HURDLE JUMPING TECHNIQUE CHARACTERISTICS IN THE 110 METER RACE IN THE 1997 WORLD TRACK AND FIELD CHAMPIONSHIP

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INTRODUCTION AND PURPOSE: Hurdle jumping technique and running technique between hurdles have been the subject of previous research (Tsarouchas, Papadopoulos, Kalamaras & Giavroglou, 1993; Salo, Pettola & Viitasalo, 1993; Papadopoulos, 1990; Mann & Herman, 1985; Mann, 1985; Schlüter, 1981). Tsarouchas et al. (1993) suggested that physiological and biological parameters most definitely determine the ability of the athlete to develop maximum speed between each successive hurdle. They also suggested that running technique, particularly the frequency of running cycles and events in the preparatory hurdle jumping phase, most likely generate the optimum conditions for hurdle jumping technique. Among hurdle jumping technique factors, takeoff and landing angles, maximum center of mass (CM) height above the hurdle, and flight time were deemed important determinants of optimum hurdle jumping (Papadopoulos, 1990; Mann, 1985; Schlüter, 1981). This study attempted to quantify the hurdle jumping technique characteristics of the gold and silver medallists in the 110 meter hurdle race in the 1997 world track and field championship.

METHODS: The performance of the gold and silver medallists over the fourth hurdle in the 1997 world track and field championship was recorded with two 60 Hz Videocameras. It was analyzed utilizing an Ariel Performance Analysis System (APAS). Three-dimensional position data of 14 body points (feet, ankles, knees, hips, shoulders, elbows, and wrists) and a point on the horizontal bar of the hurdle were calculated by combining the video images of the two cameras utilizing the direct linear transformation (DLT) method (Abdel-Aziz & Karara, 1971). The raw data was digitally smoothed with a cut-off frequency of 5 Hz before being submitted to further analysis. Dempster's (1955) data as presented by Plagenhoef (1971) was utilized to predict the segmental and total body anthropometric parameters necessary to solve the mechanical equations. Variables examined were: 1) maximum height of the center of mass (CM) over the hurdle (H_{max}); 2) flight time over the hurdle (t_{flight}); 3) CM velocity takeoff angle (f_{toff}); and 4) landing angle (f_{land})—angle of the line connecting the CM to contact point on the ground.

RESULTS AND DISCUSSION: Table 1 presents temporal results and horizontal takeoff and landing distances. As is shown, the flight duration and pre-and post-hurdle horizontal distances were less for the gold medallist. Table 2 shows that horizontal takeoff velocities were identical (8.7 m/s) for both athletes. The higher vertical takeoff velocity of the gold medallist (1.98 vs. 1.81 m/s for the gold/silver medallists, respectively) resulted in larger CM height above the hurdle (0.42 vs.

0.36 m for gold/silver medallist, respectively). Landing angle results showed the gold medallist's CM to be directly above the landing foot, whereas the CM of the silver medallist was behind (90 vs. 85 degrees for the gold/silver medallists, respectively; Table 2). This indicates no loss of horizontal velocity in landing for the

Table 1
Horizontal Jump Lengths and Temporal Results

Variable	Gold Medallist	Silver Medallist
Total time (sec)	12.93	13.05
Flight time (sec)	0.35	0.37
Horizontal distance to hurdle from takeoff (m)	2.24	2.32
Horizontal distance from the hurdle at landing (m)	1.65	1.79

winner, but some loss due to opposing frictional forces for the second place athlete. Since both athletes landed with the lower extremity almost fully extended, the difference in landing angles may explain the shorter flight duration of the gold medallist (0.35 vs. 0.37 sec for the silver medallist) in spite of greater takeoff velocity. Landing with the CM directly above (or in front) of the landing foot indicates superior (and highly sophisticated) jumping technique which requires active hip joint extension in flight—equivalent to "throwing" the leading extremity downward/backward while the CM continues its parabolic trajectory. In a previous study of the performance of the gold, silver and 8th place athletes in the 100 meter

Table 2
Takeoff Velocities, CM Vertical Position, and Takeoff and Landing Angles

Variable	Gold Medallist	Silver Medallist
Takeoff Horizontal Velocity (m/s)	8.70	8.70
Takeoff Vertical Velocity (m/s)	1.98	1.81
CM Height above ground at takeoff (m)	1.29	1.26
CM maximum height above hurdle (m)	0.42	0.36
Takeoff angle (deg)	13.0	12.0
Landing angle (deg)	90.0	85.0

hurdle race in the 1984 Olympics, similar trends were found in flight time and hurdle stride lengths, but not in vertical takeoff velocities (Mann & Herman, 1985). The small difference in final time between the gold and silver medallists (0.12 sec) could very well have been the result of the superior technique of the gold medallist in terms of shorter flight duration over the hurdle, and/or no loss of horizontal velocity in landing due to his ability to land with his CM over his support foot, which diminished or eliminated opposing frictional forces.

CONCLUSION: Based on the limited results of this study and the athletes' final times (12.93, 13.05 seconds for the gold and silver medallists, respectively), it can be speculated that certain hurdle jumping technique characteristics (i.e., t_{flight} and f_{land}) may be more important than others (i.e., H_{max} and f_{toff}). Further study using more subjects and analysis of hurdle jumping technique over multiple hurdles is recommended.

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