KINEMATIC ANALYSIS OF THE RUN UP FINAL STRIDE AND TAKE-OFF TECHNIQUE IN CHINESE FEMALE FOSBURY FLOP JUMPERS

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INTRODUCTION: The flop high-jump technique consists of a run up, take-off, flight and landing. Among these four phases, the take-off is the key to performance. The path that a jumper's center of gravity (CG) follows during flight is determined by the height of center of gravity before take-off, velocity that the athlete is propelled upward at take-off, and take-off angle. The run up will influence take-off technique and body movement in flight. Therefore, the final stride of the run up is the transitional phases connecting the run up and take-off. The purpose of this study was analyzed and estimated the final stride of the run up and kinematics of take-off technique used by Chinese female jumpers.

METHODS: Seventeen elite Chinese female jumpers (all used left leg take-off) were used as subjects. Two cameras operated at 50 Hz to record each subject's technique during a competition. AIJIE Video Analysis System was used to digitize the video records. The DLT method for 3-D space reconstruction from 2-D images was used. All digitized coordinates were filtered using a low-pass digital filter with a 10 Hz cutoff.

RESULT AND DISCUSSION: Base on the kinematic character of technique, the final stride of the run up and take-off technique can be divided into phases by six events: instant of free leg touchdown (FT), free leg maximum flexion (FF), free leg leaves the ground (FL), take-off leg touchdown (TT), take-off leg maximum flexion (TF) and take-off leg leaves ground (TL).
From the instant of FF to FL, the angular range and velocity of the right knee and right ankle showed significant difference ($p < 0.001$) among subjects. At the instant the free leg leaves the ground, the average of right knee angle was 144.3°, left hip angle was 134.9°, and forward trunk tilt was 84.7°. It shows that the right leg of subjects had not fully extended and the swing height of the take-off leg was not enough. It suggests that the anterior muscles of the take-off leg did not contract fast enough during the next motion.
From FL to TT, the length of the final stride of the Chinese subjects was 1.53 m while the international elite female high jumpers was 1.83 m, step length/body height was 86.6% and 103.2%, respectively. This difference was significant ($p < 0.001$). It suggests that the length of the final strides of the Chinese jumpers were shorter than those of the international jumpers. Thus, the center of gravity of the Chinese jumpers moved a shorter distance through flight and resulted in a shorter flight time, which resulted in a reduction of the vertical velocity of the CG at take-off.
From TF to TL, the angular velocity of lateral trunk tilt of the Chinese subjects averaged 86.7°/s. It was significant different ($p < 0.001$) than the international elite jumpers whose average angular velocity was 129.6°/s. This suggests that the vertical velocity of internal trunk tilt of Chinese female high jumpers were lower than international elite female high jumpers.

CONCLUSION: Horizontal velocity of CG of the Chinese jumpers was smaller than those of the international elite jumpers through FT to FF. The range of knee extension was insufficient in the Chinese jumpers. However, the Chinese jumpers' techniques from FL to TT were superior to international elite players since the length of the final stride of Chinese jumpers was shorter than international jumpers. The average vertical velocity of CG of the Chinese jumpers was smaller. The heights of their CG and the angular velocity of internal trunk tilt at the instant of take-off leg leaves the grounds were small than international elite jumpers.

These factors will affect the distance between CG and bar when jumpers reach their highest point.

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