ARM AUGMENTATION OF VERTICAL JUMP PERFORMANCE IN YOUNG GIRLS AND ADULT FEMALES

A.J. Harrison and A. Moroney

Biomechanics Research Unit, College of Science, University of Limerick, Ireland

The development of vertical jumping ability is not fully understood with respect to the contribution that the arm action provides to performance. This study examined the role of the arm actions on the performance of countermovement vertical jumps. Two groups comprising ten adults females and ten six-year old girls. Ground reaction forces were obtained while subjects performed countermovement vertical jumps with and without arm actions. Jump performance was measured by determining the duration of the airborne phase. The results indicated that the arm action significantly improved performance in both adults and children and adults jumped significantly higher than children irrespective of whether arm action was used. It was concluded that children appear to be equally effective to adults in using arms to improve jumping performance.

KEY WORDS: leg spring stiffness, complex training, stretch-shortening cycle.

INTRODUCTION:

Jumping is a fundamental human movement that requires complex coordination of both upper and lower body segments. Vertical jumping is an essential component in many sports and recreational activities. When performing a maximal height vertical jump, the majority of athletes will use a countermovement jump that results in a coordinated flexion of the hips, knees and ankles and a subsequent rapid extension of these same articulations prior to take-off.

It has been shown that the use of both the countermovement and arm swing is the best condition in which to augment and enhance vertical jump performance (Feltner et al., 1999; Harman et al., 1990; Khalid et al., 1989; Oddson, 1989; Payne et al., 1968). The vertical jump performance can be enhanced in two ways: the arm swing and the Stretch-Shortening Cycle (SSC). There is also some interaction whereby the arm swing may enhance the SSC effect. Many studies on adult subjects have indicated that the arm action in the vertical jump enhances the performance, (Feltner et al., 1999; Harman et al., 1990; Luthanen and Komi., 1978; Shibayama et al., 2006). Such studies have demonstrated that jump height can be increased by increasing the height and the velocity of the body's centre of gravity at take-off. Lees et al. (2004), found that subjects jumped higher by .086m compared to the no arm condition. This was due to an increased height (28%) and velocity (72%) of the centre of mass at take off. The increased height at take-off resulted from a complex series of events, which allowed the arms to build up energy early in the jump and transfer it to the rest of the body during the later stages of the jump. Similarly Ashby et al. (2002) while examining the standing long jump, found comparable results. 71% of the increase in the performance of the jump was attributable to the use of the arm swing.

Despite the importance of the arm action to vertical jump performance, very few studies to date have examined the effect of the maturation on the performance of the vertical jump. Harrison and Gaffney (2001) found that six year old children could utilise the SSC in vertical jumping equally well compared to adults. This result was in contrast to Bosco and Komi (1980) who concluded that adults were more effective than children in using the SSC. It is clear that considerable change takes place in locomotion kinematics and kinetics as a function of age (Cech and Martin, 1995; Gabbard, 1992). The aim of this investigation was to evaluate the effect of age on the contribution that the arm action provides in the performance of a countermovement vertical jump. Since comparative studies of children and adults provide the opportunity to maximise the period of development and therefore identify greatest changes in the dependent variables, this investigation compared the performances of children and adults in countermovement vertical jumps in both with and without arm conditions.

METHODS:

Twenty subjects participated in this investigation. This consisted of ten adult females and ten girls from year 2 of primary school (approximately aged 6 to 7 years). The children were selected at this age because this is the minimum age that accurate measures in strength related activities can be obtained (Jones and Round,1990). The study had obtained ethical approval from the University research ethics committee. Written informed consent was obtained from all adult subjects and the parents of children prior to their participation in the study.

Table 1: Physical Characteristics of the Subjects.

Group	Age	Mass (kg)
Women	22.1 ± 1.2	63.0 ± 2.0
Girls	6.6 ± 0.52	21.0 ± 3.0

Procedures: All subjects were required to perform maximum effort countermovement vertical jumps under two conditions, with arm action and without arm action. During the without arms condition, subjects were asked to place their hands on their waist. Five jumping trials were performed in each condition. All jumps were performed from an AMTI Force platform (model ORL 6) sampling ground reaction forces at 1000 Hz. The vertical ground reaction forces (Fy) were inspected and the airborne period of the jump was determined by identifying the period where $Fy = 0 \pm 4$ N. This threshold was chosen because in an unloaded condition the force platform readings will fluctuate within a maximum range of ±4 N. Flight height (FT) was determined using the equation: $FT = 4.905 \times T^2$: where T = flight time/2.

Statistical Analysis: All statistical analysis was conducted using a software package (SPSS for Windows, Release 11.0.1). Since the type of data in this investigation was ratio type and the general assumptions for homogeneity of variance and normality were not violated, it was appropriate to use parametric statistics. A GLM ANOVA with repeated measures was used to determine significant differences in performances between groups and conditions. The GLM ANOVA had 1 between-subjects factor, namely, Age with two levels, adult and child and two within-subjects factors; Jumptype with two levels, namely, arms and without-arms and trial with 5 levels. The ANOVA model also included the interaction term Jumptype × Age.

RESULTS:

The mean FT scores for children and adults in arms and without-arms conditions are shown in figure 1. The GLM ANOVA revealed a within-subject main effect for jumping condition ($p=0.001$). In all cases the assumptions for homogeneity of variance and for sphericity were not violated. The data showed that both groups recorded flight heights 9.7% higher in the with-arm action condition for children and 7.5% higher in the with arm action condition for adults. The ANOVA also found significant between-subjects main effects for Age ($p=0.035$). The interaction effect Jumptype x Age was not significant ($p>0.05$). These data indicate that adults jumped higher than children but the contribution of the arms to performance was relatively similar in both children and adults.

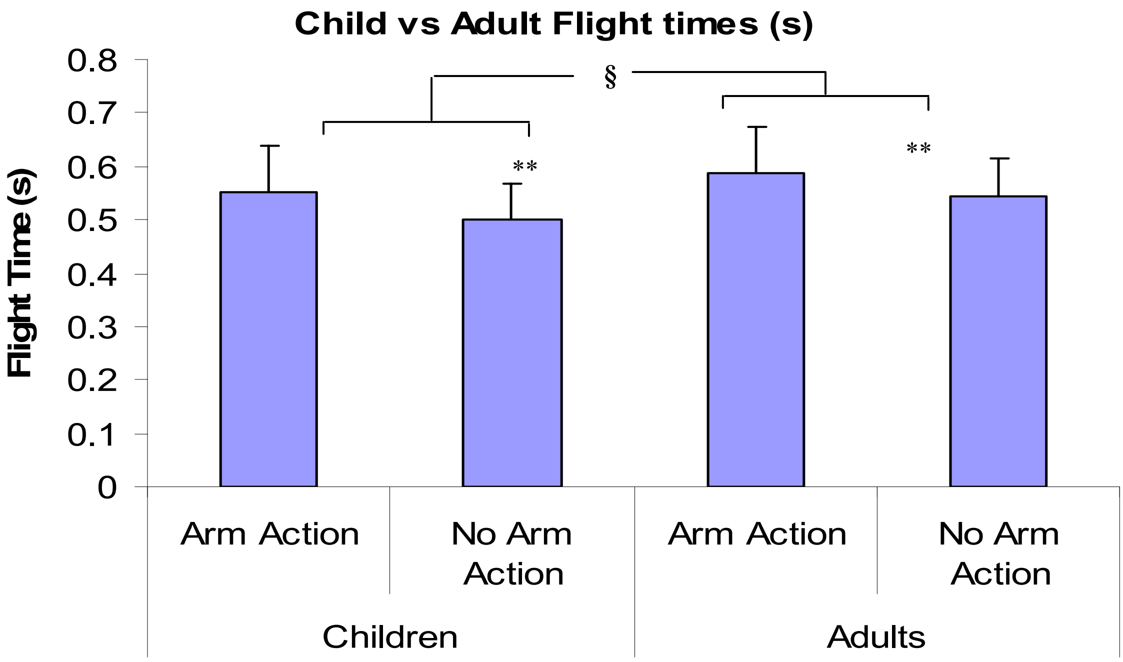

Figure 1: Mean ± 95% confidence interval for flight times in children and adults in both conditions. ** denotes significant difference arm action and no arm action conditions (p<0.001). § denotes significant difference between Children and Adults (p <0.05).

DISCUSSION:

The results of this study show that children and adults used the arm action to improve vertical jump performance as determined by the flight time of the jump. It appears that girls aged six are approximately equally capable to adult females in using the arms to improve performance. These data suggest that the coordination and control of the arm action in six-year old girls are generally similar to the adult form. Improvements in performance of the jump may be due more to differences in body stature and muscle strength and power rather than coordination and control. The analysis techniques used in this investigation focused only on the effects that arm action had on the jumping performance in relation to flight time. It is assumed that flight distance can be reliably estimated from flight time in all cases. This in turn assumes that the position of the centre of mass at the instant of take-off is the same as at the instant of landing. The contribution of the arm in elevating the centre of mass at the instant of take-off was not investigated. It is reasonable to assume that the arm position at the instant of take-off can influence the position of the centre of mass. Therefore, it is not known whether the influence of arm action on centre of mass position at take-off is affected by the development process. Further study to determine the arm action differences between children and adults could be carried out using integration of force-time records.

CONCLUSION:

This study showed that arm action in jumping will increase performance in countermovement vertical jumping. The increases in performance due to arm action are similar in six year old girls and adult females. These data suggest that the coordination and control of vertical jumping performance with respect to arm action will have reached a mature level by the age of six years.

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