KINEMATIC ANALYSIS OF HURDLE CLEARANCE OF 60-M HURDLES IN ELITE HURDLE SPRINTERS DURING WORLD INDOOR CHAMPIONSHIPS 2010

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INTRODUCTION: Previous studies have examined the biomechanical variables of sprint hurdling of world-class athletes (Mero, & Luhtanen, 1986; McDonald, & Dapena, 1991). However, less is known about the factors that differentiate the performance among elite hurdle sprinters. Salo, Grimshaw, & Marar, (1997) compared international and national/county level female hurdlers and found that better hurdlers use greater take-off distance, which enables lower take-off angle and greater horizontal take-off velocity. Our previous analysis between international level hurdlers and decathletes revealed an opposite pattern of greater take-off distance for decathletes than for hurdlers (Kuitunen, Palazzi, Poon, & Peltola, 2007). The present study aims to examine the possible differences in hurdle clearance between different level of elite hurdle sprinters.

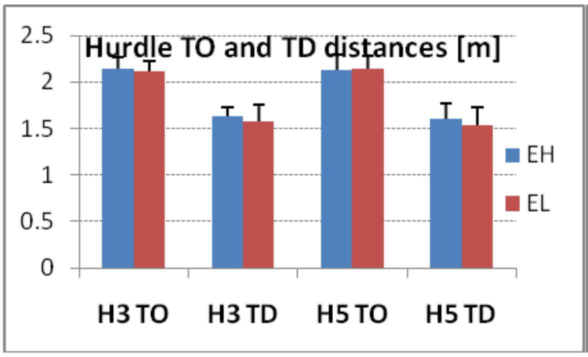
METHOD: Data was collected during the 13th World Indoor Championships in Athletics (March 12-14, 2010, Doha, Qatar). Semifinals and final of the men's 60-m hurdle races were recorded with four video cameras. Two panning high speed cameras (300 frames/sec) were placed above the spectator stands adjacent to 3rd (H3) and 5th (H5) hurdles for analyzing the take-off (TO, the instant of foot leaving the ground before the hurdle) and touchdown (TD, the instant of foot touching the ground after the hurdle) moments to each hurdle. Footages from the both cameras were synchronized by the starting gun light signal. In addition, two stationary video cameras (50 fps) were set perpendicular to the track at H3 and H5 for analyzing the TO and TD distances to the hurdle.
The hurdle sprinters (n=22) were divided into two groups according to their race performance: elite high group (EH; <7.7s) (n=10) and elite low group (EL; >7.7s) (n=12). The fastest race for each athlete was selected for analysis. Intermediate and interval times between the hurdles (between two consecutive TDs) and hurdle clearance times (from TO to TD) were calculated from the high speed video data and the TO and TD distances (distance from the tip of the shoe to the hurdle at the TO and TD, respectively) were determined from the footage of stationary cameras. Hurdle clearance velocity was determined by dividing the total hurdle clearance distance (TO distance + TD distance) by the hurdle clearance time. Known track marks were used as calibration for distance measures. Official results and reaction times were provided by Seiko (official timing for IAAF). T-test for independent samples was used to compare the differences between the groups and P<.05 was set at the level of significance. Data is presented as group means (± SD).

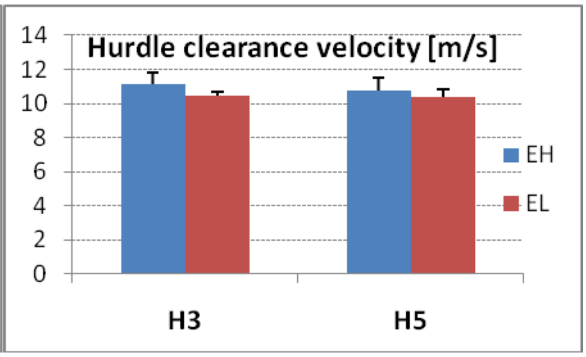
RESULTS: The mean race results for EG and IG were 7.55±0.13 and 7.82±0.06s (P<.001), respectively. The EG athletes demonstrated significantly faster reaction times (0.155±0.018 vs. 0.189±0.031s, P<.01) as well as intermediate and interval times as compared to the IG athletes (P<.05 - .001) (Table 1).
No differences were found in the hurdle clearance times between the groups (EG 0.35±0.03 vs. IG 0.36±0.02s). However, it showed a significant correlation to race result within the entire subject pool (r=.63, P<.01). The TO and TD distances were neither significantly different between the groups, although the EG showed a trend for slightly greater TD distance (1.63±0.10 vs. 1.58±0.17m for H3 and 1.61±0.16 vs. 1.53±0.20m for H5, respectively) (Fig. 1). On the other hand, EG demonstrated greater hurdle clearance velocity than IG for H3 (11.12±0.66 vs. 10.44±0.25 m•s^{-1}, P<.01) (Fig. 2). The hurdle clearance velocity was also found to correlate significantly with the race result (r=-.80, P<.001 for H3 and r=-.61, P<.01 for H5).

Table 1. Time analysis for 60m hurdle races for the two athlete groups.

Group	Time [s]	H1	H2	H3	H4	H5	Result
EH	Intermediate	2.58[2]	3.63[2]	4.64[3]	5.65[3]	6.67[3]	7.55[3]
	Hurdle	0.35	0.35	0.34	0.34	0.35	
	Interval		1.05[1]	1.02[3]	1.01[3]	1.02[1]	0.87[3]
EL	Intermediate	2.66	3.73	4.79	5.84	6.90	7.82
	Hurdle	0.37	0.36	0.35	0.35	0.35	
	Interval		1.07	1.06	1.05	1.05	0.92

[1,2,3] $P<.05$, $P<.01$, $P<.001$, significantly different between the groups





Figures 1 (left) and 2 (right). Take-off (TO) and touchdown (TD) distances to the hurdle (left) and hurdle clearance velocity (right) for the hurdles 3 (H3) and 5 (H5) for the elite high (EH) and elite low (EL) groups.

DISCUSSION: The present findings suggest that neither hurdle clearance time nor TO and TD distances to the hurdle differ between top level hurdle sprinters. This is different from the previous studies using hurdle sprinters of lower performance level (Kuitunen, Palazzi, Poon, & Peltola, 2007; Salo, Grimshaw, & Marar, 1997). Most likely the differences in hurdling performance among elite hurdle sprinters are fairly small as indicated by the present data. However, hurdle clearance velocity seems to play a role in differentiating the race performance among elite hurdle sprinters. This emphasizes the importance of achieving high horizontal velocity in between the hurdles and maintaining it during the hurdle clearance (Salo, Grimshaw, & Marar, 1997).

CONCLUSION: Differences in hurdle clearance are very small among world-class hurdle sprinters and the main difference is likely related to achieving and maintaining high horizontal velocity for the hurdle clearance.

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