INTRODUCTION

Research suggests a link between physical and cognitive development in children exists (Diamond, 2000, Krombholtz, 1997). Developmental experts believe that motor delays negatively influence future development (Gallahue, 1996). A common motor skill frequently observed in children is the vertical jump (VJ). Many VJ studies have assessed kinematic and kinetic performance variables and training techniques on adults. Several kinematic studies have assessed the vertical and horizontal jumping performance of young children. However, no kinetic studies of very young children performing a VJ have been published. The purpose of this study was to compare kinetic, performance, and temporal measures of kinetically more and less efficient 3-5 year old children performing two VJ techniques. Kinetic efficiency (KE) represented the magnitude, direction, and duration of the forward-backward Y-forces.

METHODS

Eighty-six normal 3-5 year-old children (mean age of 4.6 years old) volunteered to participate in this study. All children had their standing height, reach height, and weight measured, along with completing the locomotor subtest of a developmental screening tool (Peabody Developmental Motor Scales – 2) to determine that their locomotor skill development was comparable to their peers.

Subjects were videotaped (JVC 9800 DVL at 30 fps) performing three maximal countermovement vertical jumps with upper extremity (UE) use (CMVJ_{UE}) and three maximal jumps without UE use (CMVJ_{NoUE}) on a force plate system (AMTI sampling at 500 Hz). To facilitate maximum height jumps in the children, a balloon was suspended near the maximum jump height (Clark et al., 1989, Jensen et al., 1994) as assessed during practice trials.

VJ height was determined by digitizing the video performance of all trials. For the CMVJ_{UE}, VJ height was defined as the difference between standing reach and jump and reach heights, while the CMVJ_{NoUE} height was the difference between standing height and the top of the head at the apex of the jump. Peak net force and power, normalized per body weight, peak velocity, and the time from peak kinetic values to takeoff were obtained from the force plate data from each respective maximum jump height trial. KE was calculated as the net normalized propulsive phase Y-impulse (fore-aft) produced during the jump.

The subjects were then placed in quartiles based on the KE of their CMVJ_{NoUE}. The 1st quartile (n = 21), defined as kinetically more efficient, consisted of those jumpers with the largest negative directed KE. The 4th quartile (n = 21), defined as kinetically less efficient, consisted of those jumpers with the largest forward directed KE.
Two repeated measures MANOVA’s were run to determine if there were differences between the dependent variables, based on UE use and KE. The first R-MANOVA utilized the performance variables as the dependent variables, while the second R-MANOVA utilized the temporal measure between occurrence of peak values and takeoff as the dependent variables. Significant R-MANOVA’s were followed by R-ANOVA’s for each dependent variable, with secondary pairwise and main effect comparisons being conducted. Familywise error rates were controlled by using a Holm’s sequential Bonferroni technique to adjust the alpha levels.

RESULTS

Kinetically more efficient jumpers had a 19% higher CMVJ\textsubscript{UE} compared to their CMVJ\textsubscript{NoUE}, while less efficient jumpers jump height did not differ between jumping techniques. In addition, the more KE group’s CMVJ\textsubscript{UE} height was 30% higher than the less KE’s CMVJ\textsubscript{UE} (Figure 1).

![Figure 1: VJ height compared between UE Use and Kinetic Efficiency. Means with same subscripts are different at p < 0.025.](image)

Regarding the timing (kinetic coordination) of peak kinetic values to takeoff, the less KE took 12% longer from peak power to takeoff than the more KE jumpers (Figure 2).

![Figure 2: Time from peak power to takeoff, no difference between CMVJ\textsubscript{NoUE} and CMVJ\textsubscript{UE}, data collapsed across techniques. Significant difference between more and less efficient jumpers, p = 0.006.](image)

CONCLUSION

The results of this study indicate that when performing a VJ, those children able to efficiently control and direct their kinetic forces (more KE) were able to integrate UE use more effectively from a performance and temporal coordination perspective than the less efficient group. These findings could potentially be implemented into an instructional program designed to improve jumping and ultimately future development.

REFERENCES


