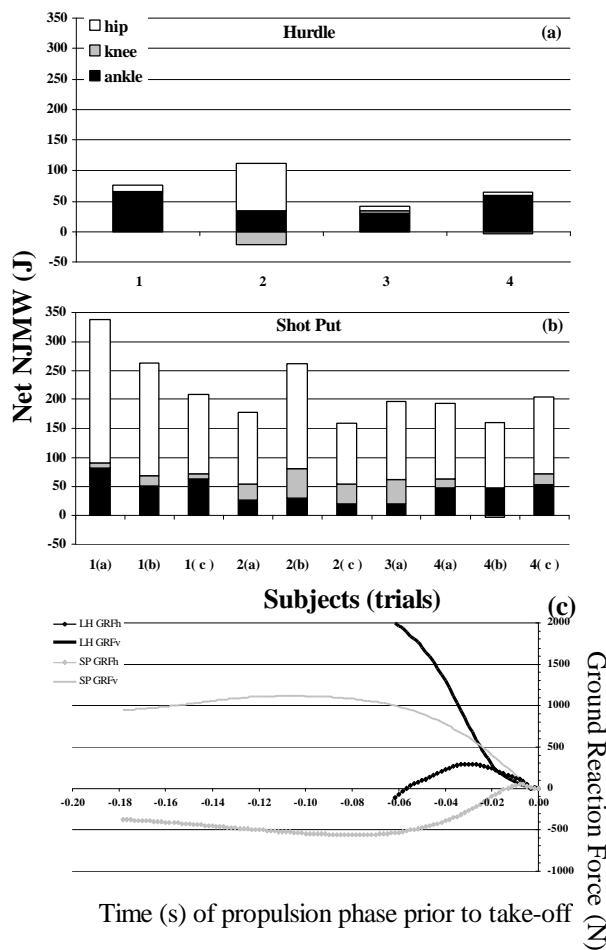


Figure 1. Net NJMW of ankle knee and hip for each subject (1-4) during propulsion phase of H (a) and SP (b), (c) vertical and horizontal GRFs during the propulsion phase of the H and SP for an exemplar subject (#4).

Although the absolute NJMW at the ankle were not significantly different between tasks, the relative contribution of the ankle NJMW to the total lower extremity work was significantly less during the SP task than the H task. The lower degree of ankle contribution to the total lower extremity work during the SP task may have been limited as a result of ankle dorsiflexion observed prior to take-off.

In conclusion, significant differences in distribution of power generation between tasks may reflect task specific differences in momentum direction, propulsion phase duration, and/or kinematic constraints imposed by the task.

REFERENCES

- Costa, K. & McNitt-Gray, J.L., (1999). *ISB '99*, 170.
 Mathiyakom, W. et al., (1998). *NACOB '98*, 439-440.
 McNitt-Gray, J.L. et al., (1995). *ASB '95*, 199-200.